Understanding the transition towards sustainable product-service systems for personal mobility. A study of electric vehicle sharing schemes in China's Yangtze River Delta Economic Zone.

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Abstract

Recent research on sustainable city-based mobility has often applied the use of socio-technical transition theory to understand how mobility provision is evolving. Such studies may consider changes evolving from market niches but have tended to overlook the role of individual firms. This study integrates individual firm-level perspectives to study the shift towards more sustainable city-based mobility paradigms using transition theory, by exploring the innovations in business models within the sector. This research aims to understand the transition towards more sustainable product-service systems (i.e., car-sharing services) by service providers of personal mobility in China, by exploring how the business models of electric vehicle-sharing services (EVSS) are influenced by market stakeholders and other factors.

This thesis uses a qualitative approach involving a multi-site network-based case study research designed to understand this complex issue. Online interviews were employed, and respondents included ten EVSS provider managers, twenty-six EVSS actual or potential users, ten managers from ‘call-hailing’ service providers and seven policy stakeholders (officers of heads of government departments). This research introduces the concept of a 'business model ecosystem', a network of interdependent business models and technologies from sectors including energy, insurance, and ICT that determine EVSS providers' success.

From its findings this thesis presents a conceptual model integrating transition theory and business model ecosystems in the context of mobility service provision, visualising the multi-layered dynamics involved in EVSS schemes. Beyond offering a holistic view of the EVSS market, this model provides valuable insights to inform strategic planning for a sustainable urban mobility transition.

The findings underscore the importance of understanding the interplay among individual firms, stakeholder collaborations, and multi-sector influences, emphasising the role of localised ecosystems and interconnected regimes in driving sustainability transitions. These insights contribute to the broader discourse on sustainable urban mobility and offer practical implications for policymakers and EVSS providers.

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"Like a mayfly in the universe, a grain amidst the vast ocean." Standing in the picturesque campus of Cardiff University, I often marvel at my own insignificance. Time turns into a song, as it passes by like a blooming flower. Standing in the currents of time, I often feel the vastness of the years, yet the boundlessness of endeavour. There are many crossroads in life, and choices often lie in a moment of thought. The Cardiff University Business School is one of the most important choices in my life, allowing me to shift from the automotive industry towards the academic field, and it would not have been possible without the support and guidance I received from numerous people. I express my deepest gratitude to everyone who made this journey easier.

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List of acronyms & abbreviations

AI	Artificial Intelligence
AV	Autonomous vehicle
BMC	Business Model Canvas
BMI	Business model innovation
BMM	Business models for mobility
B-Side	Business-side
B2B	Business to business
B2C	Business to consumer
CE	Circular economy
CNY	Chinese Yuan
C-Side	Consumer-side
DSP	Dominant Social Paradigm
EIPRO	European Environmental Impact of Products
E-mobility	Electric mobility
eMaaS	Electric mobility-as-a-service
EV	Electric vehicle
EVSS	Electric vehicle sharing service
ICT	Information and communications technology
IE	Industrial ecology
IM	Industrial metabolism
LCA	Lifecycle assessment
LCEV	Light city EV
MaaS	Mobility-as-a-service
MFA	Material flow analysis
MLP	Multi-level perspective

NEP	New Environmental Paradigm
NECP	New Ecological Paradigm
NEV	New energy vehicle
OEM	Original equipment manufacturer
PAV	Private autonomous vehicles
PSS	Product-service systems
SAV	Shared autonomous vehicle
SBM	Sustainable business model
BMIfS	Business model innovation for sustainability
SC	Social constructionism
SCP	Sustaincentric Paradigm
SEV	Sharing electric vehicle
SI	Service innovation
SOSI	Sustainability-oriented service innovation
SPCS	Sustainable production-consumption systems
TT	Technological transitions
UAM	Urban air mobility
VCP	Verified content provider
YRDEZ	Yangtze River Delta Economic Zone

Chapter 1. Introduction and background

1.1 Research background

Over the past three decades, China's economy has boomed, with an average growth rate of 6.4% (Shane 2019). China has also urbanised rapidly, reaching a 57% urbanisation level in 2016 (Reike et al. 2018), rising to 65.2% in 2022 (National Bureau of Statistics of China 2023). Such strides are part of a development process in which China has become known as the "industrial workshop of the world", has become the world's largest recipient of foreign direct investment (Mathews et al. 2011), and has accrued the largest middle-class population of approximately 400 million since 2015 (Zhou 2018). Such growth has been acknowledged as important in reducing rates of extreme poverty (Liu et al. 2023), lifting approximately 123.3 million people out of poverty from 2012 to 2021 (Zuo et al. 2023). However, it has also led to increasing concern within the Chinese government about a range of environmental impacts due to the inherent unsustainability of such growth using existing technologies and business models (Mathews et al. 2011). Both existing growth levels, and the opportunities to change the environmental impacts of China's economy, relate to Chinese citizens' willingness to embrace new technologies and business models. For example, with over 40% of global e-commerce transactions (Jiang and Murmann 2022), China represents the world's biggest e-commerce market, with its mobile payments accounting for over 10 times the value in America (Jiang and Murmann 2022).

The expansion of urban populations across the globe has created a multitude of challenges, including housing and feeding them and meeting their mobility needs. In China, with a population of 1.4 billion (National Bureau of Statistics of China 2023), these challenges are important. Accelerated urbanisation has culminated in over 900 million individuals residing in cities, resulting in 372 million vehicles traversing the roads by 2020 (Luo et al. 2022). As the largest contributor to global CO2 emissions, with 10.17 billion metric tons in 2019, China's approach to urban mobility may affect global efforts to mitigate climate change (Chen et al. 2021; Xiao et al. 2023). Thus, how China meets the mobility needs of its citizens in the coming decades is a question whose answer may impact the entire planet's population.

The decision to study this topic was driven by an interest in the substantial impact that China's urban mobility policies and practices can have, combined with a concern for sustainability studies, and coupled with the authors' working background in the automotive industry, regional experience, and awareness of the unique challenges faced by the rapidly urbanising Chinese society. As a developing nation with a vast population and increasing urbanisation, China serves as an important context for understanding the potential influence of sustainable mobility solutions at both local and international scales. Additionally, the insights garnered from this research may be valuable in informing policy decisions and guiding the establishment of more sustainable transportation systems in other countries facing similar challenges. By examining the potential of electric vehicle sharing services (EVSS) to contribute to the revolutionisation of urban transportation in China, this research aims to contribute to the global effort towards creating more sustainable, equitable, and efficient urban mobility systems while simultaneously addressing the urgency of the global climate crisis.

The purpose of this research is to understand the transition towards more sustainable product-service systems (i.e., car sharing services) by service providers of personal mobility in China through exploring how business models influence stakeholders' acceptance of EVSS (thereby exploring how sustainable business models can evolve beyond a niche market). Developing such an understanding will present a valuable opportunity to contribute to the global pursuit of sustainable urban mobility, reduced carbon emissions, and improved quality of life in urban environments.

1.2 Sustainability challenges

The development paradigm that dominated in the 20th Century was fundamentally unsustainable (Altieri 1989). The environment was mostly treated as though the earth's resources could be exploited indefinitely (Bithas and Christofakis 2006; Hopwood et al. 2005), with an assumption that human skills and knowledge could overcome all the challenges resulting from the over-exploitation of nature and the environment (Dryzek 2005). This techno-optimistic view relies on technology innovation and the ability to substitute between different forms of capital to address sustainability challenges. However, other scholars recognise that natural resources need to be more sustainably managed and used to ensure future generations can continue to benefit from them (Dryzek 1997; Hopwood et al. 2005).

Economics has tended to predominate in discussions of human development and its interaction with the physical environment, because the generation of economic growth was treated as crucial to fund improvements in human health, reduce the degree of poverty and facilitate social progress which could contribute to human well-being (Douthwaite 2012; Hopwood et al. 2005).

Table 1.1 shows some of the key challenges of sustainability, particularly in relation to economic development. Resource depletion, resulting from the overconsumption of natural resources, together with inequitable distribution of the costs and benefits of economic activity, poses a significant risk to both ecosystem health and human well-being. As economies evolve and grow, the demand for resources escalates, intensifying the pressure on finite resources and potentially jeopardizing the long-term stability of ecosystems. Furthermore, economic development processes often result in environmental degradation, as industrial production and urbanisation give rise to pollution, climate change, and habitat destruction. These environmental repercussions not only impinge on human health and wellbeing but also on the biodiversity underpinning the planet's ecological equilibrium. Consequently, it is considered to be of paramount importance to devise sustainable economic models that meticulously consider the complex interdependencies between economic growth and environmental preservation (Gladwin et al. 1995; Junnila et al. 2018). This approach can help to ensure that development is attained without compromising the integrity of ecosystems or the well-being of future generations (Junnila et al. 2018).

Table 1.1 Key challenges and descriptions in the context of sustainable development (Developed by the author).

Key Challenges	Description	Sources
Resource depletion	The extraction of natural resources for economic growth can deplete non-renewable resources, jeopardizing ecosystems.	(Long and Ji 2019)
Environmental degradation	Economic activities can lead to pollution, deforestation, and land degradation, undermining resilience, and human health.	(Junnila et al. 2018)
Inequality	An overemphasis on growth can exacerbate income disparities and perpetuate social inequalities, impeding broader social advancement.	(Meng et al. 2020)
Over consumption	Promotion of consumerism as a driver of growth can lead to unsustainable consumption, generating waste and social/environmental harm.	(Del Pero et al. 2021; Glotz-Richter 2016)
Short-termism	Economic policies that prioritise short-term profits may discourage investments in measures of long-term sustainability.	(Fernandes et al. 2021)

1.3 Sustainability in the Chinese context

China is an important country for the prospects for global sustainability due to its status as (until 2023) the world's most populous nation, as the second largest economy which is forecasted to become the largest in the 2030s (Liang et al. 2023), and as the country with the third largest land mass. China faces a number of environmental crises linked to factors including contaminated land, soil erosion, water shortages and species loss (Liu and Raven 2010). Amongst the environment impacts, air pollution and air quality are particularly serious, with problems including growing greenhouse gas emissions and their contribution to global warming and inhalable particulate matter and its impact on health. Urban air quality is a concern given that China's air quality is ranked 120 out of 180 countries in 2018 (Yu and Morotomi 2022).

China's rapid economic growth has depended on intensive consumption of energy, particularly fossil fuels; with China being the largest coal consumer, and second largest importer of petroleum products (Walls 2009). With such over-consumption, China has been producing the largest amount of carbon dioxide (CO_2) emissions, exceeding the US since 2006, as well as being the third largest producer of SO_2 emissions (Yan and Crookes 2010). An estimated 623 million tonnes of CO_2 emissions can be ascribed to the mobility sector, accounting for roughly 7.5% of the total emissions in the country (Mathews et al. 2011; Reike et al. 2018). The trajectory of such emissions is predicted to increase due to a growing middle-class population and expanding urbanisation resulting from continuous economic growth, with the Chinese targeting a rate of 6.5%-7.0% (He et al. 2018a).

Recently, the Covid-19 pandemic significantly impacted China's economic growth trend (Ahmad et al. 2020; Zreik 2023). In 2020, although China was the sole major global economy with a positive gross domestic product (GDP) growth rate of 2.3%, this is still a decline from the 6% growth experienced in 2019 (Mustafa et al. 2021; Zhang et al. 2020). During the initial three months of 2020, China suffered a severe time of pandemic and the country's GDP experienced a year-on-year decline of 6.8% (Zhang et al. 2020). Several stringent pandemic prevention and control measures, including city-wide lockdowns, regional quarantines, and import-export restrictions, negatively impacted the overall economic operational environment (Jiang et al. 2022). In the period following the epidemic, the primary objective for the macro economy is to focus on economic revitalisation (Jiang et al. 2022). The International Monetary Fund (IMF) projects that the worldwide economy will grow by 3.0% in 2023, followed by a 3.3% decrease in 2024, while China's GDP rates are expected to be 5.0% in 2023 and 4.2 % in 2024 (International Monetary Fund 2023).

In terms of air pollution as a consequence of economic activity and growth, government action has brought some successes, for example sulphur dioxide emissions (which have been shown to cause acid rain and respiratory diseases) have been improved through the compulsory installation of flue gas desulphurisation systems and have been in decline since 2005 (Wang and Hao 2012). There has also been growing concern about inhalable PM2.5 particulate matter which comprises solid or liquid matter whose particles' aerodynamic diameters are less than 2.5 micrometres (Cao et al. 2013). Such particulate matter is detrimental to human health through a radiative aerosol effect which undermines cardiovascular function by accumulating micro particles inside the lungs (Polichetti et al. 2009). Since 2008, China's state council has pursued PM2.5 reduction through national ambient air quality standards (Cao et al. 2013) with all Chinese cities being required to *"Attain concentrations below 35 $\mu g/m^3$ annual arithmetic average and < 75 $\mu g/m^3$ for 24-hr periods."* (Cao et al. 2013, p.1197). Additionally, the concentration of particulate matter impairs visibility and can cause traffic accidents and impair quality of life. In summary, the emission of air pollutants adds to China's environmental problems and is the source of the increasing amount of reported cardiovascular diseases as well as other public health problems (Wang and Hao 2012).

1.4 Circular economy (CE) in China

Rapid economic growth and urban expansion in China have been achieved at the expense of resource depletion and environmental deterioration (Mathews et al. 2011). This has prompted policy makers to explore innovative ways to reconcile population growth, urbanisation, consumer expectations and environmental imperatives. An emerging approach to generating more sustainable production systems and consumption habits is that of the Circular Economy (CE), which can be defined as an operationalisation of the concept of "sustainable development", which aims to simultaneously achieve improved environmental quality, economic prosperity and social benefits (Kirchherr et al. 2017; MacArthur 2016). While traditional industrialised economies operate on a linear 'take-make-use-dispose' model (Chen et al. 2016a; Sariatli 2017), CE initiatives take their inspiration from nature to create more closed systems in which resources circulate and are reused (Lovins et al. 2005).

Given continued growth in the Chinese population and pressure to achieve better material living standards, it is unsurprising that the Chinese government have adopted CE as a key development model (Mathews et al. 2011). Early discussions amongst Chinese scholars proposing the circular economy as a potential development model in the 1990s (Dajian 2008) led to China becoming the first country to promote CE as an official development strategy (Zhu 2008), when the Circular Economy Promotion Law was adopted and discussed during the 11th Chinese People's Congress in 2008 (Mathews et al. 2011).

Although a single broad consensus definition of CE has not yet been achieved (McDowall et al. 2017; Yuan et al. 2008), the roots of the CE concept lie in the work in the 1970s by Meadows et al., who used the World3 computer model to explore the interactions between human activity and the earth's systems, and published their thesis on "Limits to Growth" in 1972 (Meadows et al. 1972). This highlighted the finite nature of key resources for industrial development and led to principles promoting material circularity beginning with the 3Rs principle: "reduce, reuse, recycle", which were extended to the 6Rs principle: "reuse, recycle, redesign, remanufacture, reduce and recover", to replace conventional linear models with an "end-of-life" for materials (Mathews et al. 2011; Winans et al. 2017). CE recommends an approach that decouples economic development from a dependence on the unsustainable exploitation of resources (Mathews et al. 2011; Stahel 2016) and is central to sustainable development through reducing production-consumption system material inputs, emission outputs, energy over-consumption and waste by adopting the 3 (or 6) Rs (Korhonen et al. 2018).

CE operates at different levels: the first – micro level – may be related to individual consumers, companies and products; the second – meso level – may relate to eco-industrial parks, supply chain strategies or city-wide initiatives (McDowall et al. 2017; Petit-Boix and Leipold 2018; Yuan et al. 2008); while the last – macro level – concerns nations and their policies. CE builds on three principles: waste and pollution reduction by product design; extension of product durability and length of life; and favouring the use of renewable resources (MacArthur 2016; Mathews et al. 2011). In China, the concept of CE having been raised by scholars in the 1990s (McDowall et al. 2017; Mathews et al. 2011) was translated into the policy agenda when China first proposed the concept of CE at the Members' Assembly of the Second Global Environment Facility in 2002 (Mathews et al. 2011). Since 2006, each of the successive Five-Year Plans have witnessed the inclusion of a policy to aid China in its transition to CE. The 11th Five-Year Plan (from 2006 to 2010) states explicitly the strategic importance of CE development. The

Circular Economy Promotion Law was published In 2008 – the world's first legislation explicitly promoting CE – and focused on the 3R principle. The 12th Five-Year Plan (from 2011 to 2015) promoted CE as the national development strategy with the publication of the 'Immediate Action Plan of Circular Economy' in 2013. During the (13th) Five-Year Plan (from 2016 to 2020), CE serves as the focal point of the policy. Currently, the (4th) Five-Year Plan (from 2021 to 2025), has an emphasis on the execution of the "dual circulation" development strategy. This approach endeavours to establish the domestic market as the principal foundation of the economy, whilst simultaneously integrating it with the global market and this represents an important geo-political shift (Wu et al. 2023).

Although producer-side material efficiency is central to CE, improvements can also come from changing consumption patterns and culture, in particular through the promotion of sharing economy concepts. There was an official policy guideline on the sharing economy launched in July 2017, highlighting the benefits of such business models for resource efficiency (Xinhua 2017). By 2020 sharing economy initiatives in China had involved 830 million consumers with a total transaction value of 43.23 billion euros representing 10 percent of national GDP, leading to descriptions highlighting China's important role in the rapid growth of the sharing economy (Xinhua 2021). This success is based on high levels of smart phone use and innovation in information and communication technology (ICTs) and their potential to contribute to sustainability initiatives (Townsend and Coroama 2018). A key element of this is the potential for CE and the sharing economy to contribute to people's daily mobility, for example, paying less via using sharing cars instead of owning a car (Korhonen et al. 2018). Such initiatives may not only help to reduce emissions, but may also contribute to inhibiting the demand for private car-ownership (Firnkorn and Müller 2011). Although promoting car-sharing services may stimulate more demand for mobility in the short term, it may also potentially reduce private car numbers and congestion in the long term (Yoon et al. 2017). Research also suggests that each sharing car may replace up to 20 traditional private cars (Jochem et al. 2020). However, the experience of Mobility Carsharing in Switzerland suggests this may be an overestimate. In 2020, their fleet of vehicles was estimated by research undertaken by Interface to have replaced privately owned vehicles at a ratio of around 11 (Mobility 2020).

The growing Chinese middle class, who are a driver of production and consumption growth, are demonstrating increasing levels of environmental awareness (Hayton et al. 2017) which creates opportunities to change consumer behaviour, and to encourage them to accept new business models such as sharing economy approaches. The Economist (2016) estimates that meeting Chinese mobility needs via American levels of car ownership would require an additional one billion cars on Chinese roads.

The recent growth of electric vehicle sharing services is viewed as a potential solution for addressing climate change issues and fostering a transition towards sustainable practices in urban environments (Lan et al. 2020). By 2020, over 95% of the shared vehicles in use were new energy vehicles (electric vehicles), with electric car-sharing services representing the leading service, establishing car-sharing as an important part of the sustainable mobility system in China (Hu and Creutzig 2022).

1.5 The Impact of COVID-19 on urban mobility and EVSS

The COVID-19 pandemic may also have a lasting impact on urban mobility globally (Christidis et al. 2021; Wells et al. 2020). Public health measures, such as regional lockdowns, social distancing, and travel restrictions, may have led to changes in social commuting patterns, a decline in public transport usage, and a shift towards private vehicles and alternative individualised modes of transportation (Christidis et al. 2021).

In the past decade, EVSS, which combines electric vehicle technology with sharing economy principles, emerged as a progressive trend, offering a potentially more sustainable approach towards urban mobility. EVSS began in earnest around the 2010. In 2018, car-sharing services had amassed over 32 million users, spreading across six continents and 47 nations (Monteiro et al. 2023). This is a significant number yet small in the context of the global population. The worldwide car sharing market, valued at USD 1.1 billion in 2015, is anticipated to expand to a worth of USD 6.5 billion by 2024 (Jung and Koo 2018). The number of car sharing users has been contextualised in relation to the global population and also to the scale of the global car market in which the global new car market's revenue may reach USD 2.86 trillion in 2023, while passenger vehicle sales may reach 57 million units (Statista 2023). A number of the key players in the EVSS markets provided interview respondents for this study (as detailed in section 5.4.5.1) and brief descriptions of those companies, largely reflecting how they describe themselves, is presented in Appendix A.

EVSS use in China was also impacted by the pandemic, and during its early stages experienced a decline in demand due to regional lockdowns. However, as this situation is evolving, the longer-term implications of the Covid-19 pandemic on EVSS and urban mobility have become important. The pandemic highlighted the demand for more adaptable, resilient, and sustainable urban mobility solutions that can adapt to evolving conditions and meet the demand of urban populations (Kakderi et al. 2021).

EVSS may have the potential to play an important role in the transition to sustainable urban mobility in the post-pandemic era. As cities globally have begun to recover from the pandemic (Zreik 2023), governments and social institutions have renewed their efforts to promote environmentally beneficial and robust transportation solutions. This includes a growing interest in shared mobility services, including EVSS schemes, to provide more sustainable mobility alternatives to private vehicle ownership (Ruhrort 2020).

The impact on society and the economy has resulted in various behavioural shifts that may influence the evolution of the transportation industry (Wells et al. 2020a; Christidis et al. 2021). For example, the shift towards remote work with flexible working hours, and the growth of e-commerce, for instance, have contributed to shifting urban mobility paradigms. These trends may have an impact on the reassessment of transportation needs, opening new opportunities for EVSS providers to cater to a more diverse range of use cases and user segments. In addition, the pandemic has accelerated the adoption of digital technologies (Budd et al. 2020), which may enable EVSS providers to enhance their operational efficiency and user experience through 'big data' analytics, real-time fleet management, and digital payment solutions (contactless payment). This may further contribute to the growth of EVSS in the post-pandemic era.

1.6 Mobility in China

Chinese cities play an important role in advancing sustainability efforts within the nation, and their initiatives may potentially serve as models for global sustainable urban development. By 2016 China had 12 cities with a GDP contribution of over CNY 1 trillion with the 100 largest cities accounting for 75.7% of total GDP (Zhang 2017). In China, cities are where national policies can be executed most effectively (Ellen MacArthur Foundation 2018), as local governments can influence urban construction and government policy plays an important role in shaping urban design (Jin 1993). Cities offer opportunities for large scale CE initiatives to be implemented and for CE principles to be designed into new urban construction (Ellen MacArthur Foundation 2018). Cities are where talents, consumers, and technologies are highly concentrated, and where new business models have the potential to be accepted quickly (Ellen

MacArthur Foundation 2018; Mathews et al. 2011). Hence, cities in China have the most potential to realise CE in the future. While transitioning to CE might lead to reductions in the total cost for urban Chinese communities when accessing goods and services, it is important to consider potential rebound effects where these savings could lead to increased consumption in other areas (Lambin and Meyfroidt 2011).

The main early policy focus for CE in China was on material efficiency, for example via the 11th Five Year Plan's emphasis on the 3Rs, and on manufacturers, for example via the 12th Five Year Plan's emphasis on industrial park level projects (Ellen MacArthur Foundation 2018). However, the greatest future potential opportunities for developing the CE in China may depend on a focus on cities and on strategies for particular economic sectors including construction, food provision and mobility (Ellen MacArthur Foundation 2018).

Mobility is a concept that helps individuals travel from one place to another by evaluating factors such as the trade-off between resources' material efficiency and economic efficiency, the degree of (in)convenience, demand from citizens and the choices between vehicle ownership models or using integrated transportation models to deliver what people need in terms of mobility (Vergragt and Brown 2007). More sustainable and customised mobility solutions may also reduce the problems associated with conventional systems such as traffic congestion (Vergragt and Brown 2007).

1.6.1 General mobility business models

China, owing to the combination of increased incomes, expanded city sizes, and the elevation of the car to a status symbol (Ellen MacArthur Foundation 2018), has experienced a rapid growth in demand for personal mobility. The total car stock increased more than tenfold from 16.1 million in 2000 to 172 million in 2015 (Roach 2019). High volumes of traffic have led to air pollution and public health concerns such as increasing reports of cardiovascular diseases and lung cancers, issues which affect the general public at large, not just those within the mobility/traffic sectors. Mobility accounts for around one third of China's outdoor air pollution and 7.5 % of its total CO_2 emissions (Hunt et al. 2016). Also, heavy traffic has led to the majority of Chinese cities suffering serious congestion issues, with ten of the world's 25 most congested cities located in China. This creates economic inefficiency as well as impacting citizens' health and quality of life. In 2017 the average Beijing car commuter's journey of 17.4km took 52.9 minutes, while in Shenzhen an average 16.8km journey took 47 minutes (Hu 2018).

The negative impacts of heavy traffic act as an obstacle to sustainable development, but CE provides opportunities to tackle those impacts.

These impacts are also potentially reversing rising car ownership trends alongside city car registration caps and rising prices making car ownership less attractive. A 2015 study in Chinese mega-cities found that 30% of current car owners would consider giving up their cars in the face of rising congestion and air quality continuing to decline (Tsang and Boutot 2015). They also expected that improved availability of alternative transport modes including public transport, taxis, rental cars, and new app-accessible mobility solutions could facilitate this.

Companies are looking to develop new mobility services based on access to products as an innovative business model rooted in CE concepts with the potential to balance economic development with environmental protection and social justice (Bocken et al. 2016; Mylan 2015). Such business models seek to replace an ownership model of consumption with a model based on access to service-based products (e.g., DIDI, a provision of personal mobility in China which operates as a similar service to Uber, or one of many bike sharing schemes). While mobility systems designed according to CE principles aim to primarily satisfy passengers' mobility needs and offer benefits such as reduced costs, resource consumption, and pollutant emissions, it is also important to address challenges in their execution (Mathews et al. 2011). For instance, the problems with shared bikes experienced in some Chinese cities highlight the need for effective management and disposal strategies to achieve reduced harm to health and society (Alan 2018).

1.6.2 Intersections of the circular economy and car-sharing: Technological and behavioural innovations in urban mobility

Combining the concepts of the sharing economy and mobility, car sharing aims to deliver personal mobility without the need for the purchase and ownership of a car. This creates the potential for sharing services to meet mobility demands with a smaller fleet than via private car ownership. Research suggests that each sharing car could replace 20 traditional private cars (Jochem et al. 2020; Mobility 2020), resulting in increased available parking space, and reduced costs for those travelling less than 12 thousand kilometres annually (Ness 2010). Several European countries like Germany, Switzerland and Denmark are seeking to reduce car ownership by encouraging people to adopt sharing services (Yoon et al. 2017). Therefore, car sharing may potentially reduce car numbers, congestion and mobility-based health and environmental impacts in China (Yoon et al. 2017).

The majority of CE research to date focuses on product innovation, industrial organisation and material recovery (Mathews et al. 2011). Kirchherr et al. (2017) similarly argue that, according to previous studies, consumers are rarely viewed as the enablers of circularity. There is an urgent need for complementary research into the role of consumption systems, behaviours, and service innovation in a transformation to the CE. For an initiative like car sharing, it is important to understand consumer responses to any newly developed business model as they shape China's urban mobility (Shaheen and Martin 2010). Furthermore, for a given production and consumption system, sustainability improvements can come both from the technology used to deliver consumer benefits and the way in which consumers access and use a given technology. This is the case for car sharing services using low-emission electric vehicles (EVs) which combines those two approaches. Therefore, the additional cost for EVs will be acceptable to customers who prioritise economic efficiency and convenience of such vehicles (Wang and Yan 2016).

1.6.3 Research set-up and transition to literature review

Following the introduction and background of this study, the subsequent chapters will explore a comprehensive literature review. This chapter will conclude by introducing the literature review, and establishing the foundation upon which the research questions and objectives are constructed.

The literature review analyses the relevant literatures with a focus on the important themes and concepts relevant to the research topic. This includes an exploration of EVSS, sustainable business models, sharing economy principles, mobility as a service (MaaS), and transition theory. The literature review will also focus on the challenges and opportunities in relation to the context of Yangtze River Delta Economic Zone (YRDEZ) in China.

The literature review aims to identify knowledge gaps and to locate the study within the wider academic discourse. It will provide a conceptual framework for advising the research design and methodology, enabling a structured approach to answering the research questions. By synthesising the current state of knowledge in the field, the literature review will pave the way for further investigation and empirical analysis, ultimately contributing to the advancement of academic knowledge on EVSS, sustainable business models, and urban mobility in China.

EVSS are an increasingly common and visible part of the development of major Chinese cities and the lives of the citizens within them. As an emerging phenomenon they represent an interesting and obvious target for academic research. Their multi-faceted nature implies that a wide range of disciplines and perspectives could be adopted to understand them and their implications including (but not limited to) urban planning and the sustainable cities movement; ecological economics; transport policy; consumer behaviour and sustainable/low-carbon lifestyles; and innovation diffusion. This thesis will seek to integrate several of these elements by adopting two main, but interconnected perspectives. Firstly, a transitions theory perspective recognising that the adoption of EVSS is part of an intended transition towards sustainability within Chinese cities involving both broad regulatory 'pushes' and the influences of technical and market-based innovations which are both a feature of transitions theory approaches. Secondly, a sustainable business models approach, recognising that in practice EVSS can be delivered through the operation of new businesses with innovative business models, and that transitions theory approaches alone can underplay the importance of the role that firms, and their business models can play.

1.6.4 Co-evolution of business model innovation and socio-technical transitions

This section will introduce the dynamic interplay between business model innovation and socio-technical transitions, particularly regarding EVSS in the Chinese urban mobility paradigm. Then, this section will explore what landscape pressures are affecting the regime where these businesses operate. At the macro level, the co-evolution of business models and transition is acknowledged (Ma et al. 2018). Landscape pressures can influence this process, particularly policy incentives from government bodies to develop more sustainable mobility solutions. These incentives may be initially targeted at reducing private vehicle ownership and emissions and have catalysed the development of innovative shared mobility models (Ma et al. 2018).

1.7 Research aim, objectives, research questions

Given the research context set out in this chapter and the literature review presented in the following three chapters. **Table 1.2** shows the research objectives and questions that were developed for the research project.

Table 1.2 Research aim, objectives and research questions.

Research aim	Research Objectives	Research questions (RQs)
The purpose of this research is to understand the transition towards sustainable product-service systems (i.e., car sharing services) by service providers of personal mobility in China through exploring how business models influence stakeholders' acceptance of EVSS (thereby exploring how sustainable business models can evolve beyond a niche market).	Explore how business models influence stakeholders' acceptance of EVSS (RQA).	RQA: To what extent, and how, are new sustainable business models providing successful EVSS businesses in China?
	Evaluate the potential for EVSS to reduce individual car use and ownership, including the role of specific EVSS attributes. (Addresses RQB)	RQB: What is the potential of EVSS to reduce individual car travel and minimise vehicle ownership, and how is this affected by its attributes?
	Understanding the multi -level dynamics of the EVSS market.	RQC: Using transition theory, how can existing shared mobility business models develop an effective relationship between service providers and the local stakeholders to promote sustainable mobility?
	Investigate the influence of various factors on car use and ownership changes among EVSS program participants and eMaaS businesses. (Addresses RQD and part of RQE).	RQD: What are the factors that affect EVSS program participants' car ownership changes in terms of mobility behaviours and attitudes towards car ownership? RQE: What factors affect eMaaS (taking EVSS as an example) businesses and in what ways?

1.8 Summary of the introduction and thesis overview

This introductory chapter has outlined the significance of the research topic, focusing on the growing importance of EVSS in addressing urban mobility and sustainability issues in the context of China and the CE. The chapter has also established the motivation for studying this topic, including the need to understand the evolving landscape of sustainable urban mobility and the researcher's interest in the region and the automotive industry.

This thesis adopts a dual perspective that includes transition theory and sustainable business models in order to investigate this research area. Transition theory provides an insightful lens for understanding the systemic and dynamic transition occurring in the urban mobility paradigm, shedding light on how new and innovative business models can facilitate the shift towards a sustainable transport systems. While simultaneously, a sustainable business models angle enables an in-depth analysis of the design, operation, and impact of EVSS, shedding light on the factors that contribute to the success or failure of individual businesses. These themes are developed further in following chapters.

By adopting this dual perspective that integrates transition theory and sustainable business models, this thesis aims to generate an in-depth understanding of the opportunities and challenges regarding the adoption and diffusion of EVSS in China, thereby contributing to the progress of knowledge and activities in the field of sustainable urban mobility. Figure 1.2 maps out the structure of the thesis.

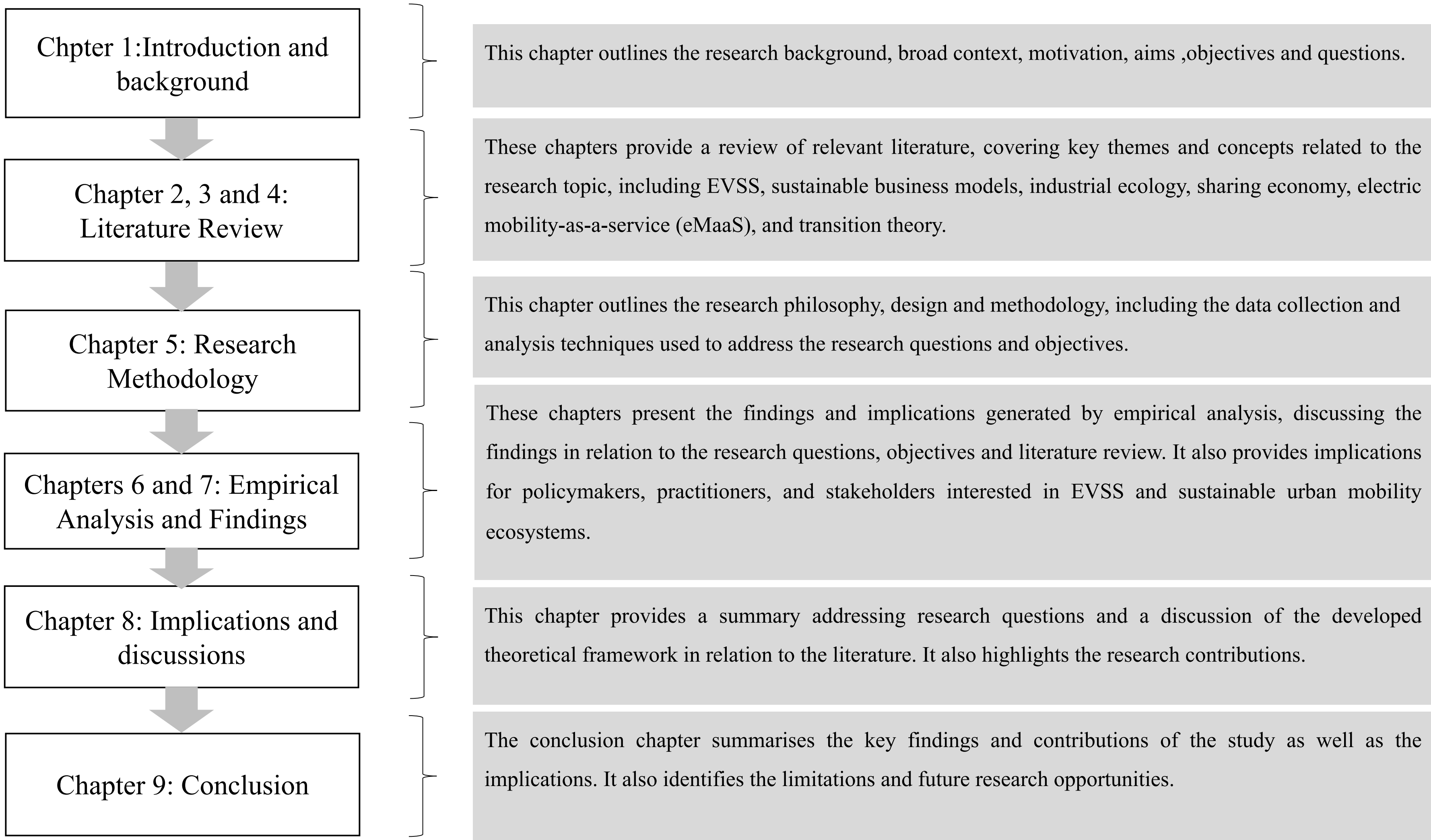


Figure 1.1 Thesis outline

1.9 Chapter summary

This chapter illustrates China's economic development, urbanisation, and environmental issues, highlighting the demand for sustainable technologies and business models. It explores sustainability challenges, particularly in the Chinese context, by focusing on urban mobility and its role in addressing climate change. The chapter also introduces the concept of circular economy and its importance in a Chinese context, underlining the potentially transformative contribution of EVSS schemes. Lastly, it sets the stage for the literature review by emphasising the importance for research on stakeholder responses to innovative business models and technology's role in urban mobility paradigms. The following chapters will provide a review of the relevant literature, beginning with broader sustainability studies then focusing on consumption patterns and product-service systems.

Chapter 2. Sustainability for urban mobility

2.1 Chapter Introduction

The challenge of delivering more sustainable urban mobility in China outlined in the introduction needs to be understood in the context of sustainability and the development of policies and practices that address the physical consequences of meeting peoples' mobility needs. The conventional approaches to development that predominated for most of the 20th century prioritised the abstract notion of economic growth. This chapter explains how the notions of sustainability and sustainable development have introduced a counterbalancing emphasis on the social, and particularly the physical, nature and implications of the systems that meet our needs as consumers, including for mobility.

2.2 The definition of sustainability

Sustainability is a long-term perspective referring to a balance between social, economic, and environmental systems that can be maintained to avoid a collapse in any of those systems and the negative consequences that would result (Glavič and Lukman 2007). Sustainability is considered as an end state, and sustainable development (SD) is the path by which it can be pursued. The idea of SD firstly emerged from the World Council for Churches and the World Conservation Strategy (Talbot 1980), although the Brundtland's report (WCED 1987, p.6) provides the most commonly used definition: "*Development which meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Tisdell 1988; WCED 1987). This definition, developed from a policy perspective, has been criticised as overly simplistic, rhetorical, and open to interpretation (Purvis et al. 2019). A number of academics have noted the difficulties of defining "sustainability" and the different meanings between disciplines (English and Costanza 1993; Pearce and Atkinson 1993) . In a review of definitional approaches, Costanza and Patten (1995) state that, from the biological point of view, sustainability means a balance between animals' survival and reproduction in order to prevent extinction. In economics, it concerns longevity and stability and hedges against major disruptions. For physicists and geologists there is ultimately no such thing as sustainability.

White (2013) reviewed the terminology involved in both definitions of, and discussions about, sustainability, and the range of key words involved are summarised in **Figure 2.1** and **Figure 2.2** Despite the variety and complexity of ideas involved in discussing sustainability, the core set of relationships involves social-ecological linkage between the dimension of ecology, society and economy (Berkes and Folke 1998). This is reflected in a key sustainable business concept, the 'Triple Bottom Line' (Elkington 1994) and interrelationships between human quality of life, development of the economy, and ecosystem stability and the capacity of natural resources to continue to meet human needs (Mori and Christodoulou 2012).

This consideration of biophysical ecology, society and economy implies two embedded hierarchies (Fischer et al. 2007). The 'real' bio-physical hierarchy emphasises that economic activity all takes place within society, all of which exists within the biosphere. This however can be inverted within political priorities so that the pursuit of economic growth is perceived to generate the wealth that allows for social policy investments, some of which will be about environmental protection. Although it might be hard to find a precise and persuasive definition of sustainability, two important components of sustainability can be found based on the previous literature reviews: one is "the triple bottom line" can be treated as an abstract connotation of environmental, social and economic systems, and long-term preservation (Böhringer and Jochem 2007; Fischer et al. 2007; Kozulj 2011; Mori and Christodoulou 2012). Furthermore, there is a clear distinction between 'strong' and 'weak' sustainability: strong sustainability prioritises preserving natural resources and systems, and weak sustainability focuses on maintaining human social and economic systems by managing the balance with natural resource (Bell and Morse 2008).

Figure 2.1 Recurring words in definitions of sustainability (White 2013, p.216).

Figure 2.2 The most "frequently-occurring" words related to sustainability (White 2013, p.217).

2.2.1 Sustainable development

"Sustainable development", is a widely adopted term in many areas, subject to many different interpretations (Parris and Kates 2003; Tanguay et al. 2010), that has provoked some confused responses (Hopwood et al. 2005). However, meeting basic human needs while protecting the ecosystems of the planet represents an ongoing challenge that is central to the pursuit of sustainable development and may require more sustainable strategies towards present realities and future dynamics (Kates et al. 2001).

2.2.2 The need for new sustainable development models

Sustainable development challenges various norms of 20th century economy and social policy aiming to promote human well-being and a flourishing international economy (Barkemeyer et al. 2014; Hopwood et al. 2005; Moffatt 2000; Parris and Kates 2003). This can be partly due to the failure of past economic policies and developmental models to consider the environmental costs, or to overcome global poverty and narrow the gap between rich and poor (Hopwood et al. 2005). Therefore, despite more than 30 years of post-Brundtland policy concern about sustainability, economic growth and job creation have continued to predominate over environmental concerns for most governments. Scholars have recognised this failure and proposed different and 'greener' concepts of development and growth (Bartelmus 2013). Many of these can be understood by mapping them (**Figure 2.3**) according to their contribution to social equity and to environmental protection, and the degree to which they challenge the status quo, as illustrated by (Hopwood et al. 2005). As Gladwin et al. (1995a) observed, sustainability represents a new paradigm for economic development and business activity that seeks a more viable compromise position between the ecologically damaging conventional technocentric paradigm and the radical, politically unacceptable (to the majority) ecocentric paradigm that had emerged in opposition to it.

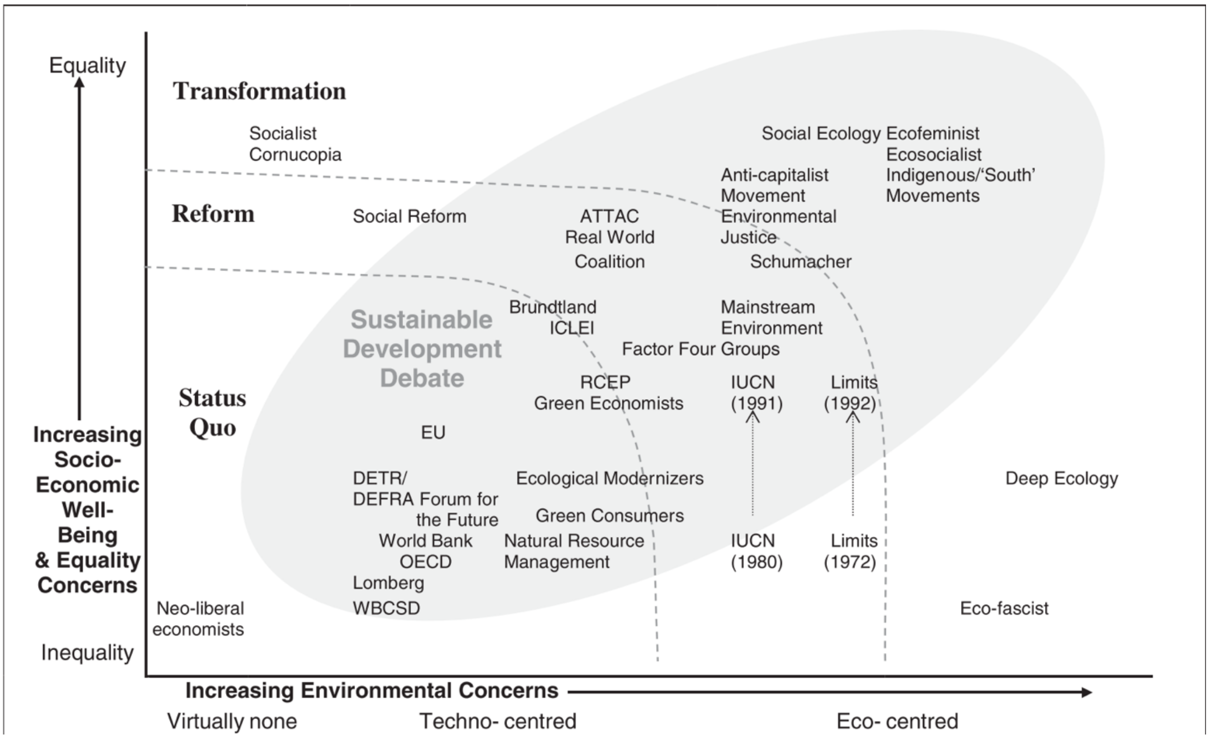


Figure 2.3 Sustainable mapping approach (Hopwood et al. 2005, p.41).

2.2.3 Physical dimensions of sustainability

A key difference between sustainability and earlier development paradigms is that it reconsiders human activity (particularly economic activity) by putting it in a concrete physical context. The physical environment is considered as the context in which activity occurs, the source of all the resources required to support that activity, and the destination for any wastes that are generated as a result. It is also recognised as a dynamic and vulnerable set of systems with the ability to both impact, and be impacted by, human economic activity (e.g., the causes, and consequences, of climate change). A physical perspective is also important because amongst the root causes of the unsustainability of the economic development of the late 20th century is the extent to which it depended on the physical movement of goods and people (Cumming and von Cramon-Taubadel 2018). This is partly reflected in the globalisation of trade and the flow of goods through global supply chains. It is also reflected in lifestyles and patterns of urban development involving the movement of people through the growth in international tourism, leisure travel and urban and suburban lifestyles based around the phenomenon of commuting.

The practical path towards sustainable development will therefore require changes to either the extent, or the means by which, goods and people move across physical space, or both (Redclift 2005; Barkemeyer et al. 2014).

Sustainability aims to provide solutions for increasing environmental damage including climate change, air pollution, and overused resources (Ghisellini et al. 2016; Hartl et al. 2018; Hopwood et al. 2005). CE is receiving increasing attention in general sustainability studies as a means to alleviate the problems caused by current production and consumption models, which cause continuous consumption growth and an increase in resource usage (Ghisellini et al. 2016). The more sustainable use of physical resources through circular initiatives is becoming increasingly attainable due to the application of information technology and networked systems. This includes areas like sustainable mobility (Mulley et al. 2020).

2.3 Industrial ecology

In the early 1950s ecologists began to explore the impact of different types of pollution on the environment, and from this research industrial ecology (IE) emerged as an early approach to understanding and managing business from a physical perspective (Erkman 1997; Hopwood et al. 2005). IE is an approach that examines the physical consequences of the intersectional relationships among customers, industry and environment (Ehrenfeld 1997). As stated by Wells (2013, p.31):

> *"The normative purpose of industrial ecology is to understand and optimise the design of industrial systems that include, but typically go beyond, the boundary of a single firm in order to achieve resource efficiency, closed material loops and dematerialisation."*

It introduces five core elements including industrial metabolism, dematerialisation, life cycle assessment, eco-design, and eco-industrial parks. This section will briefly describe these elements and discuss their role in translating the broad topic of sustainability into more concrete notions of sustainable production and consumption systems. From an economic or strategic view, IE applies a physical systems perspective based on material and energy inputs/outputs, reflecting a biological metaphor of metabolism.

Industrial metabolism (IM) is a systematic, comprehensive and integrated perspective on the relationship between nature's 'ecosphere' and the industrial economy (Erkman 1997). It highlights the biophysical foundation of human and social activities, and the complicated patterns of material flows in and out of industrial systems. From the technological perspective, it seeks to translate unsustainable industrial systems to become better harmonised with ecosystems to maintain their viability through the application of new technologies, policies and practices (Erkman 1997).

Dematerialisation aims to optimise the material flows within economic systems through technological evolution, structural measures and policy incentives (Erkman 1997). The purpose of dematerialisation is not simply to reduce the weight of material per unit of economic output, but to reduce the environmental impact related to material use (de Bruyn and Opschoor 1997; Voet et al. 2004). Dematerialisation can be achieved by multiple routes:

- Reducing the wastage rates associated with a material.
- Using alternative materials (applying sustainable materials for specific functions to replace unsustainable ones).
- Applying recycling or reuse principles and practices.
- Decreasing any unnecessary demand (and resulting consumption), for example from excessive packaging or unnecessary product replacement (e.g., the continuous upgrading of a product such as a mobile phone driven by consumers' desire, but without delivering substantial functional improvement).

Life cycle assessment (LCA) is a technique to prompt the understanding, characterisation, and assessment of majority types of environmental impacts from a product or procedure (Anastas and Lankey 2000; Finnveden et al. 2009). It represents a comprehensive and scientific method that addresses a product's entire life cycle from acquiring resources, input materials processing, energy manufacturing, use and maintenance to final disposal, in order to identify and possibly reduce total environmental (and possibly negative social) impact (Anastas and Lankey 2000; Curran 2008; Finkbeiner et al. 2006).

Eco-design is a process defined as "*the integration of environmental aspects into product design and development to reduce adverse environmental impacts throughout a product's life cycle*" (Navajas et al. 2017, p.1). Early sustainability thinking often focussed on the need for consumers to make better consumption choices. Eco-design recognises that the impacts of consumer choice also reflect design choices (in products and systems) amongst producers. It considers and concentrates on each stage within a product's life cycle which potentially may have an environmental impact in order to reduce its impact significantly when the product is designed (Poudelet et al. 2012). Implementing eco-design into organisational strategies and product development processes can provide multiple benefits (relating to the economy, society, human health, employee commitment and legislative compliance) for industry and to public institutions (Navajas et al. 2017).

Although LCA is not an explicit element of the eco-design process, successful eco-design depends on comprehensive and accurate LCA (Navajas et al. 2017). Additionally, it is essential for service and manufacturing companies to aggregate cost efficiency, environmental concern and service/product quality into design considerations (Kobayashi 2005). Addressing quality and cost efficiency might be helpful for a company to achieve a sustainable competitive advantage, as purely focusing on enhancing a product's environmental performance may not be enough (Kobayashi 2005).

Eco-industrial parks (EIPs), apply a spatial dimension to reducing the environmental impacts of economic activity through communities of companies that co-operate with each other by sharing resources (which may include suppliers, by-products, innovation technologies, water, human resources and energy) in an efficient and sustainable way that applies the principle of "circularity" (McManus and Gibbs 2008). EIPS succeed both through spatial colocation and by connecting firms across individual production and consumption systems to understand and reduce sustainability impacts.

2.3.1 Applying industrial ecology for urban sustainability

IE principles (such as IM) can be applied in multiple ways to manage a range of human activities to achieve sustainability (Erkman 1997). Although initially applied to companies or industries, IE concepts such as IM have been expanded to multi-industry co-locations (EIPs), households and urban areas such as cities. Sustainability science provides an extension of industrial metabolism into the study of sustainable cities as a field of activity which aims to reduce the utilisation of natural resources, energy and production of waste as much as possible in order to improve cities' sustainability and liveability (Newman 1999). This is important given the proportion of the global population living in cities, rates of urban growth and the extent to which cities contribute to the human ecological footprint (Goldstein et al. 2013; Huang et al. 2010; Newman 2006). Chinese cities are a vital subset of global cities given their number and scale with cities forecast to contain 67% of China's population by 2030 accounting for 82% of its economic activity (Ellen MacArthur Foundation 2018). **Figure 2.4** shows the flow of material and energy considered in city level.

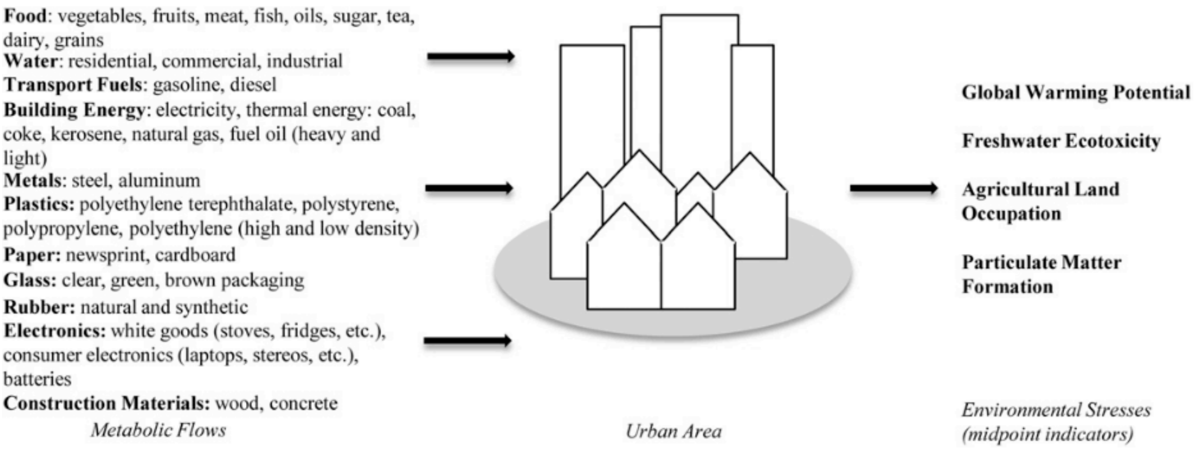


Figure 2.4 Ecological footprint flows in urban area (Goldstein et al. 2013, p.6).

A model, representing an “Extended Metabolism Model of human settlements” (**Figure 2.5**) was developed for sustainable city planning which demonstrates both the physical and biological aspects of a city’s “metabolism” while simultaneously emphasizing the human actions that play an essential role in managing waste and resources, including efforts to convert waste into useful products (Newman 1999).

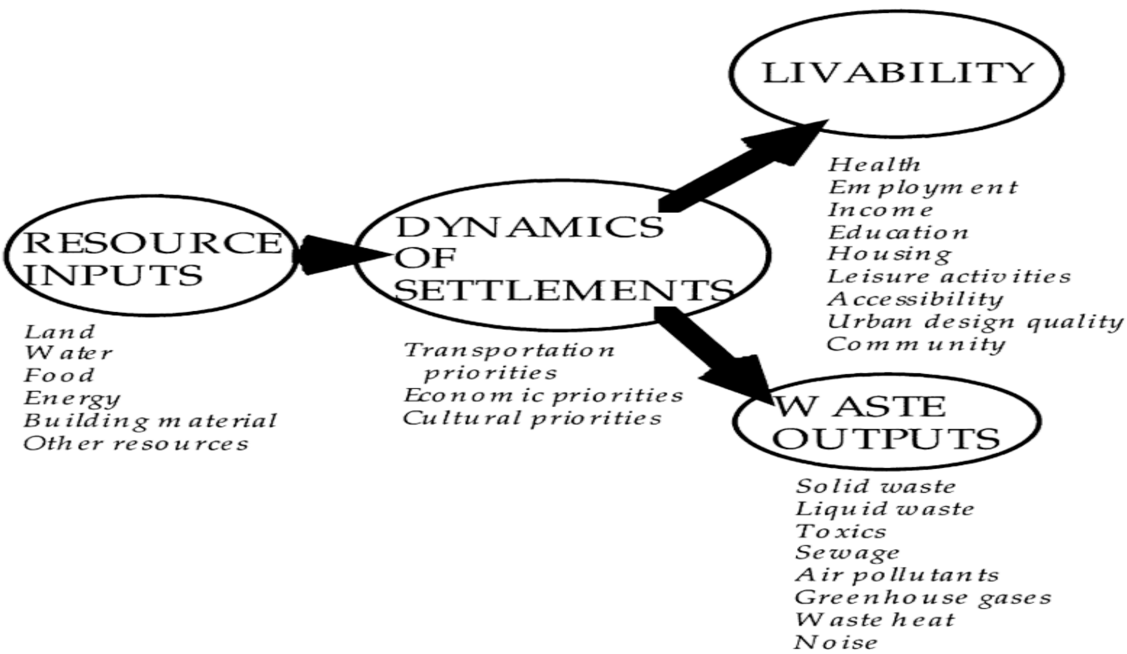


Figure 2.5 Extended metabolism model of human settlements (Newman 1999, p.220).

Within cities, dematerialisation strategies may also be employed to contribute to sustainability for example by telecommunications substituting for the use of an urban transport networks (Marvin 1997). Dematerialisation strategies have the potential to reduce the carbon intensity and energy requirements of urban mobility and (at least partially) decouple the generation of environmental pollution from economic growth (Ayres and Ayres 2015; Tapio et al. 2007).

2.3.2 The ecological impact of automobiles

Previous sections present LCA as a tool to understand and assess the environmental impacts of a product or process. Socio-ecological impact matrices may serve as a qualitative approach that interprets the effects of a product throughout its lifespan, from its inception to termination (Belz and Peattie 2009). **Figure 2.6** delineates the influences of internal combustion vehicles throughout their lifecycle. Belz & Peattie (2009, p. 63) highlight that roughly 80% of vehicles' total energy use and air pollutants are generated during the driving stage of its lifecycle.

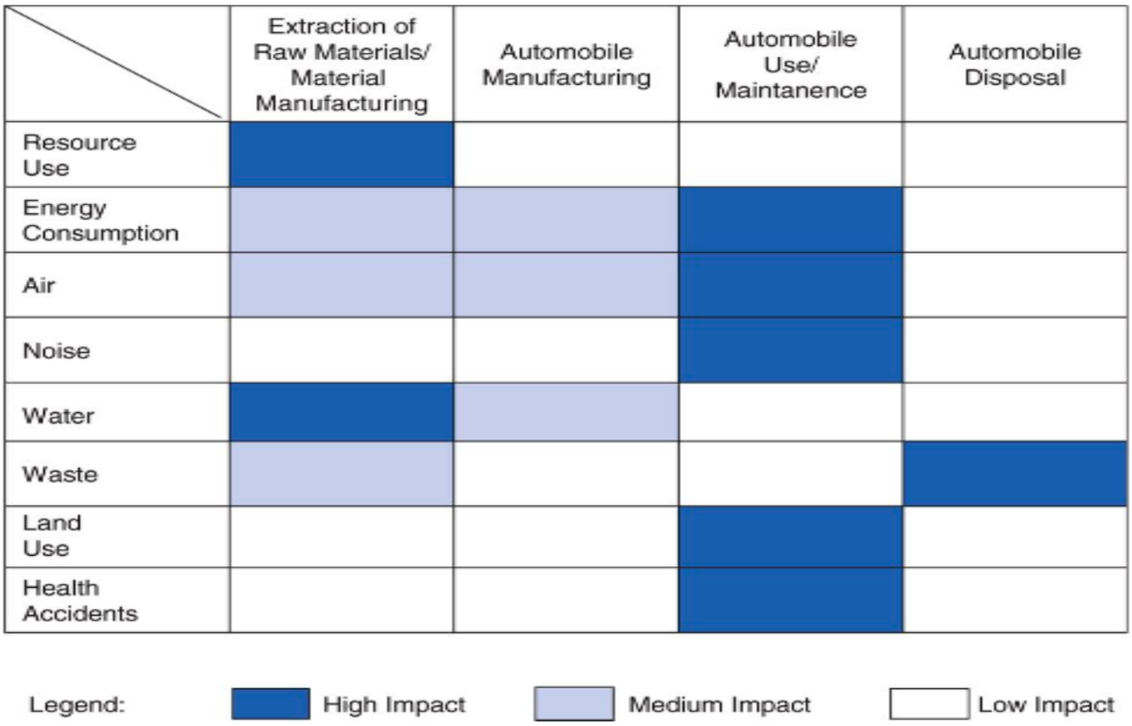


Figure 2.6 Automobiles' impact assessment matrix (Belz and Peattie 2009, p.64).

2.4 Sustainable production-consumption systems (SPCS)

SPCS consider how human needs are met from a holistic systems perspective considering and integrating the range of natural ecosystems that provide the resources, the technologies through which those resources are transformed, and the human stakeholders involved in production and consumption processes (**Figure 2.7**) (Lebel and Lorek 2008). SPCS seek to apply IE principles and techniques like material flow analysis (MFA) to understand markets and industries from a physical perspective to reduce resource inputs and waste outputs to reduce environmental impact and improve human health (Lebel and Lorek 2008; Martinez-Hernandez et al. 2017; McManus and Gibbs 2008). An SPCS perspective involves understanding consequences across these three systems (**Figure 2.7**), but it does so by considering them throughout all stages of a value chain involved in meeting consumer needs.

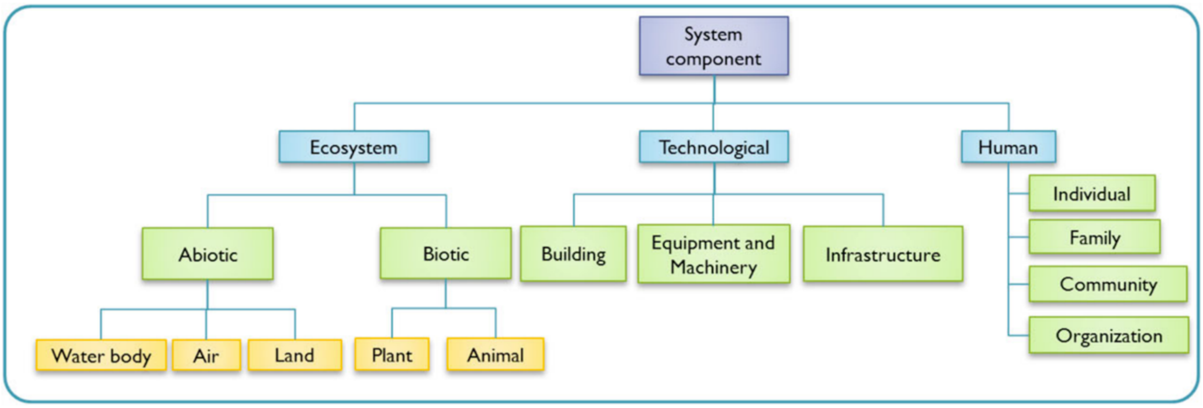


Figure 2.7 A physical view of SPCS's components (Martinez-Hernandez et al. 2017, p.819).

A SPCS perspective has been used in trying to identify those sectors of the economy most responsible for unsustainable environmental (and social) consequences. In terms of private citizens' consumption, research has identified a limited number of SPCSs or "activity clusters" (Lorek and Spangenberg 2014, p.129) that account for the majority of sustainability impacts. The European Environmental Impact of Products (EIPRO) study (Tukker and Jansen 2006) relating domestic consumption to impacts including pollution, human and environmental health risks, and greenhouse gas emissions concluded that 70–80% of impacts relate to food and drink, housing and transport. Similarly, Spangenberg & Lorek's (2002, p.128) study into "*activity clusters comprising resource consumption*" concluded that construction and housing, food and nutrition, and transport and mobility accounting for 70% of material extraction and 90% of energy and land use. Transport and mobility systems within cities are therefore clearly a priority area in which to develop more sustainable production and consumption systems.

2.5 Mobility as an arena for SPCS development

Mobility, an important component of society, has emerged as a domain for SPCS development. As urbanisation progresses and global populations expand, the demand for efficient, sustainable transportation systems has become increasingly pressing. Within the context of SPCS, mobility transcends the mere movement of individuals and goods, encompassing the methods through which resources are employed and consumed to enable such movement (Lebel and Lorek 2008). Consequently, addressing mobility within the SPCS paradigm necessitates a comprehensive approach that explains the interconnections and interdependencies between various transport modes and their associated subsystems.

Transport mode-based subsystems can be broadly categorised into active travel-based, private vehicle-based, and public vehicle/infrastructure-based systems. Each of these subsystems offers unique opportunities and challenges in terms of SPCS objectives (**Table 2.1**): Active travel-based subsystems, which comprise non-motorised transport modes such as walking and cycling, can epitomise a more sustainable and resource-efficient means of transportation, with minimal environmental impacts, congestions, and health advantages for users.

However, electric bikes have introduced a new dynamic to these subsystems. While electric bikes maintain some of the potential benefits of traditional cycling, such as reduced congestion and lower emissions compared to motor vehicles, they also bring about shifts in energy usage and potential changes in the physical activity levels of their users (Sundqvist-Andberg et al. 2021). The sustainability impacts of active (and semi-active) travel will depend upon emerging technologies and will involve a balancing of the benefits of increased accessibility and range against considerations such as the environmental impact of battery production and electricity generation (Burchart-Korol et al. 2020).

Conversely, private vehicle-based subsystems, although offering convenience, adaptability and comfort, contribute substantially to resource depletion, greenhouse gas emissions, and urban congestion. Public vehicle/infrastructure-based subsystems, which encompass public transit and shared mobility alternatives, proffer a more sustainable and accessible mode of transportation (Schade and Schade 2005); however, they may confront obstacles in terms of coverage, affordability, and infrastructure implementation. Lastly, agent-based systems (see **Table 2.1**) provideing individualised, flexible and convenient mobility service through digital technologies (e.g., Apps).

Integration between these transport mode-based subsystems can be achieved through the development of multi-modal transportation networks that promote the transition between different modes, such as walking, cycling, vehicle driving, public transit, and shared mobility services (Baggag et al. 2018; Feys et al. 2020). Such integration can enhance the overall sustainability of urban mobility, ensuring efficient resource use, reduced environmental impacts, and improved accessibility for all users.

Table 2.1 Opportunities and challenges of different transport mode-based subsystems in urban mobility (Gordon and Paprzycki 2005; Ning et al. 2020).

Transport Mode-based Subsystem	Opportunities	Challenges
Active Travel-based	Minimal environmental impact	Limited to shorter distances
	Resource-efficient	Dependent on favourable weather conditions
	Promotes health and well-being	Safety and efficiency concern
Private Vehicle-based	Convenience	Resource depletion
	Adaptability, comfort and security	Greenhouse gas emissions
	Personalisation of travel	Urban congestion and pollution
Public Vehicle/Infrastructure-based	Sustainable transportation options	Coverage challenges
	Accessible transportation	Affordability issues
	Reduced environmental impact compared to private vehicles	Infrastructure implementation challenges
Agent-based travel support systems	Access to vast online travel information.	Handling information overload.
	Personalised travel itineraries using agent infrastructure.	Dealing with unreliable and evolving agent technologies.
	Accessibility through various internet-enabled devices.	Addressing abandoned projects and shifting research focus.
	Trustworthy information from Verified Content Providers (VCP).	Managing the dynamic nature of online content. Ensuring the trustworthiness of information from different sources.

To achieve greater energy efficiency and carbon reductions, alternative fuelled vehicles will need to be adopted, although conventional petrol and diesel vehicles may not that be that easy to abandon (Laporte et al. 2018; Lebel and Lorek 2008). This may particularly be the case for less wealthy countries who may find it more difficult to access appropriate technologies or to afford the necessary investment (Lebel and Lorek 2008). Recent developments such as electric vehicles are likely to determine future trends in mobility paradigms in the short to medium term (Hu et al. 2010; Jung and Koo 2018; Laldin et al. 2013). In terms of improving the impacts of human lifestyles, customers are being encouraged (often via government policies and campaigns) to use sustainable mobility tools (such as active travel solutions, sharing cars, buses, and subway) rather than adopting unsustainable tools like private car ownership or long-haul flights. This is occurring while marketers simultaneously continue to try to induce people to buy new products including cars (Cohen and Muñoz 2016; Hernandez 2019; Lebel and Lorek 2008).

Establishing SPCS is not as simple as just launching a new product because it can require integrated contributions and behaviour changes from multiple stakeholders potentially including manufacturers, consumers, intermediary companies, and other institutions (such as regulators). Previous literature identifies several mechanisms to enable SPCSs but also identifies the challenges involved in applying them (See **Table 2.2**).

Table 2.2 Examples of enabling mechanisms for sustainable production-consumption systems (Lebel and Lorek 2008, p.245) .

Enabling mechanism	Short description	Concerns, constraints, or challenges
Produce with less	Innovations in production process reduce the environmental impact per unit made.	Rebound effects occur through which gains are wiped out by increases in the number of units or how they are used.
Green supply chains	Firms with leverage in a chain impose standards on their suppliers to improve environmental performance.	There may be unfair control of small producers.
Codesign	Consumers are involved in design of products and services to fulfill needs with less environmental impact.	Incentives are not adequate to involve consumers.
Produce responsibly	Producers are made responsible for waste from product disposal at end of life.	Incentives for compliance without regulation may be too low for many types of products.
Service rather than sell	Producers provide service rather than sell or transfer ownership of assets, which reduces number of units made while still providing functions needed.	This is a difficult transition for firms and consumers to make as it requires new behaviors and values.
Certify and label	Consumers preferentially buy labeled products. Labels are based on independent certification, and producers with good practices increase their market share.	Consumers are easily confused with too much information or with a lack of transparency and credibility of competing schemes.
Trade fairly	Agreements may include a minimum price, and other investments or benefits are made with producers. Consumers preferentially buy products labeled as or sold through fair trade channels, and producers get a better deal.	Mainstream trade still dominates. It is hard to maintain fair trade benefits to producers when a product becomes mainstream.
Market ethically	Reducing unethical practices in marketing and advertising would reduce wasteful and overconsumption practices.	There is a reluctance by policy makers to tackle very powerful private sector interests with regulation.
Buy responsibly	Campaigns educate consumers about impacts of individual products, classes of products, and consumption patterns, resulting in overall behavior changes.	Converting intentions and values into actions in everyday life is often difficult for consumers. Issues of convenience, flexibility, and function still matter a lot.
Use less	Consumption may be reduced for a variety of reasons, for example, as a consequence of working less. There are many potential environmental gains from less overall consumption.	There is a dominant perception that using less means sacrifice. Less income and consumption may not automatically translate into better consumption impacts.
Increase wisely	Increasing the consumption of underconsumers can be effected in ways that minimize environmental impacts as economic activity expands.	Wealthy developed countries need incentives and goodwill to assist the poor and those in developing countries, for example, by leaving adequate space and natural resources for them to develop.

Both producers and consumers have a role in delivering progress towards more sustainable urban mobility systems (Lebel and Lorek 2008). Vehicles can be designed and produced responsibly and manufactured with less energy and raw materials to reduce environmental impacts (Lebel and Lorek 2008; Czerwinski 2021). They can be provided (either directly or via intermediaries) and marketed to consumers on a service and use, rather than product ownership, basis (Lebel and Lorek 2008). Consumers can also adopt more sustainable consumption behaviours such as choosing less damaging transport modes and vehicles, using sharing services or sharing rides, and reducing their use of vehicles (e.g., by walking for short journeys). Achieving more sustainable mobility in Chinese cities is therefore not simply a question of technologies, markets or behaviours but will need to involve new sustainable business models (Ellen MacArthur Foundation 2018).

Manufacturing responsibly necessitates that producers consider the entire lifecycle of their products (Lebel & Lorek, 2008). For instance, in 2005, China saw the sale of over 10 million electric bikes, making them a prominent mobility option (Cherry and Cervero 2007). However, since 2016, traffic accidents involving electric bikes have doubled compared to those involving conventional bikes, and the environmental impact of electric bike batteries has become a growing concern (Bai et al. 2020; Cherry and Cervero 2007). Consequently, several Chinese cities, including Xiamen, Shenzhen, Beijing, and Zhuhai, have implemented policies restricting e-bikes on major roads (Bai et al., 2020).

The notion of using less and increasing wisely suggests that consumption could be reduced by limiting the frequency of product use, thereby creating a demand for industries to provide more services rather than focusing on sales (Lebel and Lorek 2008). In the context of China, private car owners typically use their vehicles for only a few hours each day instead of utilising them around the clock. This highlights the potential for alternative mobility solutions and the need for a shift in industry focus towards providing sustainable services.

Broadly, sustainable mobility aims to increase economic and social welfare while simultaneously reducing negative impacts (Nykvist and Whitmarsh 2008; Schwanen et al. 2011), which for road-based transportation involves a range of issues including congestion, emissions, accidents, air pollution and noise (Tsang and Boutot 2015; Hunt et al. 2016; Wells 2016; Wang and Wells 2020). Conventional approaches toward sustainability mobility have tended to emphasise single technologies or behaviour changes, for example the willingness of consumers to purchase greener vehicles (like hybrids) or use public transport services. For example, customers in China get a subsidy when purchasing electric cars and for those who do part exchange their petrol, or diesel car will get extra money. Furthermore, previous researchers emphasise that reducing travel demand may also help to achieve sustainability towards mobility (Nykvist and Whitmarsh 2008). A SPCS perspective considers mobility more holistically by considering vehicles or public transport providers as part of a wider system that encompasses vehicle manufacture, vehicle retail and repair, fuels, roads, parking, service providers, vehicle taxation, insurance, regulation, urban planning and, of course, consumers. The likely adoption of a given mobility related technology or behaviour by consumers will therefore be potentially influenced by the interplay of all those different factors. Therefore, from the perspective of SPCS owning a car just for intermittent use may cause financial as well as environmental waste due to the need for insurance, road tax, regular maintenance, and parking fees. Hence, a business strategy of providing personal mobility as a service via a "product-service system" (PSS), might facilitate dematerialisation by providing mobility via a service rather than relying on ownership of cars as private assets (Lebel and Lorek 2008).

2.6 Product-service systems (PSSs)

PSSs is a business strategy that delivers consumer benefits from products via an access-based service model instead of through traditional purchase and ownership (Abed 2006; Stål and Jansson 2017). PSSs can be defined as "*a marketable set of products and services capable of jointly fulfilling a user's need. The product/service ratio in this set can vary, either in terms of function fulfilment or economic value*" (Abed 2006, p.238). PSSs represent an integrated system of products, service and ecosystem networks that aim to provide convenient and economic means of achieving customer satisfaction (Abed 2006). In the context of PSSs, ecosystem networks can be the interconnections among various stakeholders involved in the development, delivery, and support of an integrated offering. PSSs merge as manufacturers, service providers, suppliers, customers, regulators, and other relevant stakeholders construct networks to facilitate a convenient and cost-effective environment of achieving customer satisfaction (Abed 2006). These actors collaborate and interact via the value chain,, from product design and development to distribution, consumption, and final disposal (Tukker 2004).

Each stakeholder contributes to the system efficiency and sustainability. Manufacturers are responsible for designing and producing products with less environmental impacts, while service providers develop innovative solutions to adapt the evolving market (Mont 2002). Suppliers ensure the availability of resources and materials, and customers provide feedback on their experiences and preferences, informing future product and service developments (Baines et al. 2007; de Jesus Pacheco et al. 2019a). Regulators and other stakeholders, such as NGOs or industry associations, may also influence the PSS through policymaking, advocacy, and standard-setting (Tukker and Jansen 2006; Tukker et al. 2008). These various interactions and interdependencies contribute to the overall success of a PSSs, ensuring it meets customer needs while minimizing negative environmental and social impacts.

For consumers, PSSs shift consumption from purchasing a product to utilising a service to meet their needs (albeit with a potential trade-off in terms of convenience) whilst also reducing environmental impact (Abed 2006). For manufacturers and service providers, the development of a PSSs has implications for market structure, marketing mix development, stakeholder relationships and potentially operationally for the whole of a product's lifecycle. PSSs generally change the rights and responsibilities linked to property (ownership) which will impact on a product's lifecycle, particularly in terms of maintenance and disposal. While conventional mobility markets based around car ownership and use will have a service element (e.g., maintenance), in a PSS the core benefits of the product are delivered via service rather than the service element representing augmented benefits.

2.6.1 Transition to PSSs

A PSS consists of three key elements: product, service and consumer experience (Chou et al. 2015; Doualle et al. 2020). Literature categorises PSS into three types: user-oriented, product-oriented, and result-oriented (Chou et al. 2015; Cook et al. 2006; Williams 2007). All three types focus on customer satisfaction, although in the user-oriented PSSs and result-oriented PSSs, customer satisfaction mainly comes from the experience of using the product function and the post-purchase feeling after using the service, rather than from enjoying product ownership (Chou et al. 2015). Conversely, in the product-oriented PSS , satisfaction comes from the convenience and added value of products that companies may continually improve (Chou et al. 2015). Car-sharing services ideally offer a convenient solution for individuals who use cars infrequently or who cannot afford a car, covering associated costs such as road tax, maintenance, and insurance.

However, these potential benefits are based on an ideal scenario. The reality is that the actual consumer behaviours and outcomes may not align with these theoretical benefits. Environmental sustainability advantages, such as extending product life cycles, refining production and consumption practices, and reducing raw material usage, are posited benefits that may be realised through the strategic implementation of these PSS types. There remains a need for empirical evidence to validate these claims and to understand the complex interplay between expected and actual outcomes in different contexts (Chou et al. 2015).

2.6.2 Significance of PSSs

PSSs may bring direct and indirect benefits in production and consumption patterns that may accelerate the transformation towards sustainability of society including companies, customers, governments and the environment (Abed 2006; Tukker 2004). For companies, PSSs may integrate business activities such as renting, sharing, upgrading and redesigning in order to reduce environmental impacts while simultaneously improving the level of sustainability, product quality and customers' satisfaction (Abed 2006; Armstrong et al. 2015). For society and government, stakeholder relationships and supply chain networks, PSSs may imply formulating policies that help to promote sustainable consumption and production patterns and lifestyles. PSSs may provide a new way of influencing and understanding stakeholder relationships and whole supply chain networks, which may also potentially help to promote more sustainable policies and outcomes (Abed 2006). Consumers may get benefits from PSSs via a better variety of options in the new market rather than a few choices in the conventional one (Wells and Orsato 2005).

For example, PSS schemes allow consumers to access a range of vehicle sizes and types when needed, whereas car ownership would tie them to a single model (Seitz and Wells 2006). Also, consumers may enjoy added-value services, enhanced product functionality and premium post-purchase experiences compared to just owning a product. Therefore, services like sharing, renting and leasing may change consumption patterns by replacing the ownership of certain product types (Abed 2006; Vezzoli et al. 2015). Producers are encouraged to recall their products and remanufacture or recycle them (rather than just abandon old ones in order to launch upgraded ones) which may also reduce environmental impacts (Abed 2006; Tukker 2004). For example, the automotive industry in China is encouraged by the government to produce EVs for car sharing services in response to traffic problems, and growing problems of air pollution (like Pm2.5 and NOx emissions) linked to vehicle emissions (Miao et al. 2019; Zeng et al. 2019).

For a Sustainable Product Service System (SPSS) to work as an alternative or complement to an ownership and use model, a range of factors may be important. These include more than simple consumer acceptance and could include factors such as interfacing with supporting technologies and services (e.g., mobile phones and insurance) and the role of issues like perceived safety, convenience and control. Previous studies in China mainly target 'middle-class' consumers by using quantitative surveys (Tyfield and Zuev 2018), whereas a qualitative approach will be used in this study in order to achieve a more in-depth understanding.

2.6.3 The challenges of PSSs

Although PSSs may represent innovations in many markets, there are longstanding examples (such as accessing books through libraries) some or which, such as car leasing services, have been specifically marketed as sustainable PSSs (Hernandez 2019). PSSs still face various constraints (de Jesus Pacheco et al. 2019b) which may hinder businesses in designing and implementing processes into a sustainable PSS. These challenges may be distinguished into two groups related to designing process and operating systems, based on previous literature (Lebel and Lorek 2008) .

The challenge of designing PSS processes involves balancing generating economic value whilst reducing environmental or negative social impacts (Creusen 2011). For instance, concepts like sharing services, leasing services, sustainable product lifecycles and closed material loops are becoming important elements in the PSS design process (Hernandez 2019). However, those concepts might not be completely acceptable in the market as business managers may not understand them and how they could be integrated into their business design process (Mont 2002). Producers may face challenges in shifting from a physical ownership model to a service one in taking responsibility for products during and after their use phase, and managing the collaborations among the stakeholders required to deliver value (Tukker 2004). Finally, customers and traditional producers may have difficulties in understanding how pricing and costing acts in such systems which may generate other uncertainties that hinder producers' ability to implement sustainable PSSs in practice (Besch 2005).

Existing research suggests that sustainable PSSs hold the potential to offer innovative solutions that promote more sustainable outcomes. However, certain car rental services, such as Zipcar, may inadvertently encourage customers to perceive these services as low-cost alternatives rather than fostering a sense of belonging to a PSSs community focused on sustainable goals (Catulli et al. 2017). As a result, the appeal of PSSs and IE initiatives might be restricted to a niche segment of the consumer market, potentially impeding their expansion to the mass market (Ceschin 2013).

2.7 Chapter Summary

The chapter has outlined the context in which the significance of EVSS needs to be appreciated. This includes discussing sustainability and sustainable development as a societal goal to which the schemes can contribute; industrial ecology as concerning the physical environmental implications of how our needs (including for mobility) are met; sustainable production and consumption systems as a way to understand how our needs are met; urban mobility as the specific context in which EVSS meet peoples' needs; and product service systems as the specific type of system that EVSS represent. The next chapter explores in detail transitions theory and sustainable mobility as two theoretical lenses through which the operation and contribution of EVSSs can be examined and better understood.

Chapter 3. Theoretical underpinnings

3.1 Chapter introduction

There are a wide range of disciplinary perspectives and available theoretical lenses through which the development of more sustainable urban mobility systems could be considered and better understood, including consumer behaviour, sustainable lifestyles, social innovation, urban planning and development, institutional theory, transport policy, product-service system (PSS) and innovation diffusion. For the purpose of this thesis, two broad theoretical bases for the study are selected and outlined in this chapter: socio-technical transitions theory and smart mobility innovations (e.g. eMaaS). The following chapter then discusses the practical application of new technologies and new approaches to developing more sustainable urban mobility in Chinese cities from a sustainable business models perspective.

3.2 Transitions theory

Understanding how society can progress from an unsustainable present to a more sustainable future is often framed as a form of 'transition' or systems level change (Geels and Schot 2007), with a variety of types of transition discussed including technological transitions (Geels 2002), technological revolutions (Perez 2010), system innovation (Elzen et al. 2011) or transition management (Rotmans et al. 2001). Transition theory emphasises how social and technical factors interact when a complex system changes from one state to another. Technological transitions (TT) represent major technological transformations, addressing fundamental societal functions such as transportation systems, communication and housing (Geels 2002; Wells and Nieuwenhuis 2012). They not only consist of technological changes, but involve changes to elements like user practices, industrial networks and infrastructure (Geels 2002). The most radical forms of transition are technological revolutions defined as "*A set of interrelated radical breakthroughs, forming a major constellation of interdependent technologies; a cluster of clusters or a system of systems*" (Perez 2010, p.189). Transition management tends to involve more evolutionary approaches based on improvements to existing systems and policy driven by a long-term perspective (Rotmans et al. 2001). Sustainability transitions have emerged as a sub-field within innovation studies, with a focus on more evolutionary changes (Markard et al. 2012).

Previous chapters have explained that our planet (and its cities) suffers from a series of environmental problems due, in part, to current transport regimes. Therefore, there is a broad agreement amongst sustainability scholars that a "transition" is needed in order to provide more sustainable innovation based mobility systems (Nykvist and Whitmarsh 2008). A socio-technical transition perspective provides an analytical framework for those empirical sustainable mobility studies associated with both green technologies and social innovation (Geels 2019) and it has been adopted by scholars to analyse and explain a series of cases in different regions and countries (Geels et al. 2016; Moradi and Vagnoni 2018; van Waes et al. 2018). A key benefit in using transitions theory to understand such complex systems and their evolution is its use of a multi-level perspective (Geels 2019).

3.3 Multi-level perspectives (MLP) on socio-technical transitions

The MLP (See **Figure 3.1**) combines a global perspective considering an entire socio-technical transition while simultaneously adopting a local lens "*which addresses-specific activities and causal mechanisms in multi-level interactions*" (Geels 2019, p. 189). The MLP consists of three functional levels (niche, regime and landscape) whose interaction influences the processes of transition (Geels 2019). The MLP dynamic at the landscape level creates pressure on the whole system influencing the lower two levels, while simultaneously the niche level can create 'bottom-up' pressure on the other two levels to influence the existing system (Geels 2019).

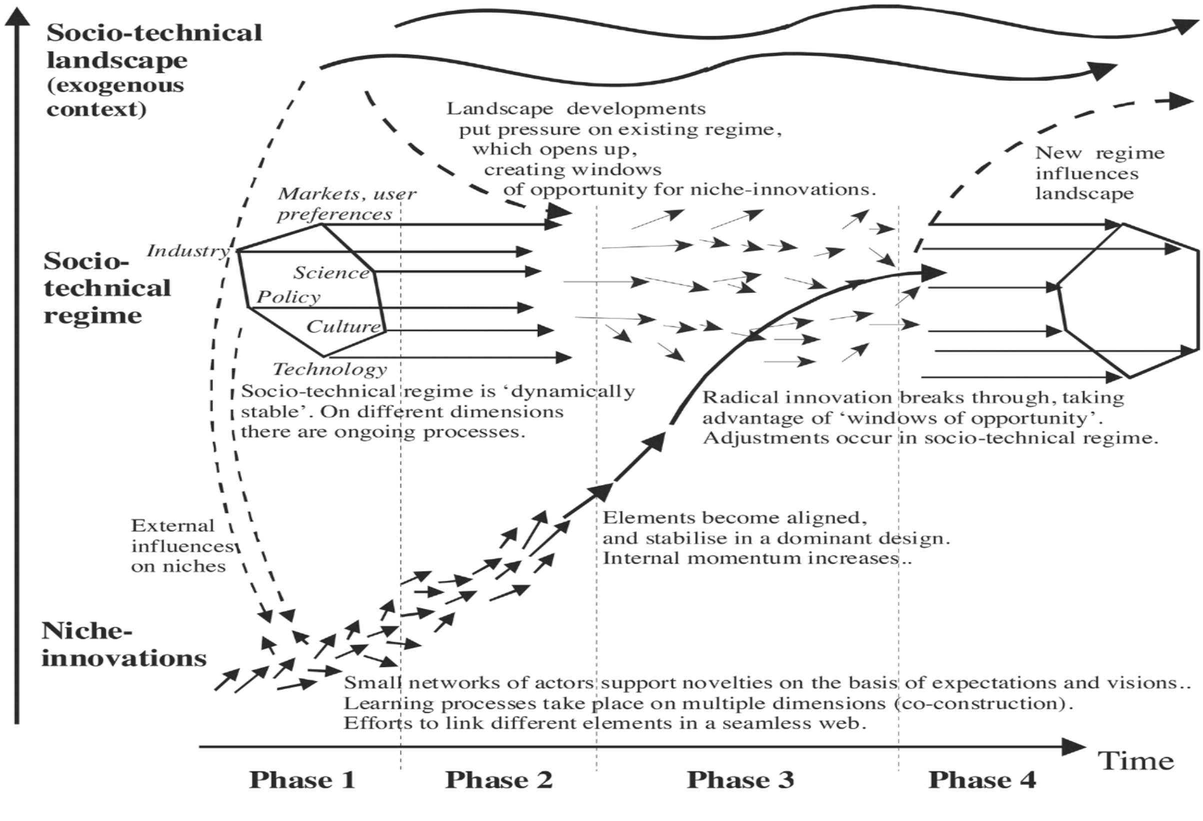


Figure 3.1 The MLP (Geels 2018a, p.226).

3.3.1 Landscape development

The socio-technical landscape represents the external environment within which particular industries or production and consumption systems operate, and changes there will directly impact the niche and regime levels (Geels 2018b). Those changes can involve economic conditions or government policies. For example, in China, government policy (such as the strategy of energy-saving and electric vehicles) can be understood as a landscape-level influence that encourages manufacturers to produce electric vehicles by launching numerous policies such as “financial support and punishment”, “points subsidy”, “infrastructure support” and “market promotion” (Wang et al. 2017).

3.3.2 Socio-technical regime

A regime is a dominant institutional structure within the current system involving interdependencies between stakeholders and which can be influenced by exogenous policy and other landscape-level influences (Geels 2010; Geels 2019 ; Meadowcroft 2005; Nykvist and Whitmarsh 2008). Mainstream markets are an example of a regime (Geels & Schot 2007). In the context of mobility, the current regime will include technologies (such as cars, buses, scooters, bikes and trains), markets (for vehicles and public transport services), socio-cultural practices (such as commuting) and consumer preferences (for convenience, safety and speed).

3.3.3 Radical niche innovation

The niche level is where more radical innovation can emerge in the system from small actors or networks of actor pioneering novel technologies and/or solutions. Successful innovations can generate learning that ultimately creates pressure for change on the whole system as well as directly at the regime level (Geels 2019). Since its inception in the late 1980s and early 1990s, the Multi-Level Perspective (MLP) has primarily focused on the interactions between niche innovations and regime actors, examining the complexities that govern the adoption and dissemination of emerging solutions within the existing socio-technical system (Geels 2002; Rip and Kemp 1998). In terms of mobility paradigms, new technologies such as autonomous self-driving vehicles could represent a driving force for future change.

Transitions theory tends to define systems in socio-technical terms with an assumption that change from one system state to another will be evolutionary and gradual (Kanda and Kivimaa 2020; Meadowcroft 2005), however sudden external changes in the landscape can accelerate change. COVID-19, as a global international pandemic, provided a development and adaptation challenge to all countries and regions (Kanda and Kivimaa 2020; Oldekop et al. 2020). It is proposed that COVID-19 plays at a landscape level which frames the MLP as a 'de-alignment and re-alignment' type of transition (Geels 2019). Therefore, the COVID-19 may have a significant impact on mobility regime while simultaneously providing new opportunities for manufactures as well as other stakeholder taking more sustainable SPSS and business models into consideration (Boons et al. 2013).

3.3.4 The pathways of the transition theory

The Multi-Level Perspective (MLP) equips scholars studying sustainability transitions with the tools to understand why socio-technical changes may occur concurrently across three distinct analytical levels. To circumvent a skewed focus towards bottom-up niche innovations, four transition pathways are introduced and these pathways are outcomes of varying timings and characteristics of interactions at multiple levels (Geels and Schot 2007, pp.406–412):

1. Transformation pathway: When landscape-level changes exert destabilising pressure on the established regime, but niche innovations are still in their early stages, incumbent actors may recalibrate their innovative activities and developmental trajectories.
2. Reconfiguration pathway: In cases where landscape-level changes put pressure on the regime, and niche innovations have achieved a more advanced state, incumbent actors can incorporate these innovations 's 'add-ons' to address specific issues.
3. Substitution pathway: When niche innovations have reached maturity, and landscape-level changes continue to exert pressure on the regime, two potential patterns may emerge. Firstly, niche innovations could replace the existing regime, capitalising on an opportune window. Alternatively, niche innovations could replace the regime due to their inherent momentum, even without landscape-level pressures.
4. De-alignment and re-alignment pathway: If multiple niche innovations are well developed and landscape-level developments destabilise the regime, these niche innovations will co-exist for a period (Geels et al. 2016). Eventually, re-alignment around a single innovation will occur, leading to the formation of a new regime.

3.4 Transition towards sustainability

There have been a series of periodic global scale transitions throughout history marking the shifts such as those from hunter-gatherer to agrarian societies; from agrarian to industrial societies; and from industrial to informational or post-industrial societies. The proposed transition from unsustainable to sustainable societies is arguably an equally fundamental transition that will require changes to a range of currently dominant socio-technical regimes relating to how societies house people, provides them with energy, feed them and moves them. For China, sustainable mobility represents an urgent transitional need due to the range of environmental issues discussed in Chapter 1, especially the current air quality in China (e.g., PM 2.5) and the increased heavy traffic congestion contributing to the majority of air pollution in China (Wen et al. 2020). China is now at the point of significant change that is part of a transition (Lee et al. 2020; Tirachini 2020), however it is not only a technological challenge but an important area for social change.

3.4.1 Transitions and social paradigms.

The socio-technical regimes within transitions theory imply that transitions may require both technical and social changes. The "Dominant Social Paradigm" (DSP) represents the predominant worldview or system of thought within a society and is often framed as a barrier to pro-sustainability changes (Dunlap and Van Liere 1984; Dunlap 2008; Gollnhofer and Schouten 2017). On a micro-level, within industrialised societies the DSP drives consumption by prioritising consumers' happiness and satisfaction over consumer and societal welfare (Gollnhofer and Schouten 2017). On a macro-level, the DSP prioritises the growth of the economy regardless of environmental harm (Dunlap 2008; Gollnhofer and Schouten 2017). The perception that the DSP represents a barrier to the pursuit of environmental protection has led to the proposal of others starting with the “New Environmental Paradigm” (NEP) (Dunlap 2008; Lalonde and Jackson 2002) and developing to include the “New Ecological Paradigm” (NECP) (Cooper et al. 2004; Dunlap 2008) and “Sustaincentric Paradigm” (SCP) (Gladwin et al. 1995a). **Figure 3.2** provides a simplified demonstration of the contrast between the DSP and newer more sustainability orientated paradigms.

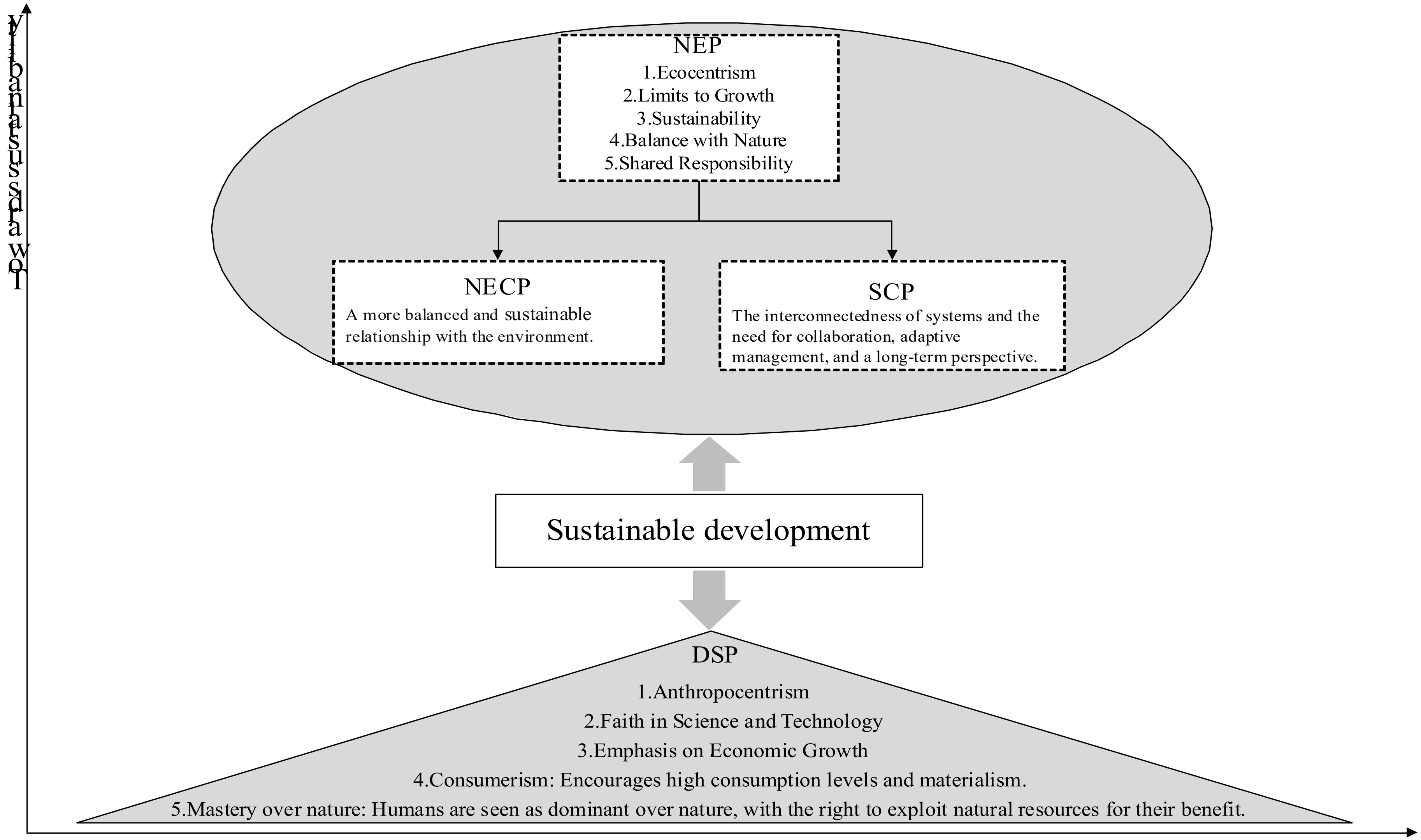


Figure 3.2 The development of DSP and NEP (Developed by the author).

For those seeking to promote more sustainable mobility technologies, it will be important to understand how those elements of the DSP might act as barriers to the development of sustainable mobility systems/business models and/or how can those models connect into elements of the DSP to help improve their prospects for success (e.g. via the harnessing of free markets).

3.4.2 Applying transition theory for sustainable mobility

Given their environmental impacts, conventional urban mobility paradigms have been widely criticised (van Wee et al. 2012) particularly due to the use of conventional vehicles with petrol and diesel engines which are highly polluting, and relating to those market segments where original equipment manufacturers (OEMs) have focussed on producing heavier cars with bigger engines (Burghard and Dütschke 2019; Wells and Lin 2015). Calls for more sustainable urban mobility systems have been growing since 1992 (Freudendal-Pedersen et al. 2020), including a need for transition management that addresses the challenges of reducing environmental damage and improving social equity *"through the stimulation of strategic 'experiments' with promising technologies"* (Geels 2002; Huétink et al. 2010, p.1270). This approach has led to an increased understanding of the necessary behavioural and institutional changes required for more sustainable mobility systems (Sopjani et al. 2019). As a result, the challenges related to sustainable mobility planning have been discussed among scholars in the context of the pursuit of transformation (Geels 2018b; Geels 2019). Transition theory has proven helpful for researching mobility and system transformation (Sopjani et al. 2019) but has been criticised by some scholars on the basis that the MLP prioritises manufacturers' interests while addressing only more minor concerns of consumers (Becker et al. 2021; Köhler et al. 2009). Progress will depend upon developing more integrated practices and systematic changes.

Transition theory highlights the interdependency of the three levels, and the societal system is associated with a range of elements such as economy, culture, infrastructure and other systems which comprise a number of social groups (Geels 2002; Geels 2010b; Juschten et al. 2019; Köhler et al. 2009). The landscape level in the MLP highlights the influence of macro-scale political patterns on both the regime and niche levels. However, concentrating solely on the transition of consumers' lifestyles necessitates greater emphasis on sustainable pressure derived from shifts in consumer behaviour and environmental paradigms to effectively drive change (Geels, 2002; Geels and Schot, 2007).

The landscape-level emphasises the political context and macro-level influences that can affect both regime and niche levels. By focusing on transitioning consumers' lifestyles towards sustainability necessitates an increased emphasis on understanding consumer behaviour and environmental paradigms (Svennevik et al. 2020), as these factors can drive change towards more sustainable practices (Geels 2002). Significantly, the regime level may highlight system integration rather than innovation if existing policies and law restrict social and technological development (Geels 2002; Nykvist and Whitmarsh 2008). Therefore, the majority of scholars emphasise the niche level, which has an impact on individual technologies to implement radical innovation (Köhler et al. 2009).

The regime level can be shaped by both niche and landscape levels, which encompass economic, political, and ecological actors (Geels 2010). Upon identifying a threat, the regimes will coordinate resources among their own actors and those within the niche level to formulate a response (Geels 2010). Thus, elements like business models, policies, and other macro-environmental scales may have an important role in steering the mobility system.

In the sustainable mobility sector, transition theory has been applied by a range of scholars (Wells and Nieuwenhuis 2012; Whittle et al. 2019; Wesseling et al. 2020) while more details will be identified in next sections (e.g., Section 3.4.4 and 3.4.5).

3.4.3 Transition towards low-carbon mobility

Conventional vehicles are associated with consumer satisfaction generated through car ownership and use, the individual freedoms and convenience it provides, and cars' symbolic value (Banister 2008; Juschten et al. 2019). Calls for more sustainable, low-carbon urban mobility partly reflect the pollution, over-production and associated waste of potentially valuable resources linked to the conventional car ownership paradigm (Freudendal-Pedersen et al. 2020; Sopjani et al. 2019; Wells and Nieuwenhuis 2004). This creates two key innovation agendas for the pursuit of low carbon mobility, a technical innovation agenda of eco-innovation in vehicle technologies (and their manufacture) and a social innovation agenda relating to vehicle ownership and use.

Eco-innovation is a key practical pathway towards environmental sustainability (Font Vivanco et al. 2015; Rennings and Rammer 2011) and aims to reduce negative environmental impact while simultaneously helping marketers to satisfy consumers' needs (Rossiter and Smith 2018). Additionally, Kemp and Pearson (2007, p.7) states that:

> "*It is the production, application or exploitation of a good, service, production process, organisational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use (including energy use) compared to relevant alternatives*".

In the sustainable mobility sector, eco-innovation has the potential to integrate with eco-design, clean-tech, urban design, and SPSS to deliver cleaner and more sustainable mobility services (Gandia et al. 2021).

A key technology in the pursuit of more sustainable urban mobility is the electric vehicle (EV). This is not necessarily an 'innovative' technology since the first EV was developed in 1834, and by 1900, EVs represented more than 30% of the total number of cars produced before internal combustion engines began to dominate the market (Chan 2007). Interest in EVs revived during the first oil crisis at the beginning of the 1970s (Rajashekara 1994) but once fuel prices fell again the internal combustion engine resumed its dominant position (Rajashekara 1994). EVs' recent reinvention as a sustainable mobility tool has allowed them to catch the public's interest for the third time in their history (Kley et al. 2011). This three-stage evolution has been driven by external factors like shortage of resources and climate change concerns (Kley et al. 2011).

EVs offer significant benefits over conventional petrol or diesel fuelled vehicles and are potentially less costly to run since electricity represents a cheaper fuel on a per kilometre basis. A number of studies and technological assessments suggest that EVs present a potential reduction in maintenance requirements compared to traditional internal combustion engine vehicles (Hovis 2013). This can be attributed to EVs having simpler drive trains, which have fewer mechanical moving parts (Un-Noor et al. 2017). As a result, the necessity for regular consumption parts like transmission fluid, engine oil and filters can be diminished (Poullikkas 2015). In terms of braking systems, EVs (or hybrid vehicles) contribute to less frequent brake pad changes, by relying on the motor's resistance to decelerate the vehicle and thereby converting kinetic energy into stored electrical energy (Propfe et al. 2012; Tsang et al. 2020). While these advantages point towards a decrease in certain maintenance demands, research indicates that the maintenance for EVs may evolve as advancements in technology emerge and the long-term performance of these vehicles becomes better understood (Poullikkas 2015; Taiebat et al. 2018). This allows them to lower the operating costs of car sharing schemes that use them and also reduce their potential environmental impacts via dematerialisation (Ellen MacArthur Foundation 2018).

Environmental concerns about air pollution, climate change and resource shortages are combining with increased gasoline prices to give battery technology increasing advantages as a mobility technology (Barkenbus 2009; Kley et al. 2011). Electrical-powered products are playing an increasingly important role in the mobility sector (Barkenbus 2009). EVs are considered as an increasingly feasible and comparatively sustainable option in passenger mobility, particularly when integrated with low-carbon power sources (Bubeck et al. 2016; Husain et al. 2021; Muthukumar et al. 2021). To encourage their adoption, in 2016 China's National Development and Reform Commission amended legislation to encourage foreign investment in EVs manufacture, to help meet the government's target of having five million EVs by 2020. EVs still have limitations, including long charging times, limited driving distance, and issues of 'fit' with users' lifestyles (Laurischkat et al. 2016; Ma et al. 2019). In addition, although EVs perform well on running costs, the full life cycle cost remains relatively high (such as battery recycling) (Delucchi and Lipman 2001).

Low-carbon mobility initiatives, including sharing cars that use EVs (particularly lightweight ones), can play a vital role in the transition towards more sustainable mobility systems (Geels 2018b; Geels 2019; Sopjani et al. 2019). As of 2021, the market size of the global EV market was estimated to be over 3 million units, with China leading the way as the largest EV market in the world (Mathilde 2022). Additionally, the adoption of EVs is expected to grow rapidly in the coming years, with the global passenger EV market projected to reach 730 million units (in stock) by 2040 (Bloomberg NEF 2023).

However, transitioning from conventional mobility patterns towards more sustainable patterns may also depend on consumers' behaviour and practice, and wider institutional influences (Sopjani et al. 2019). Therefore, the core challenges for the transition towards low-carbon urban mobility systems not only focus on technology and service innovations, but also aim to understand how these innovations can engage consumers to shift their personal mobility choices (Sopjani et al. 2019).

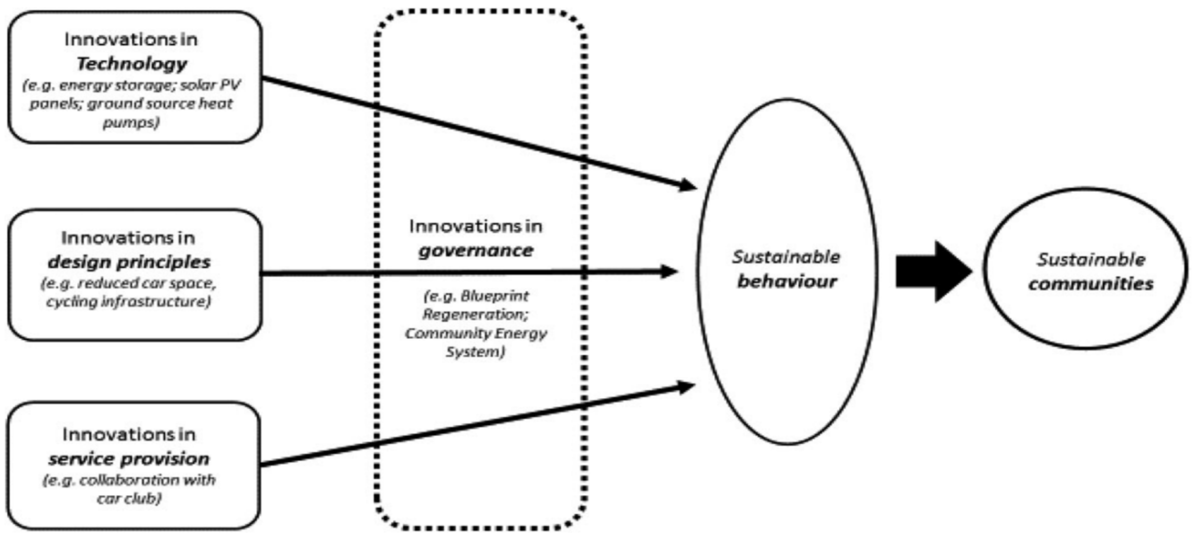


Figure 3.3 Types of innovation derived from a project on the Trent Basin development (Rossiter and Smith 2018, p.22).

Figure 3.3 illustrates the significance of governance innovations to leverage technical and service model innovations, fostering behaviour changes aligned with enhanced environmental sustainability (Rossiter and Smith 2018). The sustainable community for the research purposes represents the Chinese city, with sustainable mobility behaviours as the target behaviour, facilitated by innovations in technology, design and services and supported by appropriate urban transport policies and governance arrangements. Scholars suggest that the role of OEMs in the conventional mobility paradigm is multifaceted, and it is proposed that these central stakeholders are engaged in a strategic shift towards the production of EVs, which could support the transition to low-carbon mobility in some ways. However, the process can be complex, with certain challenges involved (Loder et al., 2023). Such a transition requires shifts, not only in manufacturing practices, but also in supply chain logistics, workforce skill sets, consumer behaviour, and policy frameworks (Ahuja et al., 2020). In terms of transition theory, the Chinese context is one where landscape level pressures can strongly influence the market, either through national or city-based regulation (Qiu et al. 2019). For example, a specific government policy dictates that producing and inventing new energy vehicles (NEVs) is a primary task for OEMs in China (Qiu et al. 2019). The OEMs therefore have the opportunity to contribute to a transition to low carbon mobility by responding to either landscape or city level pressures. For example, at a city level. EVs have more rights of access to locations than conventional vehicles, effectively promoting their use (Qiu et al. 2019). Other influences come more from changes at regime level, for example new business practices like time sharing and leasing services can be driven by OEMs rather than that being imposed on them (Qiu et al. 2019).

3.4.4 Applying the Multi-Level Perspective (MLP) to understand mobility systems

The MLP has been widely used to address and assess sustainable mobility systems (Whittle et al. 2019). **Figure 3.4** gives an overview of how the mobility patterns operate from a MLP perspective. At the landscape level, government policies and the external environment (the economy, culture, climate change and events like the pandemic) will directly impact mobility patterns. However, supportive external landscape pressure does not guarantee progress towards more sustainable mobility (Geels 2018b). For example, sharing bikes in China was seen as a failed product service despite a supportive policy environment as those bikes were subject to over-production and poorly operated schemes (Gu et al. 2019). At a micro level the lack of a viable business model, along with the potential for misbehaviour among consumers or other stakeholders, may create barriers (Evans et al. 2017). Providers may aim to amass more capital and expand their companies, rather than adopt a sustainable plan to operate their businesses. As a result, the landscape level might not achieve success independently; bottom-up approaches, such as regime and niche levels, demand innovations and viable business models for service providers. This calls for a thorough, academic examination of the challenges faced by various stakeholders in the pursuit of sustainable practices.

The regime level can also play an essential role in the mobility activities' reconfiguration (Augenstein 2015; Geels 2018b) since the existing regime is not always stable and inert but is affected by continuous changes including from landscape-level changes such as policy modification (Geels 2018b). These incremental modifications may contribute to the efficiency of the whole system's operation to reduce emissions (Geels 2018b). Nevertheless, climate change, an important sustainability issue, is considered by the majority of scholars to be taken into account by the regimes (manufacturers, institutions, users) since it could potentially lead to negative impacts (Geels 2018b; Moradi and Vagnoni 2018). In contrast, other influential factors such as traffic congestion, vehicle accessibility and safety, insurance legislation, air pollution as well as profits should be considered as they may impact strategies and innovative technologies (Birtchnell et al. 2018; Geels 2018b).

Multiple types of niche-innovations may impact mobility regimes (Geels 2018b):

- New technological niche-innovation, as alternative mobility tools (such as shared EVs) may replace conventional tools such as private cars with internal-combustion engines (Geels 2018b; Qiu et al. 2019);

- New niche-innovation may create new connections between regimes or improve system efficiency (Geels 2018b). For example, intelligent mobility systems such as Apps (WeChat and Alipay that connects with service providers' App) may systematically link sharing-cars and public mobility tools efficiently).

- Mobility demand can be influenced by non-transport niche-innovations, (e.g., remote working and video-conferencing software such as Zoom reducing travel demand). However, developments like remote working, home study or traffic restrictions may also operate at the landscape level (Geels 2018b) as was the case when Covid-19 led to city-wide lockdowns and a shifts towards remote working.

Figure 3.4 does not discuss how people access and use the cars, so EVSS is effectively missing from this analysis and one of the contributions in this thesis is adding that to the understanding of how passenger mobility systems are being reconfigured.

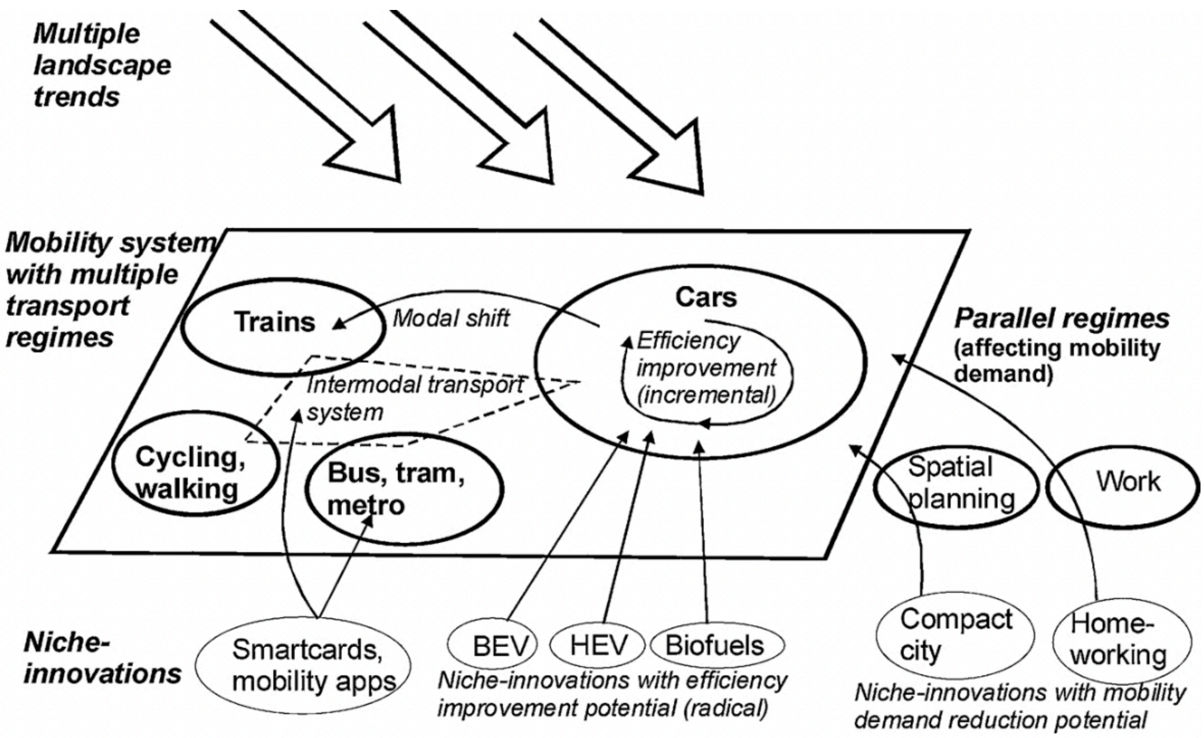


Figure 3.4 Integrative MLP-conceptualisation of passenger mobility system reconfiguration (Geels 2018b, p.88).

3.4.5 Transition of service innovation and information communications technology (ICT)

As Figure 3.4 suggests, non-transport technology innovations (including smartphone apps, sharing services and social networks) are potentially influential within urban mobility systems and markets, impacting users' choices, lifestyles and satisfaction, and the practices of the businesses that serve them (Vecchio and Tricarico 2019). Innovative ICT tools are relevant for mobility, because they promote social interconnectivity and allow the integration of travel modes to make it easier to plan and implement long journeys without car ownership (García-Fuentes and de Torre 2017; Vecchio and Tricarico 2019). ICT tools can improve interoperability among mobility systems, users and operated companies (Vecchio and Tricarico 2019) and can be integrated into cities' (urban) traffic systems to encourage users to interact more efficiently with city infrastructure (García-Fuentes and de Torre 2017). New circular economy orientated consumption practices such as the use of sharing services represent innovative solutions to improve mobility system efficiency that also depend on ICT access and use (Perillo 2013; Vecchio and Tricarico 2019).

Car-sharing services are a product-service system in which ICT represents a complementary technology to the vehicle itself. Users will access the service via online booking and will then use their mobile phone to scan a code to get access to the car. These cars are electric with "high tech" functions such as self-driving, lane-keeping, human-computer interaction, and inductive charging (Borowski et al. 2020). However, there is a risk that appealing to consumer on the basis of such high-tech functions may lead to increased emissions from urban transport systems if they divert citizens away from walking, using bikes and public transportation towards using autonomous vehicles (AV), electric vehicles (EV) and new energy vehicles (NEV) (Freudendal-Pedersen et al. 2020; Crayton and Meier 2017).

3.5 Bridging the gap between the transition theory and Shared Mobility Services (SMS)

Transition theories, including the MLP and innovation systems (e.g., ICT), have been criticised for neglecting important aspects of sociotechnical change, such as the role of individual firms in innovation and the influence of social practices (Sarasini and Linder 2018; Ruhrort 2020; Sarasini and Langeland 2021).The existing model (**Figure 3.4**) inadequately addresses how individuals access and utilise vehicles, resulting in a significant knowledge gap in understanding of the role EVSS might play. A recent upsurge in platform-based shared mobility services, such as car-sharing, bike-sharing, and e-scooter-sharing, has been observed in many countries such as Germany (Burghard and Dütschke 2019; Melkonyan et al. 2020), however, the role of these services in transitioning towards more sustainable, less car-centric, mobility systems remains unclear.

To address these shortcomings, this research will examine the impact of EVSS's business models and stakeholders' integrations on transition processes, emphasising their potential for both inertia and transformation in order to enhance the understanding of how business models influence stakeholders' acceptance of EVSS.

This study aims to explore the role of SMS in triggering system dynamics and feedback loops in city-based mobility paradigm, while also examining the potential for conflict and collaborations between service providers and stakeholders. By examining the market growth of shared mobility services, this study will identify how increasing numbers of shared vehicles could create opportunities to redistribute space and resources away from private cars.

Combining a business model lens with key concepts and constructs from transition theory, this research will explore the sources of transition and inertia that stem from existing business models. Focusing on EVSS with the potential to radically transform road mobility through business model innovation, this study will contribute to the understanding of business model innovation dynamics in sustainability transitions.

This research will also explore how car-sharing business models can potentially shift user mobility practices by modifying their elements, recruiting new practitioners, and creating linkages between relevant stakeholders.

Conventional framings of mobility system evolution, of the type represented in Figure 3.4, tend to emphasise the role played by transport technologies. For progress towards a more sustainable mobility paradigm, it is imperative to also recognise the potential contribution of "smart mobility" technologies. By utilising ICT-enabled service innovations, smart mobility offers a viable pathway for achieving sustainable mobility goals. These innovative solutions not only address environmental concerns but can also contribute to enhancing urban liveability and well-being (Kammerlander et al. 2015).

3.6 Sustainable mobility as smart mobility

The demand for urban mobility has been observed to continually rise, with road-based transportation modes representing the most 'mainstream' among all the options (Prettenthaler and Steininger 1999). The notion of sustainable mobility has emerged in which mobility contributes to economic and social progress but with less damage to the environment and consuming fewer natural resources (Cohen 2010). Sustainable mobility is defined as (Del Pero et al. 2021, pp. 1-2):

> "*Sustainable mobility must address the three imperatives of sustainable development: satisfying human needs, ensuring social justice, and respecting environmental limits. Subsequently, these imperatives must be translated into criteria for assessing the sustainability of the narratives. We argue that there are three such criteria: providing accessibility to basic transport (needs), ensuring equal access to transport services (justice), and ensuring that impacts of transport activities do not threaten environmental sustainability (limits)*".

Sustainable mobility initially emphasised changing mobility patterns and behaviours by encouraging people to cycle, walk and use public transport instead of owning and using a private car (Høyer 2000). Car-sharing services may play an important future role in reducing car ownership in ways that generate economic, social and environmental benefits (Bokolo et al. 2020; Steininger and Bachner 2014; Zhou and Park 2020)).

The mainstreaming of ICT and other technical innovations within mobility systems are referred to as the smart mobility paradigm (Ma et al. 2018; Vence and Pereira 2018), within which the terms "sustainable" and "smart" are often aligned (Ma et al. 2018; Noy and Givoni 2018; Stead and Banister 2001). This paradigm challenges conventional mobility consumption and planning in several ways:

- It shifts travel goals from a focus on meeting individuals' needs towards achieving sustainability goals;
- It seeks to actively manage and control mobility demand, shifting the perspective from reducing travel time and cost towards "reasonable travel time";
- It focuses more on the quality and experience of travelling rather than its quantity.

Sustainable mobility involves decreasing travel demand, with ICT use as one potential solution for reducing travelling (Ma et al. 2018; Vence and Pereira 2018).

Smart mobility is one facet of the broader Smart City paradigm, which aims to provide a better quality of life while simultaneously putting more emphasis on innovative technology to achieve sustainability (Gandia et al. 2021; Stead and Banister 2001). Following this, three themes are particularly relevant to this thesis:

- Individual mobility: involving travel across urban areas, or between points of interest to tourists, emphasising how it can be achieved more sustainably (Peprah et al. 2019).

- Information mobility in the city: Traffic information and business models will be integrated with traffic conditions to reduce traffic congestion and promote mobility flows across cities (Gandia et al. 2021; Peprah et al. 2019).

- ICT mobility: Providing updated online information platforms (including dynamic information for users to check and interact with each other) allowing users to choose suitable mobility options before starting a journey (Peprah et al. 2019; Ubakanma et al. 2016). Simultaneously, this information (such as speed, restricted zone, prices and traffic condition operated by GIS systems) can be updated and communicated during travelling.

The diffusion of smart mobility represents an opportunity to reduce negative environmental impacts, dependency on fossil fuels, and traffic congestion worldwide (Wappelhorst et al. 2014). However a transition to smart mobility systems may face several possible barriers (Cellina et al. 2016; Freitas et al. 2017; van Oers et al. 2020; Vrščaj et al. 2021; Wappelhorst et al. 2014) including:

- A lack of charging stations and vehicle driving range;
- Battery recycling issues;
- Public transportation infrastructure limitations;
- Users' lack of awareness of sustainability and related smart mobility benefits;
- Mismatches between specific innovations and technologies and users' needs.

Overcoming these will depend upon creating technically and economically viable services and businesses that provide mobility services to consumers in a convenient and affordable way that addresses their needs.

3.6.1 Mobility-as-a-service (MaaS)

MaaS, is an innovative technological product-service system contributing to a "green travel" transition in the mobility paradigm (Gandia et al. 2021). The initial comprehensive description of MaaS was generated in Finland in 2014, and it is explained as a mobility activity provided by a service operator integrated with dynamic transport patterns that offer multiple mobility options (Jittrapirom et al. 2017). Moreover, researchers also suggest that automobility as a service can exclude public transport (Wells et al. 2020). Given these characteristics, the function of MaaS can be generalised into three themes (Gandia et al. 2021):

- Individualised innovation: MaaS is designed for users' mobility options, which puts more weight on consumer experience, satisfaction, users' accessibility and functional efficiency through sharing and personalisation in real-time interaction (Gandia et al. 2021; Mulley et al. 2020). Practically, in terms of its simplicity, MaaS provides convenient access for users to achieve an efficient decision-making process (Golub et al. 2019). In terms of its flexibility it provides alternative options for users to adopt by providing and comparing different prices, times, distances of different mobility tools (Gandia et al. 2021). Consumers may also combine several different mobility tools to complete their journey efficiently (Mase 2012);

- Integrated service: MaaS provides a range of service packages for users to choose different service levels based on their needs (Gandia et al. 2021);

- Potential market opportunities: MaaS provides new market channels, addressing users' preferences and demands, while providing a major data platform for operators (Gandia et al. 2021; Lyons 2018).

A range of factors will determine the potential success of a MaaS initiative including technology factors, market and profit opportunities for commercial actors, governance arrangements and acceptability to potential users (Gandia et al. 2021). In terms of the final point of "User Acceptability", four driving factors can be observed in previous literature (Epprecht et al. 2014):

- Users' preference for different mobility tools and their attitudes towards innovative mobility (Epprecht et al. 2014);

- Attitudes towards public transport since positive attitudes may contribute to accepting MaaS, reducing pollution and costs (Gandia et al. 2021);

- Attitudes to ownership. Although MaaS may provide a vehicle to meet users' mobility demand practically. A car has symbolic value, and users may be motivated by emotions that are more important than practicalities (Steg 2005);
- Electrical device application. As users interact with MaaS through multi-media rich applications, understanding users' motivation and preferences is increasingly possible and valuable This understanding could capture behavioural determinants behind the adoption of technologies like self-driving cars and predict trends in public transport sharing and car ownership (Epprecht et al. 2014)

These factors can help to reduce car ownership and allow cars to be used more efficiently within the MaaS paradigm through PSS innovations such as a car-sharing service (Kim et al. 2019; Schlüter and Weyer 2019; Svennevik 2019).

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

MaaS represents an evolution in the sustainable mobility paradigm in which vehicle ownership is replaced by consumers accessing vehicles via a PSS. Such systems can contribute to sustainability through greater efficiency of vehicle use, but this has the potential to be enhanced by also adopting vehicles with a lower environmental impact in the form of an electric vehicles delivering eMaaS (Ellen MacArthur Foundation 2018). Electric vehicle sharing services (EVSS), represent a type of eMaaS scheme that combines the structure of a PSS with "electric" as a more sustainable technology and energy source for urban mobility systems (Johansson et al. 2019; Luo et al. 2021), have the potential to reduce environmental impacts and alleviate urban traffic congestion (Bokolo et al. 2020; Luo et al. 2021). eMaaS can also contribute to more sustainable mobility indirectly via the heterogeneous data generated from users of EVSS and other stakeholders (Service providers, traffic department and charging station) (Bokolo et al. 2020). These data can be used to analyse consumer behaviour, service quality, vehicle utilisation, traffic status, air quality, the efficiency of a smart city or urban transport network, as well as to ensure users' safety (Brezovec and Hampl 2021). This can assist service providers in providing value-added services, extending business opportunities, and improving citizens' quality of life by utilising these data. Mobility solutions such as EVs, light city EVs (LCEV), e-bikes and scooters are increasingly available from "shared mobility services" (SMS) that provide access to the product as a service (Costa et al. 2022; Geels 2018; Qiu et al. 2019; Looser and Mohr 2020).

In terms of the relationship between eMaaS and EVSS, the latter is one type of the former and this thesis will generally refer to eMaaS in terms of the contribution that EVSS makes to eMaaS in practice and our understanding of it.

3.7 Chapter Summary

This chapter critically discussed transition theory as a theoretical underpinning for this thesis and to outline a potential research gap. Together with an exploration of eMaaS schemes this provides a 'big picture' perspective on the development of more sustainable urban mobility systems. The next chapter applies these theoretical insights in a more specific and practical context to explore sustainable urban mobility in Chinese cities. This exploration uses sustainable business models as a focus, showcasing innovative technologies and the development of EVSS by firms as a specific contributor to more sustainable urban mobility in China.

Chapter 4. Business models for innovative urban mobility services

4.1 Chapter introduction

Urban mobility plays an important role in building more sustainable cities and meeting travel needs within them, especially in major cities like Shanghai that is included within this study (García-Fuentes and de Torre 2017; Ma et al. 2018). Reducing private car use is one of the critical challenges in promoting sustainable mobility, and better balancing economy and environment within cities (Valsecchi Ribeiro de Souza et al. 2019). There is a growing consensus that a transition is needed towards sustainable mobility in urban areas (Ambrosino et al. 2016) to improve the quality of travel experiences, reduce the negative impacts of congestion on the environment and economy, stimulate innovation in mobility solutions and better involve multiple actors across society (Valsecchi Ribeiro de Souza et al. 2019). Approaches such as PSS and MaaS, and innovative technologies such as EVs and ICT-based travel apps, all have the potential to contribute, but delivering this potential will depend upon the generation of new business models that can deliver innovative services in the mobility market.

Ride-hailing services like Uber represent one form of new business model with claims to contribute positively by providing an alternative mobility solution to private car ownership and promoting shared rides. However, there is an ongoing academic debate regarding their actual impact on traffic congestion, public transport use, and carbon emissions (Tirachini 2020). In addition, there is a lack of focus on understanding the specific factors involved in integrating innovative and sustainable business models into the broader mobility paradigm (Cassetta et al. 2017; Valsecchi Ribeiro de Souza et al. 2019). Marketers have promoted low emission solutions at a firm level, but less is known about how these solutions can achieve economic satisfaction and environmental sustainability while simultaneously successfully enabling a sustainable business model in the market (Bocken et al. 2020; de Souza et al. 2019; García-Fuentes and de Torre 2017). Therefore, considering new eMaaS-based business models, this chapter will discuss the intersection between the sustainable urban mobility literature, sustainable business model literature and business model innovation literature.

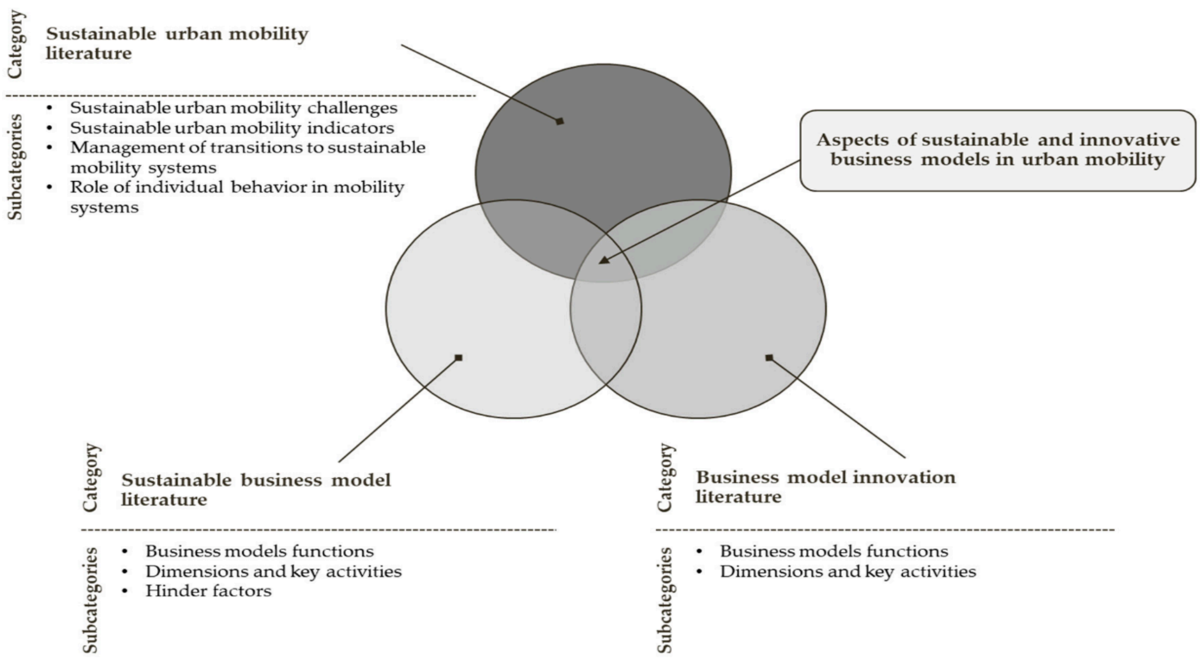


Figure 4.1 The intersection in three key literature related to urban mobility paradigm (Valsecchi Ribeiro de Souza et al. 2019, p.1761).

Figure 4.1 shows how these three key literatures are relevant in understanding the evolution of urban mobility patterns and the businesses that comprise them, and their intersection helps to understand the driving factors that allow sustainable and innovative business models to diffuse within the urban mobility market (Bellini et al. 2019; de Souza et al. 2019; Vence and Pereira 2018). These factors include (Valsecchi Ribeiro de Souza et al. 2019):

- Adopting new cleaner energy;
- Reconfiguring the capacity of transport resources;
- Using sustainable modes to encourage technological innovation that allows the substitution of renewable resources;
- Providing sustainability-orientated services that discourage car ownership;
- Identifying and satisfying the needs of all stakeholders in urban mobility patterns;
- Reducing the demand for travelling;
- Creating value for environment and society from a systematic view;
- Providing multiple sustainable mobility solutions that can extend benefits by reaching a wide range of customers.

4.2 Business models and innovation

There is no single agreed definition of the term "Business Model" within the literature (Cohen and Kietzmann 2014, but a widely used one comes from Ostenwalder et al. (2005, p.5): *"A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm."* Other contributions stress the central role of certain ideas about "value" in the literature, including economic value, consumer value and the value of delivery and creation (Schaltegger and Wagner 2011). This is reflected in a helpful definition of a business model (from an economic perspective considering individual companies) from Teece (2010, p.179):

> *"The design or architecture of the value creation, delivery and capture mechanisms. The essence of a business model is that it crystallises customer needs and ability to pay, defines how the business enterprise responds to and delivers value to customers, entices customers to pay for value, and converts those payments to profit through the proper design and operation of the various elements of the value chain."*

Furthermore, Wells (2013b, p.28) states that a business model may help to address a firm's strategy: *"Business models may allow or constrain certain strategic choices, and open up or restrict certain market opportunities, either accidentally or by design."* Wells (2013b, pp., 28-29) discusses the interplay of business models and technology innovation, delineating four scenarios in which innovation can stem from technology, the business model or both together (See **Figure 4.2**).

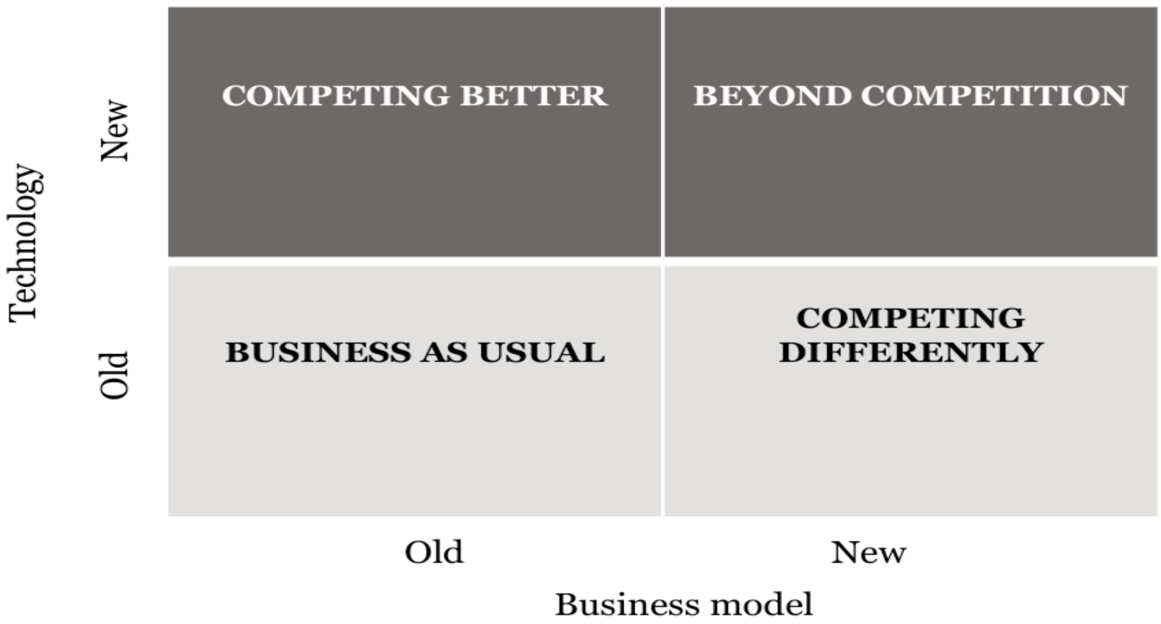


Figure 4.2 The interplay of business model and innovative technology (Wells 2013b, p.29)

These core notions of value creation, stakeholder relationships and strategy are combined to generate four BM building blocks as follows (Boons and Lüdeke-Freund 2013; Doganova and Eyquem-Renault 2009):

- A value proposition model: which provides a guideline for the ecological and social value measurement alongside economic value;
- A supply chain model: to identify responsible suppliers and their value contribution;
- A customer interface model: to explain how customer needs are met and customer welfare addressed;
- A financial model: to ensure a viable business is achieved from the delivery of value to customers and other stakeholders.

Business model innovation (BMI) is a potential mechanism for combining sustainability with business strategies (Osterwalder et al. 2005; Sarasini and Langeland 2021), however: assessing the impact of sustainable innovation is complex and requires an understanding of impacts throughout the entire 'business ecosystem' (Evans et al. 2017; Sarasini and Langeland 2021). BMI considers a wide range of stakeholders rather than just the economy, and it considers all stakeholders' needs including environmental protection and social contribution (Evans et al. 2017). As a result, BMI can potentially deliver continuous value to consumers while contributing to the sustainable development of the company and society (Evans et al. 2017; Perrini and Tencati 2006).

4.3 Business models for mobility (BMM)

The connection between commerce and sustainability can be an important discussion concerning the enduring well-being and contentment of humanity. This may apply to nations that have already undergone industrialisation and those currently experiencing its transformative effects (Wells 2013a). Specific business model concepts and theoretical perspectives can be characterised by particular production and consumption systems. Business Models for Mobility (BMM) may be defined as follows: The mobility provider offers a journey from point "A to point "B" as a product/service. This model posits that the customer does not necessarily own the mobility tool, such as a car (Giesecke et al. 2016; Kley et al. 2011).

Moreover, certain providers may have time and distance limitations and the provider aims to allow the customer can cover a specific distance whenever needed. This reflects the customer-centric nature of these models, focusing on satisfying user mobility requirements without vehicle ownership (Lehmann-Ortega and Schoettl 2005; Kley et al. 2011).

Based on the description above, the classical BMM can be generalised into three elements (Lehmann-Ortega and Schoettl 2005; Kley et al. 2011):

- Value proposition: In a conventional BMM, this could involve an OEM delivering a vehicle with a specification and features that the customer prefers. When looking at MaaS, the service provider may offer use of the preferred vehicle for a specific time.
- Systematic value chain: Configure the potential stakeholders in the product design chain. For the traditional BMM, OEMs provide the mobility tools and related parts (like service parts) that customers can use during a specific period to guarantee their mobility needs. In terms of MaaS, the customer might be connected to different external services based on their needs before and after the trip.
- Profit model: involving patterns of ownership and payment types, from pay-to-own, to leasing or pay-as-you-drive models with refuelling, charging, and maintenance charged separately.

New BMM can involve long established technologies (such as trams and bikes), new technologies (such as e-scooters) or new incarnations of old technologies combined (such as EVs). To deliver new BMMs providers are increasingly adopting innovative technology to improve user benefits and deliver additional value (Kley et al. 2011; Markeset and Kumar 2005). These innovative BMMs tend to place greater emphasis on electric mobility (E-mobility) patterns. Kley et al. (2011) suggest that new BMMs can be generated in four main ways:

- Extend vehicle capacity utilisation: e.g., new BMMs providing car-sharing services that lower users' costs and need for vehicle ownership. This can be applied to EVs as they have lower consumption costs compared to conventional cars. EV service can also be applied to public mobility tools which may satisfy customers' specific journey needs.

- Reconfigured utilisation concepts: e.g., new service systems can be applied to EV charging issues to improve economic efficiency by charging in off-peak periods.

- Reuse vehicle components: e.g., This may relate to intelligent energy management as the battery of high-speed cars can be used in low-speed mobility tools. For example, swapping and reconditioning the used batteries from relatively high-speed EVs and reusing them for relatively low-speed EVs such as electric farm vehicles.

- Increase product acceptance: e.g., EV's driving range is limited, charging points can be displayed in the navigation system. In terms of sharing services, providers may be able to offer innovations such a battery swapping services to avoid prolonged charging periods although such swap systems seem to have struggled to gain a presence in the market (Sarker et al. 2015). For example, companies like NIO have made strides with its battery swapping stations in China, demonstrating that such a system can be successful in the market.

Figure 4.3 shows three fundamental types of business models in the context of BMM. The transactional product-orientated model is often seen as the classical one in which manufacturers provide a tangible product for purchase sometimes backed by extra services (Kley et al. 2011). In contrast, more relational service-oriented models provide benefits throughout service period (Kley et al. 2011).

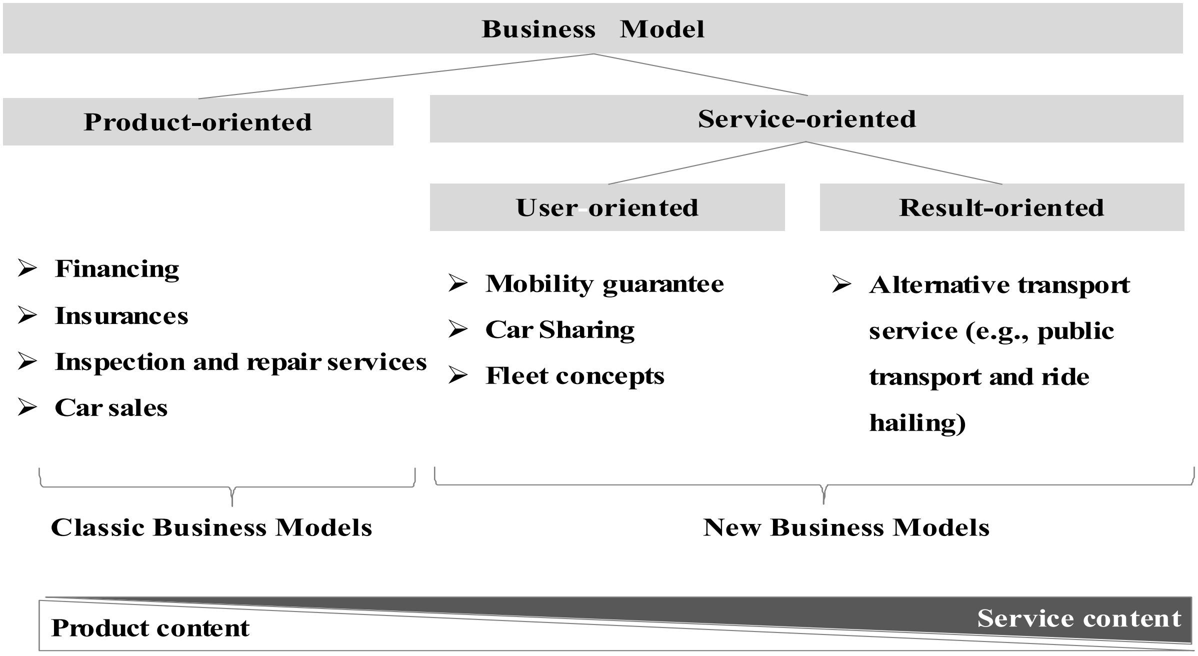


Figure 4.3 Applying Tukker's (2004, p.248) typology to business models for mobility concepts (developed by the author).

4.4 Sustainability-oriented business models

Business sustainability studies have developed from an emphasis on evolving specific products or business functions to an increasing focus on extending current business models to explore new sustainability-oriented business models (Boons and Lüdeke-Freund 2013). BMI is one way through which more sustainable production and consumption systems can be developed and is a key element of CE strategies. Five types of more sustainable and circular BM have been identified (EMF 2013), four of which: refurbishment/remanufacture, repair/reuse, sustainable materials management, and industrial symbiosis, are primarily focused on production issues and materiality. They may require changes from consumers (e.g., accepting recycled products or returning used products), but consumption orientated changes within the BM are often minimal. The fifth type, PSS, requires a more fundamental change to all elements of the BM. The sustainability benefits of PSS use have been challenged. Junnila et al. (2018; 2020b) and Wells et al. (2020) empirically demonstrated that financial savings from PSS use often contributed to carbon-intensive services such as holidays, thereby counteracting any environmental benefits achieved.

4.4.1 Business model innovation for sustainability (BMIfS)

Business model innovation for sustainability (BMIfS) can be achieved by ICT (new technologies) and by product-service innovation, as well as by reconfiguring the relationships amongst the stakeholders (Evans et al. 2017; Zhang et al. 2015). Firms (which perform successfully in BMIfS) transform these relationships by considering a sustainable and long-term perspective that benefits the critical internal and external stakeholders (Evans et al. 2017; López et al. 2019).

In summary, these stakeholders provide multiple perspectives for BMI towards BMIfS (Evans et al. 2017):

- Sustainable value forms conceptualise economic, social, and environmental benefits;
- BMIfS may require systematic and sustainable value flows among a wide range of stakeholders, which consider the environment and society as essential stakeholders;
- BMIfS may perform well with a value system integrated with sustainable aims, design, and governance;
- BMIfS may also need to understand and address all the stakeholders' benefits and duties for interactive value creation;
- Integrating SPSS with innovative technologies towards foster BMIfS.

Within the mobility sector MaaS initiatives such as car sharing services represent an obvious example of BMs that are innovative and more sustainable. EVSS can also be understood as a more sustainable business model both due to the resource efficiency of their MaaS basis and their use of EVs as a technology. The majority of scholars believe that firms can take "sustainability" into consideration in their BM (Laurischkat et al. 2016; Singh Pahwa and Goyal 2019), aiming to make their BM lives longer (Laurischkat et al. 2016; Polydoropoulou et al. 2020; Zarazua de Rubens et al. 2020).

Understanding the sustainability implications of new service-based BMMs is aided by using a "Sustainability- Oriented Service Innovation" (SOSI) perspective which provides a systematic approach to service innovation, involving a range of stakeholders (Calabrese et al. 2018). Although some within the business model for innovation community have a critical view on the business model canvas. For the researcher's purposes, it can be helpful to understand the business. Thus, before explaining SOSI in more detail, it is helpful to outline the Business Model Canvas, as established by Osterwalder and Pigneur (2010), which operates as both a precursor to, and component of, the SOSI perspective.

4.4.2 Business model canvas (BMC) for eMaaS

The BMC was created by Alexander Osterwalder and Yves Pigneur. It was first introduced in their book "Business Model Generation" published in 2010. **Figure 4.4** shows that BMC includes nine building blocks and the six building blocks of value proposition design, which are a detailed explanation of the two BMC blocks—value propositions and client segments—have been established (Lewandowski 2016; Polydoropoulou et al. 2020). BMC is a strategic management and entrepreneurial tool that allows individuals and organisations to describe, design, challenge, invent, and restructure their business models (Faedo et al. 2010).

Sarasini et al. (2017) explored the BMC framework to figure out various strategies by which MaaS can create sustainable value. This sustainability can be linked with several aspects, such as mobility services, data-based services, environmental technology, and material recirculation. Polydoropoulou et al. (2020) use BMC to address infrastructure, operator capabilities, regulations, social values and how technologies can be adjusted for MaaS schemes.

However, there is gap in that few scholars address how BMC can be implemented into eMaaS schemes within the urban mobility ecosystem.

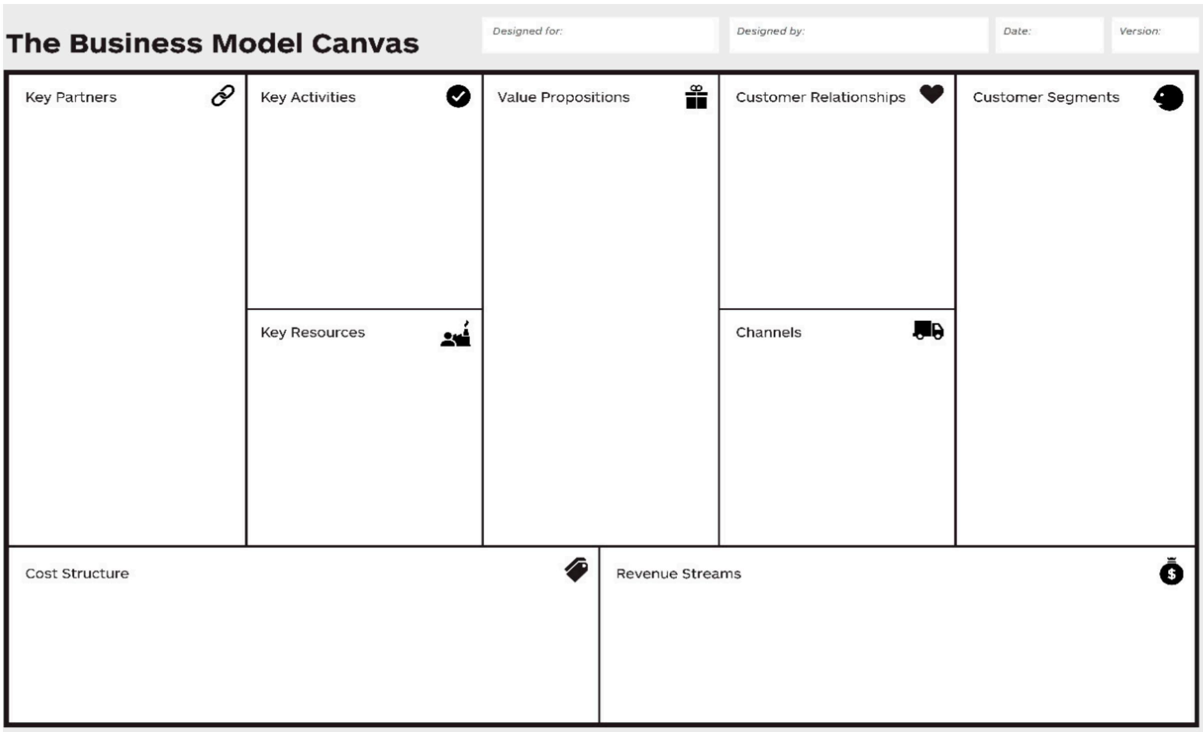


Figure 4.4 Business model canvas (Lewandowski 2016, p.11)

4.4.3 Business ecosystems: A framework for understanding co-evolution

An understanding of the dynamics involved in business models and the impacts of external factors on the strategies of companies within a given market, that goes beyond a perspective limited to individual companies or specific supply chains, comes from the field of business ecosystems. The literature of business ecosystems is usefully summarised by Mäkinen and Dedehayir (2012) who frame business ecosystems as analogous to biological ecosystems that encompass a range of interdependent species that may be very different in nature (including plants, insects, birds and animals). A business ecosystem is a network of interdependent companies (and possibly other types of organisations) who, although potentially very different in nature and roles (including the industry within which they are located), combine efforts to deliver a product or service within a shared environment (Mäkinen and Dedehayir 2012). This concept goes beyond traditional notions of market structure, competition and cooperation (Moore 1993), allowing market players to cooperate as well as compete in efforts to innovate, develop capabilities and secure competitive advantage (Moore 1993).

A core idea concerning business ecosystems is the concept of co-evolution, in which independent organisations, some of which may be competitors to each other, evolve in an interconnected and reciprocal way (Mäkinen and Dedehayir 2012). The purchasing of products and services, knowledge sharing, the provision of support and other wider interactions can drive such co-evolution (Mäkinen and Dedehayir 2012). The business ecosystem perspective can help to understand the developmental impact between businesses and their external environment, for example in cases where an external change in the business ecosystem affects a business indirectly by impacting another ecosystem member, or by creating a system bottleneck that is not in the firm's direct supply chain (Gomes et al. 2018; Mäkinen and Dedehayir 2012).

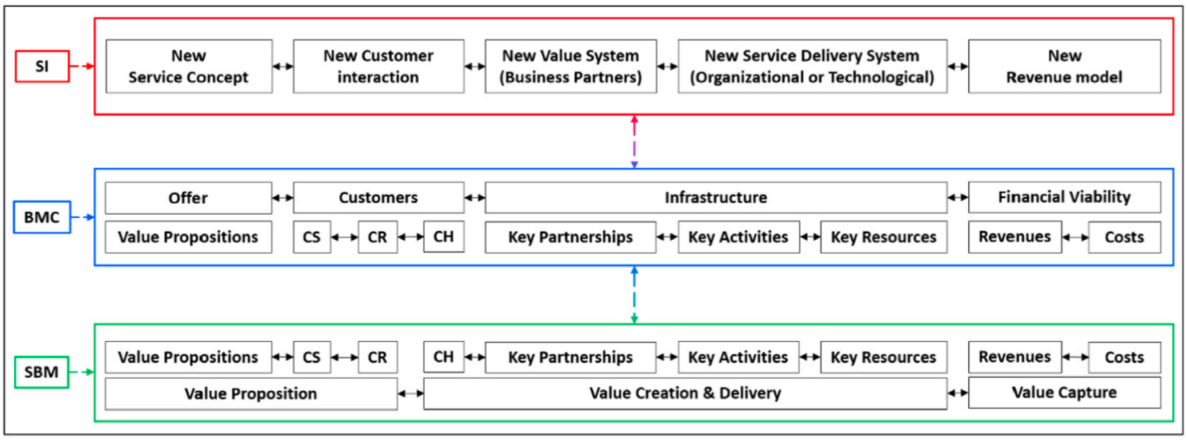
Examples of business ecosystems within the literature include some that are centred around the technologies or processes of a single company (such as Amazon), a specific technology such as the mobile phone, of something much more diffuse such as the notion of an internet ecosystem (Mäkinen and Dedehayir 2012). The automotive industry could be considered such an ecosystem, and one that has been proposed that has similarities to EVSS services is that of car leasing (Pierce 2009). Pierce (2009) emphasises the impact of core firms on the ecosystem's structure and dynamics. This may bring insights to EVSS schemes as an natural ecosystem which compromise various stakeholders, such as core firms (EVSS providers), governments, OEMs, urban citizens and other public transportations. Section 4.8 will explore more about stakeholders.

The transition to shared mobility models, like car-sharing and ride-hailing services, arguably reflects a sustainable shift in the wider automotive industry's business ecosystem. Shared mobility business models challenge traditional vehicle ownership and have implications for urban planning, environmental impact, and mobility consumption. However, evolving business models within a business ecosystem-based framework will not be without challenges. For example, satisfying different stakeholder interests, keeping pace with regulatory changes, and scaling sustainable practices can be important factors that will influence the effectiveness of these models.

4.5 Sustainability-Oriented Service Innovation (SOSI)

Understanding the sustainability implications of new service-based BMMs is aided by using a SOSI perspective which provides a systematic approach to service innovation, involving wider stakeholders (Calabrese et al. 2018).

Both empirical and theoretical research using SOSI are still under-developed in the literature (Yun et al. 2020), but as demonstrated in **Figure 4.5** it connects and integrates three critical models: den Hertog et al.'s (2010) Service Innovation (SI) model; Osterwalder and Pigneur's (2010) Business Model Canvas (BMC); and Bocken et al.'s (2014) Sustainable Business Model (SBM).



Note. *The acronyms in the figure, i.e. SI, BMC, SBM, CS, CR and CH respectively identify: Service Innovation, Business Model Canvas, Sustainable Business Model, Customer Segments, Customer Relationships and Channels.*

Figure 4.5 Conceptual frameworks of SOSI (Calabrese et al. 2018).

The resulting SOSI tool, shown in **Figure 4.6**, converts the SOSI concept into four broad themes and nine specific factors. The four themes provide more significant opportunities to identify core business plans while simultaneously the nine factors contribute to understanding the utilisation of SOSI (Calabrese et al. 2018). SOSI may be applied to new service design, building up the new delivery systems and stimulating the interaction with users by taking a holistic approach to the three dimensions of business, environment and society (Janssen et al. 2016). In particular, by adopting SOSI tools, firms may be able to (Calabrese et al. 2018):

- Apply valuable proposition into service designing process;
- Maintain multiple consumer segments;
- Build up new partnerships and customer relationships;
- Utilise resources;
- Provide extra benefits for the whole society.

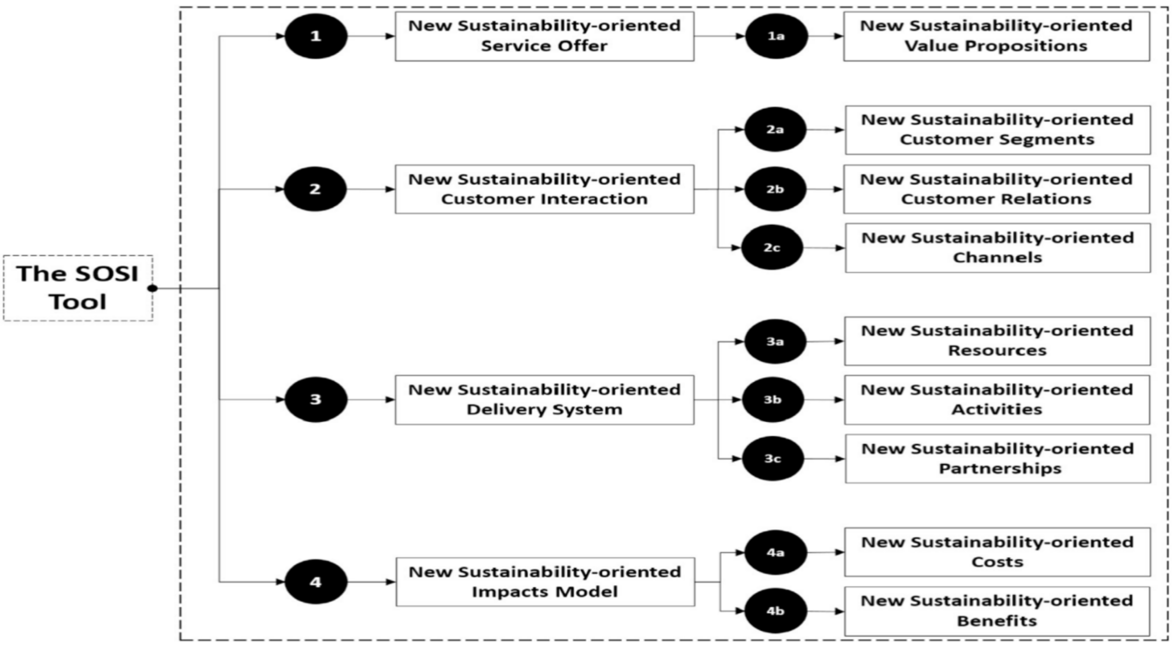


Figure 4.6 The SOSI tool's framework consists of four macro elements and nine associated micro factors (Calabrese et al. 2018).

4.6 Shared mobility services for sustainability

Shared mobility services in the sector of public transport have operated for decades world-wide, and the emergence of ICT tools have both enhanced these services' quality and allowed new private sector shared mobility ventures to thrive. In China, shared mobility services have emerged, supported by the central government, to address the gap of supply and demand for more sustainable mobility solutions (Cohen and Kietzmann 2014; Firnkorn and Müller 2011; Yoon et al. 2017).

Car-sharing services have experienced a significant increase in recent decades, and by 2014 there were more than 600 companies providing this service globally (Cohen and Kietzmann 2014). These companies provide multiple solutions that allow customer to avoid the financial and practical costs of owning a vehicle. Instead, customers may be charged by distance and/or time. A car-sharing business model may provide an important benefit for users and local transportation networks since each shared vehicle may remove up to 20 private vehicles (Jochem et al. 2020; Li et al. 2022).

Practical experience of car sharing services and EVSS internationally have shown varying results and that establishing a profitable business without ongoing support from government in the form of subsidies (Lagadic et al. 2019). For example, Autolib, in Paris represented a high-profile sharing service that ultimately failed because of high operational costs and low utilisation, lack of regulatory support, a competitive charging market and users' preference shifting (Brown, 2018; Golalikhani et al. 2021; Lagadic et al. 2019). In contrast, Mobility Car-sharing in Switzerland is widely viewed as a successful and profitable model (Lagadic et al. 2019). It has succeeded in achieving a balance between vehicle availability and utilisation to meet user needs by managing a well-structured and integrated approach, complementing the public transport system (Juschten et al. 2019). Car sharing benefits for reducing cars, environment and congestion, but so far experience has shown both success and failure. The types of car-sharing business models are summarised in Table 4.1 (Cohen and Kietzmann 2014; Martin et al. 2010).

Table 4.2 demonstrates three main car-sharing models: traditional, one-way, and peer-to-peer. Traditional car-sharing exhibits positive environmental impacts by reducing car ownership, but benefits highlighted in research may be affected by self-selection bias (Cohen and Kietzmann 2014). One-way car-sharing's environmental influence is ambiguous, as it could either support car-free living or replace other sustainable transport modes for individuals (Liao and Correia 2022). Research on this model is limited, but pilot programs are in progress. Peer-to-peer car-sharing enhances vehicle utilisation and reaches low-density areas but faces policy, trust, and insurance obstacles. Its environmental effects are uncertain and require further investigation (Cohen and Kietzmann 2014; Martin et al. 2010).

In addition, European car-sharing development (**Table 4.2**) primarily features traditional models, with Switzerland as a frontrunner. Members are predominantly male private users and exhibit a lower car ownership rate while favouring public transit passes. The displacing of private vehicles varies, with compact cars prevalent in car-sharing fleets (Sprei and Ginnebaugh 2018).

Table 4.1 Car-sharing business model for sustainability (Cohen and Kietzmann 2014).

Segment	Value proposition	Supply chain	Customer interface	Financial model	Examples
B2C point to point	Reduces emissions and congestion	OEM vehicles; some programs using EVs and hybrids	Shift from vehicle acquisition to shared use	More affordable access to a vehicle than owning and maintaining	Car 2 Go
	A vehicle when you want/need one and no requirement to return to same location			Potential for profitability and exit	
B2C roundtrip	Reduces emissions and congestion	OEM vehicles; some programs using EVs and hybrids	Shift from vehicle acquisition to shared use	More affordable access to a vehicle than owning and maintaining	Zipcar
	A vehicle when you want/ need one			Potential for profitability and exit	
Nonprofit/ cooperative	Reduces emissions and congestion	OEM vehicles; some programs using EVs and hybrids	Shift from vehicle acquisition to shared use	More affordable access to a vehicle than owning and maintaining	Modo
	A vehicle when you want/ need one			Member revenue, sponsorship, government subsidies/grants	
P2P	Reduces emissions and congestion	P2P models are unique in that they require virtually no additional production or suppliers; instead P2P firms serve as intermediaries between owners and renters; that is, generally more environmentally sustainable than B2C models	P2P models encourage vehicle owners to share a resource	Provides additional income to vehicle owners to offset the high cost of ownership	Relay Rides
	A vehicle when you want/need one and no requirement to return to same location		For the renter it also shifts from acquisition to shared use	For renters it provides more affordable access to a vehicle for than owning and maintaining a personal vehicle	Flight Car
	Usually more variety of vehicle types for renters			Scalable revenue model based on a percentage of transaction without need to acquire vehicles	
	For the owner, a way to generate extra income from a subutilized resource				

Table 4.2 Overview of car-sharing models, key characteristics, and their impacts on car ownership and the environment.

Car-Sharing Model	Key Characteristics	Impact on Car Ownership and Environment	Sources
Conventional Car-Sharing	Access to a fleet of vehicles with designated parking spots	Reduced/delayed car ownership	(He et al. 2017)
	Vehicles can be reserved for hours to days, then returned to parking spot	Fewer vehicles on roads	
		Enhanced fuel efficiency	
		Decreased emissions	
		Altered travel behaviours	
Point-to-Point (Free-Floating)	Vehicles picked up at one location and dropped off at another	Unclear impact on energy consumption and VMT	(Le Vine et al. 2014)
	Vehicles parked on streets with permits or in designated zones	May promote car-free lifestyles	
		May substitute eco-friendly transportation options	
Peer-to-Peer Car-Sharing	Members lend or rent personal vehicles to other drivers	Ambiguous energy and environmental effects	
	Enhances vehicle utilisation	Increases vehicle utilisation	(Bocken et al. 2014)
	Better suited for areas with lower population density	Vehicles involved may be older and less efficient	(Sprei and Ginnebaugh 2018)
European Conventional Car-Sharing	Emerging markets in 14 countries, with over 1% of Switzerland's population participating	Displaces 4-8 personal vehicles per car-sharing vehicle	
	Predominantly serves private clients, with a majority of male members aged 26-49	Members possess fewer cars	(Glotz-Richter 2016)
	Members more inclined to own public transportation passes	Compact vehicles dominating fleets	

4.7 Towards shared mobility in China

The continuous development of urbanization in China, increasing travel demand, and flawed public transport systems bring major challenges to urban transport nationally, especially for high mobility demand areas like the Yangtze River Delta Economic Zone (Hu and Creutzig 2022). The growth rate in urban roads was 6.4% in China annually from 2010 to 2018, with a vehicle ownership growth rate of 16.8% annually (Mi and Coffman 2019; Hu and Creutzig 2022). While expanding car ownership may meet mobility demand temporarily, it has various negative consequences such as traffic congestion, air pollution and carbon emissions (Wu et al. 2019; Yu et al. 2020).

Since 2010, shared mobility in China has experienced rapid growth (Mi and Coffman 2019). However, current literature may not sufficiently explain how this market has developed, how this mobility option shapes daily transportation patterns, and what can be achieved by emerging shared mobility in relation to environmental goals and climate change (Sun et al. 2019; Zhang and Mi 2018).

EVSS are gaining importance as a means of fostering more sustainable transportation development (Bruglieri et al. 2014; He et al. 2017; Galatoulas et al. 2018). By transitioning private mobility from vehicle ownership to service usage, EVSS encourages the adoption of energy-efficient vehicles, such as EVs, which have lower operational expenses and enhanced energy efficiency (Bruglieri et al. 2014; He et al. 2017; Galatoulas et al. 2018). This makes them less susceptible to fossil fuel scarcity and uncertainties in crude oil supply. Moreover, EVs can utilise various electricity sources, including solar and wind energy (Bruglieri et al. 2014; He et al. 2017; Galatoulas et al. 2018).

The effectiveness of EVSS depends on tailoring the service to accommodate users' mobility requirements and offering a diverse range of vehicle choices (Bruglieri et al. 2014; Galatoulas et al. 2018; He et al. 2017). Research indicates that the majority of EVSS schemes achieve greater environmental advantages than simply replacing privately-owned gasoline vehicles with EVs (Bruglieri et al. 2014; Galatoulas et al. 2018; He et al. 2017). Furthermore, deploying moderately fast, rather than the fastest charging technologies, has been found to be adequate for optimizing fleet usage and service coverage.

The potential environmental benefits of EVSS, combined with the potential advantages they can offer consumers and their accordance with governmental policy might seem like a guarantee of marketplace success. However, the research evidence concerning vehicle sharing services provides of examples of successful schemes such as Switzerland's Mobility Carsharing (Juschten et al. 2019; Lagadic et al. 2019; Suter & Gmür 2014) and also failures such as Paris's Autolib (Lagadic et al. 2019). Such successes and failures each provide potentially valuable lessons for future providers of EVSS in Chinese cities, but key insights from a review of vehicle sharing schemes were that it is a challenging market within which to make a profit, and that having the correct business model is crucial to success (Lagadic et al. 2019).

The growing interest in EVSS may underscore its potential as a promising and more sustainable transportation alternative in the years to come. With appropriate stakeholder interactions and appropriate business model innovation, EV-sharing systems may be able to contribute towards cleaner and more efficient urban transport environment (Bruglieri et al. 2014; Galatoulas et al. 2018; Ruhrort 2020; He et al. 2017; Sarasini and Langeland 2021).

4.7.1 Governance of EVSS

To succeed EVSS may need to overcome three fundamental barriers (Hu and Creutzig 2022). Firstly, as EVSS are a 'heavy assets' business, most service providers are still at a survival level and still need a transparent and profitable business model (Hu and Creutzig 2022). Secondly, a lack of support such as charging stations and parking spaces for EVs can hinder their widespread use at the urban infrastructure level (Zarazua de Rubens et al. 2020). The governmental support for EVSS appears to be inconsistent, as there is a discrepancy between the efforts of central and local governments in some cities. While the central government actively promotes these policies, the local governments do not always exhibit the same level of commitment to implement them at the city level. This misalignment of objectives may hinder the effective promotion and adoption of EVSS (Sun et al. 2019; Wilson and Mason 2020).

4.7.2 Institutional dimensions: policy governance for EVs

The government plays a regulatory role in shared mobility markets in China (Table 4.3), and the government advocates citizens to shift towards shared mobility tools and provides policy governance in support of addressing urban traffic congestion and reducing pollution (Zhang and Mi 2018; Hu and Creutzig 2022). In addition, the government has cooperated with service providers to supervise call-hailing services and EVSSs regarding road safety and passenger safety (Sun et al. 2019; Hu and Creutzig 2022). The local governments of Shanghai and Beijing have also promoted EVSSs to people (particularly those who have not seen or used EVSS) who may travel in first-tier cities[1] but not be familiar with these services (Niu and Xu 2016; Wang et al. 2019d).

The transition from a conventional private/public transport paradigm to a shared mobility enhanced paradigm challenges the government to create a supportive policy environment to achieve lower carbon emissions and other environmental goals (Hu and Creutzig 2022). This may require a systematic and close collaboration among central government and local government (including relevant departments) to promote EVSS (Wilson and Mason 2020). A summarised table 1 shows a landscape level of policy for the EVs sector.

Progress may also depend on the ability to harness the potential role of cloud computing and big data in delivering more sustainable, shared mobility. These technologies can evaluate the reduction of emissions and congestion by tracking real-time urban travel data, ultimately contributing to a safer and more sustainable transportation environment for all passengers (Dowling and Kent 2015; Bokolo et al. 2020).

Table 4.3 Major national/landscape level of policies for EVs in China (From 2015 to 2019). Source (Hu and Creutzig 2022).

Time	Relevant Policy	Activities
Oct-15	A strategic plan for enhancing charging infrastructure for NEVs	Accelerate the planning and construction of urban infrastructure, and the development of transportation systems and standards.
Dec-16	Focus on improving the integrated design of charging systems and parking lots.	Address barriers such as "difficult parking" and "difficult charging".
Aug-17	Guiding plan on encouraging the rental of small and mini vehicles.	Promote the development of the small and mini vehicle rental market, increasing vehicle utilisation.
Aug-18	Launch of a credit policy for passenger NEVs (measuring the distance an NEV travels).	Encourage the production and purchase of NEVs through a credit policy, reducing pollutant emissions.
May-19	Measures for financial support systems for users in new transportation models.	Provide financial support for users adopting new transportation models, promoting the popularisation of NEVs and shared mobility.

[1] First-tier cities in China refer to the most developed metropolitan areas, which are significant in terms of their national influence and international prominence: Shanghai, Beijing, Guangzhou and Shenzheng.

4.7.3 The Influence of land-using on EVSS: Urban infrastructure

Existing urban infrastructure includes public transport and private vehicles, may be insufficient to meet the increasing demand for transportation options (Kriston et al. 2010; Santos et al. 2010; Ma et al. 2018). The majority of urban citizens are seeking for alternative transportation modes and these alternatives can be categorised into two general groups: public transport systems with fixed services covering a specific area, and point-to-point transportation options like vehicles, bikes, and scooters that are more flexible (Kriston et al. 2010).

Public transport systems have limitations in terms of their capacity to adapt to increasing transportation demand, especially when individuals need to make multiple transfers to reach their destinations (Kriston et al. 2010; Santos et al. 2010; Ma et al. 2018). While private vehicles, which provide faster door-to-door travel in the majority of OECD countries, also face challenges in increasing vehicle ownership levels and the need to reduce their environmental impact (Kriston et al. 2010; Santos et al. 2010). These can include traffic congestion and parking issues due to the increasing volume of private vehicles (Davenport and Davenport 2006; Ma et al. 2018). In response to these limitations, eMaaS have become more widely adopted within urban mobility systems (Kriston et al. 2010; Bokolo et al. 2020; Liao and Correia 2022). Shared electric vehicles can be integrated into existing systems and urban infrastructure will play an important role in shaping the implementation of EVSS (Liao and Correia 2022). In terms of urban physical infrastructure, the pursuit of more sustainable mobility has promoted transport modes that involve sharing, such as bike-sharing, carpooling, EVSS, and public transport (Santos et al. 2010) and has contributed to more sustainable urban infrastructures. However, the success of EVSS depends on the availability of charging and parking infrastructure and the integration of EVs with existing public transportation systems (Duarte and Ratti 2018). Urban planners may consider these factors to ensure that the physical infrastructure supports the growth of EVSS.

In terms of the integration of transport and land-use policy: Developing a solution to the challenges arising from urbanisation and motorisation requires the integration of transport and land-use policies (Duarte and Ratti 2018). Urban planners may consider the interplay between land use, transport policies, and infrastructure to create urban environments that support the implementation of EVSS (Liao and Correia 2022).

The rapid urbanisation and motorisation of Chinese cities have given rise to multifaceted challenges that underline the need for integrated transport and land-use policies (Huang et al. 2020).

With fast-paced growth and densely populated urban centres, these cities are not only expanding vertically but also horizontally. Such spatial expansion may occur alongside the reduction of bike lanes and a notable scarcity of parking spaces, exacerbating congestion and environmental concerns (Vanoutrive and Huyse 2023). These factors can be combined with a complex modal split - where in some areas, there may be a heavy reliance on private vehicles, in others there may be a greater dependence on public transportation or non-motorised forms of transport - highlighting the pressing need for strategic urban planning (Lee et al. 2022; Vanoutrive and Huyse 2023). Urban planners, therefore may consider the interplay between land use, transport policies, and urban infrastructure development. These factors are likely to make the extension of EVSS schemes attractive to policymakers, since they have the potential to reduce some of these urban pressures by offering alternative/additional mobility solutions to private vehicle ownership and generating more efficient use of urban space (Liao and Correia 2022).

4.7.4 Influence of the national/social credit reporting system

In the sharing economy, user behaviour is an important element that influences the success and sustainability of platforms such as EVSS schemes. China operates a National/social credit system (e.g., Alipay system) that aims to evidence the trustworthiness and credit worthiness of individual citizens and consumers in relation to (among other things) their consumption patterns (Creemers 2018; Kshetri 2020). This system aims to regulate user conduct and promote a sense of trust and responsibility (Chong 2019). However, the development and implementation of such a comprehensive and nuanced system is complex and fraught with challenges. Privacy concerns, fairness issues, and potential misuse of information have been raised as major obstacles to the acceptance and effectiveness of this system (Creemers 2018).

Without a robust and well-functioning credit system, it is more difficult to track and prevent consumer misbehaviours (Özekici 2022) which for EVSS may lead to increased costs for maintenance and repairs, which are inevitably passed on to the users, making the services less affordable. Additionally, user misconduct harms the reputation of particular platforms, potentially hindering the adoption rate and overall market growth. The impact of shortcomings of the national/social credit reporting system on user behaviour is a potentially important concern for shared economy platforms. Users' misbehaviour seems to be a neglected element of EVSS schemes and further research can be helpful to understand the specific dynamics of the social credit system and user behaviour, and to develop strategies to address the resulting challenges.

4.8 The multiple stakeholders of EVSS schemes

The urban environment involves many stakeholders for eMaaS (Paddeu et al. 2018). This section identifies critical stakeholders in an urban EVSS including those impacted by its implementation (Feys et al. 2020; Paddeu et al. 2018). Success will depend on stakeholders being involved in the decision-making process to represent their interests (Siddiqi and Buliung 2013) and on understanding the objective of each stakeholder group (Mohamed et al. 2019). Table 4.4 shows the interest of relevant stakeholders.

4.8.1 Stakeholder dynamics in the urban eMaaS ecosystem: understanding roles, interactions, and market influence

Key primary stakeholders in schemes include users adopting eMaaS, who seek to access efficient and convenient mobility services; wider citizenry for whom schemes represent a change to their city; public transport operators; the transport-responsible institutions who make traffic policy and regulate transport safety; city planners who are responsible for traffic infrastructure planning; and eMaaS providers who are interested in offering mobility services that benefit urban mobility schemes and lifestyles (Paddeu et al. 2018).

Secondary stakeholders include (Rivasplata et al. 2013; Siddiqi and Buliung 2013): OEMs (automobile industry), who make cars and are interested in this new market; third-party software developers responsible for managing related ICT platforms; other public transport providers (like car-hailing services with Uber being the best known with DIDI being the dominant provider in a Chinese context) who are also part of eMaaS marketing development; traditional call-up Taxis who used to be one of the main eMaaS providers, however, in many Chinese cities providers like DIDI are gradually displacing them.

New types of eMaaS are increasingly based on advanced ICT, so that EVSS can be viewed as an ICT- based market (Hernandez et al. 2013). Furthermore, EVSS may be considered key stakeholders in the urban mobility ecosystem. They likely have interdependent relationships with other stakeholders, creating a complex network of interactions and influence.

Table 4.4 Overview of stakeholder's interest in EVSS schemes (Developed by the author).

Stakeholder Group	Stakeholders	Stakeholder Interests
Public authority and organisation	Financial institutions	Provide multi-financial plan for users and providers
	City planners	Configure a safe, convenient, clean and effective mobility system
	Insurance company	Provide individualised insurance plan for users and providers
	Environmental groups	Emissions and environmental pollution
	Traffic policy maker	Urban congestions, safety, environmental impact, supervision and subsidy
	Traffic police	Accidents, congestions, personal health
	EV manufactures	Sales, profit, NEV credits
	Non-EV manufactures	Sales, profit, NEV credits, market share
Manufactures and business sectors	eMaaS providers	Extra value and profits (Sustainable mobility by means of electricity)
	New and used vehicle retailer	Market share
	Independent repair garage	Profit and frequency of service; can be a new opportunity
	After-market (Car-parts retailer)	Profit and frequency of service
	Vehicle-leasing companies	Market share and consumer flow
Wider citizenry	Private vehicle owners	May want to try new mobility tools
	Sharing-EV passengers	Safety and trust
	Users	Pricy, safety, trust, driving experience and convenience
Peer competitors	Online-hailing service	Market share and consumer flow
	Public transport service	Market share and consumer flow

Based on the description of stakeholders' discussion and scoping the existing literature, four types of influence factors can be summarised:

- Consumers who have a travel demand and mobility needs;
- Service providers who supply EVSS;
- Government (national and local) who play a regulator role;
- Environmental benefits that may be desired by consumers, government and EVSS providers.

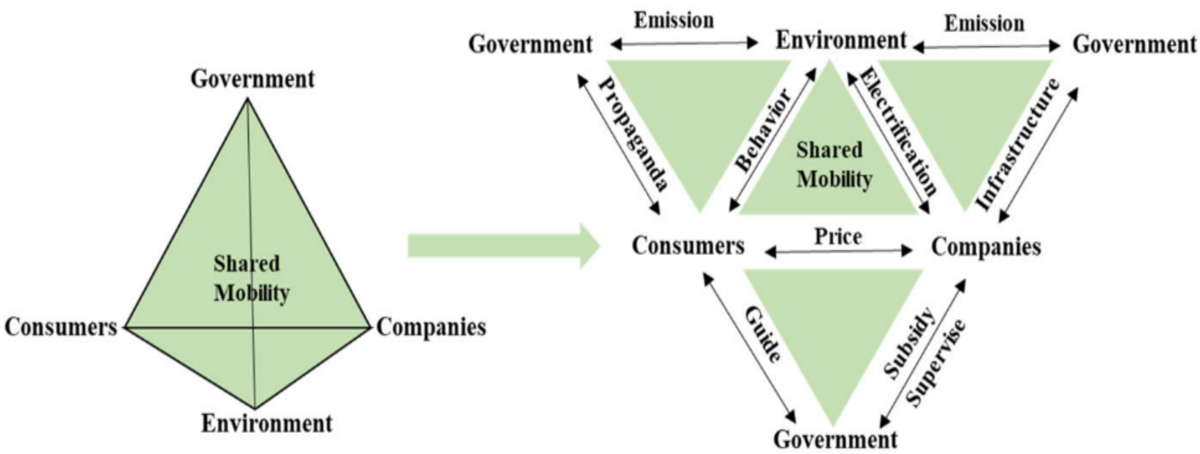


Figure 4.7 The conceptual framework of the influencing factors on shared mobility (Hu and Creutzig 2022, p.381).

4.8.2 Consumer demand

EVSS providers are interested in understanding users' behaviour, intentions, and preferences, as these factors impact the market demand (Bartels 1974; Acheampong and Cugurullo 2019; Acheampong et al. 2021; Shams Esfandabadi et al. 2022). The implications of shared-mobility acceptance on car ownership, alternative mobility tools, and the environment is vital for urban planners and EVSS' providers looking to enhance their business models (Fagnant and Kockelman 2018; Sarasini and Linder 2018; Sarasini and Langeland 2021).

The shared mobility literature has investigated users' intentions to switch travel modes, but the actual outcomes of car-sharing usage, like changes in traffic congestion and emissions, are equally important to assess (Acheampong and Cugurullo 2019; Acheampong et al. 2021; Chen et al. 2016b; Hjorteset and Böcker 2020; Matowicki et al. 2021; Nazari et al. 2018; Shams Esfandabadi et al. 2022). Various studies have identified different socio-demographic, socio-economic, and attitudinal variables that influence EVSS usage by commuters and other users across regions and cities (Shams Esfandabadi et al. 2022). Research has also explored the factors driving the intention to adopt carsharing in major cities around the world (Shams Esfandabadi et al. 2022). The majority of these studies have implications for both service providers and regulators, with the latter receiving greater emphasis.

In terms of individuals' shifting intention among transport modes, those users with multimodal travel habits exhibit a stronger willingness to switch to new transport modes (Shams Esfandabadi et al. 2022). Also, it seems that public transport users are more likely to switch to carsharing if the cost is lower (Shams Esfandabadi et al. 2022).

Figure 4.5 shows the interdependencies between these four sectors. Consumer demand drives the EVSS paradigm (Wang et al. 2019c), however, both economic and individual factors may have an impact on EVSS adoption and use (Cohen 2019; Feys et al. 2020; Min and Xing-fu 2019). Price may influence consumers' decision-making process, as affordability can be a factor that, with lower transaction costs in the EVSS model, could reduce the dependence on vehicle ownership by making electric vehicle use economically appealing for consumers (Standing et al. 2019). In sharing schemes, the fixed costs of travel are shared amongst users, allowing EVSS to become an affordable mobility option.

Demographic factors like age, education level and income may also influence the acceptance of EVs as vehicles (Wu et al. 2019). A close connection between consumption habits and demographic factors may be linked such as younger age and higher-income people being more willing to use smartphone-dependent services and try new travel tools (Wang et al. 2019d). 60% of younger users have apps to manage their trips and would like a multi-modal, personalised, and high-quality travel experience (Hu and Creutzig 2022). Also, they are less interested in cars for their symbolic value and may begin to delay purchasing a private car (Cohen 2019; Hu and Creutzig 2022). Personal privacy, safety, hygiene, travel consumption habits, and trust are also potentially influential factors for consumers (Hu and Creutzig 2022). Trust is an issue because consumers may provide personal information to service providers when using an EVSS, creating a risk linked to personal information.

Figure 4.8 shows the role of EVSS providers and demonstrates the complex relationships among users, other stakeholders, evolving business models, and other entities involved in the EVSS ecosystem. Arrows represent the various interactions among these actors, such as profits, feedbacks, cooperation, and direct or indirect influence.

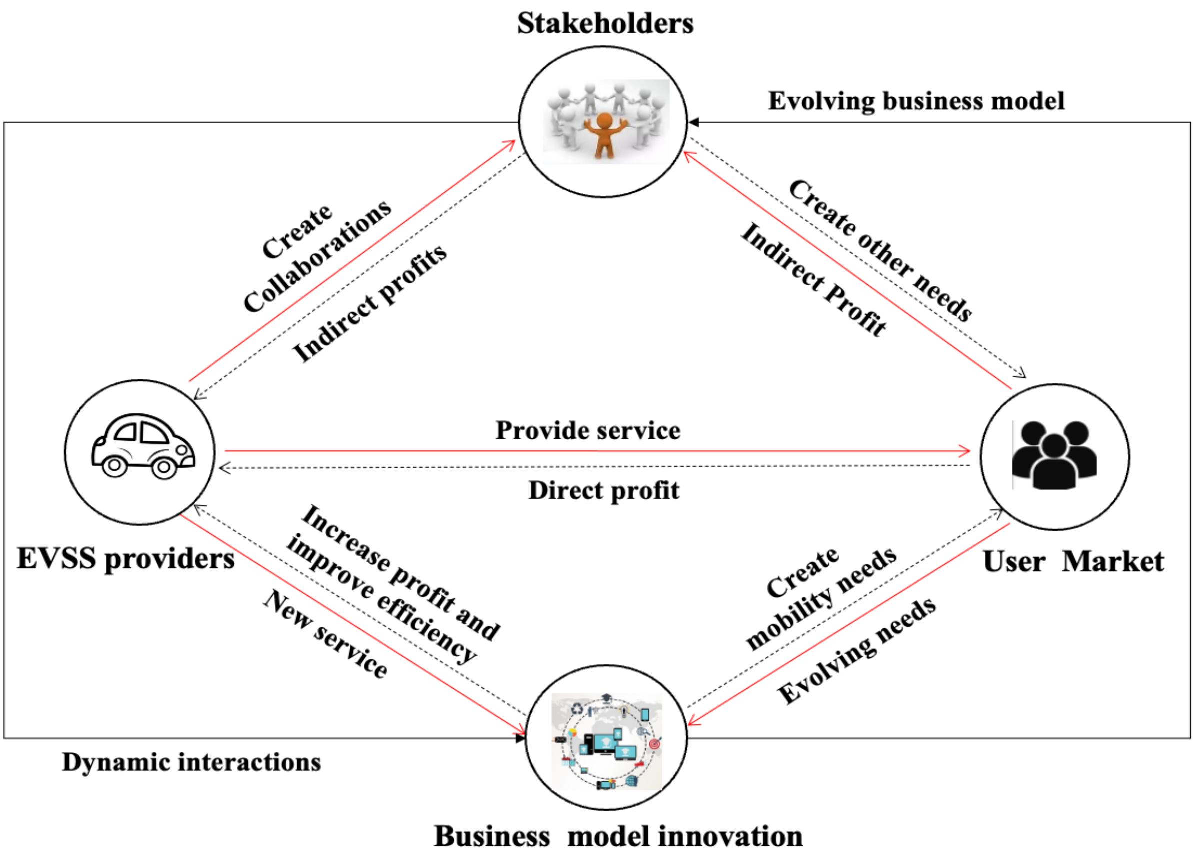


Figure 4.8 Conceptual model for integrating EVSS, users, and other stakeholders' interactions (Developed by the author).

4.8.3 Mobility demand

While eMaaS and EVSS may not necessarily create new demand for EVs, they may increase their adoption by making them more accessible and affordable (Reyes García et al. 2019). The relationship between the presence of EVSS in a city and the demand for mobility is likely to be complex. It could be argued that the presence of EVSS may create potential mobility demand by prompting citizens to undertake journeys that they would not have contemplated because no easy means were available (this does however run contrary to 'purist' marketing theory that would argue that demand is inherent within the consumer and cannot be created by the offers of firms and their marketers). Similarly, the policy and sustainability aim of EVSS substituting for private car use will be undermined if instead they act as substitutes for active travel journeys or journeys using public transport. The answers to whether EVSS stimulates new journeys and which transport modes they act as substitutes for will not be known until the schemes are more mature and more research data about their use is available.

4.9 Limitations of sharing-EVs

The limitation of sharing-EVs can be generalised into three aspects: technology, environmental concerns and social concerns (such as engagement of customers' willingness).

Regarding the limitations of technology, these can be generalised into battery technology, charging reliability, driving range. (Martins et al. 2019). The average range of a SEV is approximately 500-750 kilometres, however, in practice this will be influenced by factors like driving behaviour, road conditions, weather and speed (Chopra and Bauer 2013; Wang et al. 2019a). Although OEMs continuously upgrade battery capacities, driving ranges cannot satisfy all consumers' mobility needs (Laldin et al. 2013). In addition, charging EVs can be a time-consuming process. This could potentially inconvenience customers who require the vehicles for short-distance travel and cannot afford long wait times. Furthermore, the availability of parking and charging outlets for these EVs may be insufficient which pose another potential challenge for customers (Martins et al. 2019).

Limitation of EVs' charging reliability reflect both the technology and the available infrastructure. OEMs can provide fast-charging points to minimise charging times; however, each charging point can only serve two EVs at a time (Martins et al. 2019). The availability of charging stations may not be sufficient for all those who want long-distance travel (Wang et al. 2019a). Also, there may be consumer safety issues if charging points are exposed outdoor creating a risk of accidents on rainy days (Wang et al. 2019a). Although OEMs may seek to solve this issue, any city that faces flooding risks may have a challenge in establishing and maintaining a charging infrastructure (Martins et al. 2019; Wang et al. 2019a).

Furthermore, technological aspects of longevity and sensitivity also need to be considered (Lee et al. 2023). Although EVs generally require less maintenance than traditional vehicles, concerns regarding their durability and longevity remain pertinent for sharing electric vehicles (Lee et al. 2023). The performance and service life of sharing EVs can be affected by numerous factors related to sensitivity, including ambient environmental conditions, the terrain they are driven on, the load they carry, and the usage of energy-intensive features like air conditioning. While EVs present a maintenance advantage, their ability to satisfy all users' needs depends on addressing these sensitivities. Current sharing EVs may fall short of offering a one-size-fits-all solution, particularly in diverse urban settings where conditions vary widely.

In terms of environmental concern, used batteries may be difficult to recycle. Intelligent energy technologies can allow battery reuse (Wang et al. 2019a), however, this ultimately extends battery lifecycles, postponing rather than eliminating environmental damage (Burchart-Korol et al. 2020).

In terms of social concerns, EVSS may achieve a lower frequency of utilisation than a taxi, a popular option for “dial-a-ride” systems in urban areas (Jung et al. 2017). As a new MaaS, EVSS may impact taxi and other public transport markets and face resistance from established providers. Insurance regulation of EVSS may not be as comprehensive as those for conventional mobility tools. Parking duration can be a factor when considering shared electric vehicles, as they may have designated parking spots located some distance from the user’s destination .(Habla et al. 2021). If no spaces are available, this could further increase the time required to park the vehicle.

From the supply chain perspective, producing new batteries will have significant social and environmental resources (The Guardian 2023). Regarding batteries, use of raw materials such as lithium, cobalt, and nickel have raised concerns due to their environmental damage, which may impact also impact water quality (McManus 2012). And EVs use 173 kilograms more minerals than internal combustion engines vehicles (International Energy Agency 2021). In terms of supply chain responsibility, EV-based products may be promoted as relatively sustainable but there are still risks relating to supply chains, manufacturers and product use of unsustainable and unethical practices (Cao et al. 2021; The Manufacturer 2022).

4.9.1 Technology advances: Electric autonomous vehicles

As urban infrastructure continues to struggle with accommodating the increasing demand for transportation options, innovative solutions like autonomous driving and automated service emerge as potential responses to these challenges (Ma et al. 2018; Nazari et al. 2018). Autonomous Vehicle (AV) technologies have garnered significant research interest in recent years, with studies exploring public perception of these innovative modes of transport (Acheampong and Cugurullo 2019; Chen et al. 2016b; Nazari et al. 2018). While some progress has been made in understanding general attitudes towards AVs, a knowledge gap remains regarding the preferences and willingness to adopt these technologies among different population segments, particularly in shared service environments (Nazari et al. 2018).

AVs may foster the advancement of shared vehicle systems, narrowing the divide between private and public transportation modes (Nazari et al. 2018). AV technologies can also promote the environmental and social benefits associated with widespread vehicle sharing (Hensher 2018). Furthermore, AVs may have a potential to replace the current private car ownership model with automated EVSS, and personal attitudes toward AVs could be important in shaping policy choices and future urban infrastructure and public mobility systems (Acheampong et al. 2021; Haboucha et al. 2017). EVSS using AVs could create mobility opportunities for, and demand from, demographics currently underrepresented in personal vehicle use, such as the very young or the elderly. Additional environmental costs linked to use by those demographics will depend upon what mode substitutions are involved (if any), however, research suggest it may contribute to social benefits (Pettigrew et al. 2018), similar to those explained in section 4.8.3 (Mobility demand).

Previous scholars have investigated user preferences for AV adoption, distinguishing between shared and individually owned vehicles (Krueger et al. 2016; Haboucha et al. 2017). Factors such as individual traits (socioeconomic background, attitudes, and current travel habits) and system features (ownership, convenience, control, expenses, and parking availability) are found to impact decisions concerning the acquisition and utilisation of private autonomous vehicles (PAVs) and shared autonomous vehicles (SAVs) (Haboucha et al. 2017; Asgari and Jin 2019).

4.9.2 Technology advances: Intelligent EVSS inspired by information-based products

In recent years, the rapid proliferation of Internet- and Web-based technologies has fostered a multitude of innovative concepts and methodologies aimed at advancing product design and manufacturing systems (Kapassa et al. 2021; Shen et al. 2020).

Intelligent vehicles, commonly associated with self-driving cars, are internet-enabled vehicles that enable vehicle-to-everything communications (Shen et al. 2020). Despite the potential advantages, the communication environment within which IVs operate is fraught with vulnerabilities and lacks adequate security measures (Shen et al. 2020).

For future EVSS schemes, the integration of intelligent vehicles may play an important role, not only in capturing and satisfying users’ mobility requirements, but also in promoting more sustainable and advanced services by transitioning towards information-based products. This paradigm shift, grounded in innovative technological advancements, can be beneficial to the development of efficient, user-orientated, and intelligent transportation solutions, ultimately contributing to a more sustainable and interconnected urban mobility paradigm.

4.10 Theoretical framework and research objectives and questions – EVSSs' role in China's urban mobility transition for sustainability

The author develops a theoretical framework after critically reviewing the literature and **Figure 4.9** presents the framework that underpins the thesis demonstrating the development of EVSS in urban mobility in China based on MLP, and it explains how a product, or a technical innovation service combined with ICT may shift from niche level to regime level in the urban mobility paradigm.

The landscape-level represents how the external environment influences the regime and niche level. Specifically, the four arrows at the top demonstrates how policy push (e.g., "Energy-saving and New-energy Vehicle Industry Development Plan" from 2012-2020), market pull, and other business environment pressures may impact the technologies, markets and companies providing urban mobility. The EV industry is also identified as an important development sector in the most recent "Made in China 2025" plan (Lu et al. 2017). Consequently, the government will maintain its financial support for this industry throughout the 14th Five-Year Plan (2021-2025) (Wu et al. 2023). **Table 4.5** summarises China's key EV-specific policies, highlighting the various areas in which the government has been actively promoting the adoption and development of Evs.

The regime level can be seen as a city-based mobility paradigm (numbers one, two and three) demonstrating the evolution of the mobility paradigm in the Chinese context, with eMaaS now playing an intersecting role amongst EVSS, smart mobility and ICT, in a way that will help to move EVSS from niche level to regime. The evolution of regimes represented in this model is not meant to imply a complete replacement of old regimes via new ones. However, the emergence of new regimes will create new choices for consumers (i.e., the emergence of EVSS will not replace the public transport of the previous mainstream regime but may create a new segment of the market replacing previous public transport or private car journeys).

The niche level can be seen as an experiment Involving innovative technology, while number six, eight and ten demonstrates the role of SOSI, ICT and sustainability interacting with the niche level. Numbers seven and nine demonstrate these elements' impact on business model innovation (BMI) as well as stakeholders' collaborations. Number four and five demonstrates the interaction between eMaaS and evolving business model, which BMI and stakeholders' collaboration influence.

Table 4.5 Key policy areas and descriptions for promoting electric vehicle adoption in China (Cao et al. 2017; Wu et al. 2023).

Policy Area	Description	Sources
New energy vehicle (NEV) Mandate	Credit-based system that requires automakers to produce a minimum percentage of NEVs, ensuring a growing market share for electric vehicles.	(TransportPolicy 2019)
National and local Subsidies	Financial incentives provided by the national and local governments for EV manufacturers and consumers, with a focus on performance-based incentives.	(TransportPolicy 2019)
License plate policies	City-specific policies that include granting free license plates for EVs, exempting them from lotteries, and offering preferential access to plates.	(Tyfield and Zuev 2018)
Charging infrastructure development	Public and private investments directed towards expanding charging networks, addressing range anxiety, and facilitating EV adoption.	(Cai et al. 2014; Qiu et al. 2019)
Battery swapping infrastructure	Promotion of battery-swapping technology as a quick and efficient alternative to traditional charging methods, reducing charging times for EV users.	(Huang et al. 2021)
Research, development, and innovation	Government investment in R&D initiatives and partnerships with the private sector to advance EV technologies and enhance domestic and global competitiveness.	(Yang 2023)
Electrification of public transport	Policies supporting the adoption of electric buses, taxis, and delivery vehicles, aiming to reduce urban air pollution and increase overall EV penetration.	(Geels 2012; He et al. 2018b)

The mobility business model innovation is another important part of this framework, and service providers seek to improve their business models (Sarasini and Linder 2018). The majority of the existing literature has focused on the use of historical and real-time data to enhance business models (Badii et al. 2017). However, the role of data interoperability, that is the ability of systems and services to exchange data and enable coordinated use of that data, has not been adequately explored. This is an area of potential opportunity as interoperability can be important for effective data communication within EVSS schemes (Bokolo et al. 2020). eMaaS seems to offer a solution by establishing an open data ecosystem, which facilitates efficient access and utilisation of e-mobility data. The availability of such data and the advent of more sophisticated data analytics may also create opportunities to more effectively some of the challenges that vehicle sharing services have faced, including factors such as viable pricing models and effective disposition of shared vehicles where past problems have led to scheme failures (Lagadic et al. 2019).

Although transition theory and the MLP are widely employed to study transitions towards sustainability, they are more helpful in mapping the nature of the change that is occurring rather than understanding the dynamics and processes through which change occurs and the role that particular stakeholders play within it (Sarasini and Linder 2018). This is particularly true for the role of businesses as Sarasini and Linder (2018, p.19) note*: "there is no theory of the firm in transition theory, such that the role of business model innovation in wider transformative processes is unclear".* They put forward a theoretical argument for adopting a business model innovation perspective for understanding the development of new sustainability-based mobility services. Applied to understanding EVSS in China, both MPL and a business model perspective are required. Transition theory illuminates the broader societal and industry dynamics that shape EVSS schemes. Meanwhile, a business model perspective offers insights into how individual EVSS providers operate within, and contribute to, this transition towards more sustainable urban mobility. The rest of this thesis seeks to take that approach further forward through empirical research that explores the implementation of such EVSS in the context of Chinese cities within the Yangtze River Delta Economic Zone. The following chapter discusses the literature relating to applying a business model perspective in the context of innovative urban mobility service.

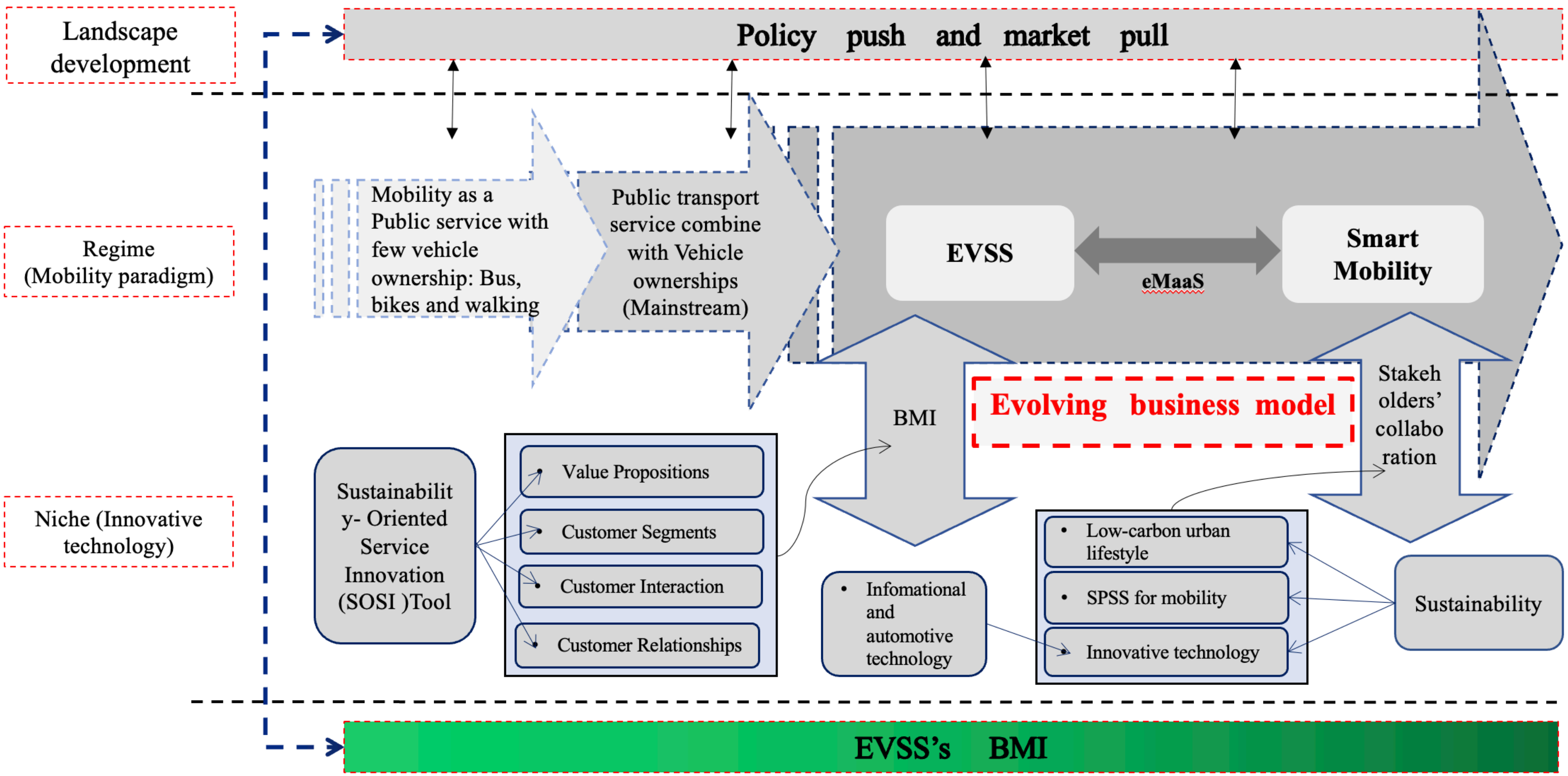


Figure 4.9 Theoretical framework (Developed by the author).

The theoretical framework presented in Figure 4.9 provides the context for this thesis's research aims, objectives and its five central research questions (RQ) originally introduced in section 1.7. Figure 4.9 illustrates the evolving urban mobility paradigm at the regime level, while the niche level demonstrates how business models influence stakeholders' acceptance of EVSS. The evolving business model supports the acceptance of EVSS from niche markets towards becoming a part of eMaaS in a city-based urban mobility paradigm. This study has the key aim of investigating how business models affect stakeholders' acceptance of EVSS and how sustainable business models can progress beyond niche markets.

In terms of the five RQs linking towards the framework (**Figure 4.9**), RQA links to how the evolving business model (see Figure 4.9) makes EVSS move from the niche level towards eMaaS schemes (see eMaaS schemes in Figure 4.9), and RQE focus on the influential factors of eMaaS (see Figure 4.9). At the same time, RQ B and D explore eMaaS schemes in more depth. Since the framework is developed based on socio-technical transition theory, RQC uses this theory to examine the interactions between stakeholders and EVSS providers.

4.11 Chapter Summary

Chapter 4 explores business models for innovative urban mobility services, beginning with exploring urban mobility and the concept of BMI. It then investigates BMM and its types and sustainable variations. The chapter also discusses SOSI and BMC particularly in car models, and the integration of stakeholders in EVSS schemes. This includes an analysis of shared mobility in China, EVSS governance, policy governance for EVs, and the multi-stakeholder nature of EVSS. Then this chapter also discusses the limitation of sharing- EVs. The chapter concludes by discussing the theoretical framework and outlining the research aims and questions. The following chapter presents the detail of the methodology adopted by the thesis to try to answer those questions.

Chapter 5. Research methodology

5.1 Chapter introduction

Chapters 2 to 4 provide an overview of the existing literature regarding shared mobility patterns, and the study's primary research questions. Four principal academic topics were identified, sustainable mobility, sharing schemes, transition theory and business models. In addition, relevant stakeholders like EVSS users, EVSSs and governmental institutions, and terms like environmental consideration, PSS, ICT as well as SBM, were identified and discussed in previous chapters.

The principal research gap that emerged through scoping and evaluating the relevant literatures was a lack of in-depth understanding of how to achieve mobility transitions towards a more sustainable level by implementing more sustainable business models. For instance, understanding the role of business model innovation can contribute to a shift towards to sustainable urban mobility paradigm. The researcher uses EVSS's business model as an empirical lens to for this project.

5.2 Chapter aims and structure

This chapter aims to demonstrate and explain the research approach and methodology adopted in this thesis. The research's trustworthiness, credibility and transferability can be enhanced by using an effective research methodology since:

> *"…the choice and adequacy of a method embodies a variety of assumptions regarding the nature of knowledge and the methods through which that knowledge can be obtained, as well as a set of root assumptions about the nature of the phenomena to be investigated."*
>
> (Morgan and Smircich 1980, p.491)

The chapter is structured in the following order. Section 5.2 critically describes the philosophical position and justification of the chosen research paradigm underpinning this study by addressing the adopted ontology, epistemology, and axiology. This section also explains the approach that was taken in this research regarding the connection between theory and research. The final part of Section 5.2 first provides a brief justification regarding the chosen research paradigm. Section 5.3 explains research design by addressing research aims, strategy, and data collection methods. Secondly, this section will address the sampling strategy, fieldwork and data analysis. The last part will discuss the ethical considerations and trustworthiness of the study.

5.3 Research philosophical underpinning and paradigm

All research reflects an implicit or explicit philosophy comprising the assumptions underpinning a researcher's approach to understanding the world. These assumptions may guide a researcher in choosing an appropriate method and strategy. It is important for business and management scholars to be aware of the alternative possible philosophical positions when they choose a research strategy (Bryman 2012).

The broadest distinction is between positivism and constructivism as two major contrasting paradigms that describe different philosophical positions (Lincoln and Guba 1994). Positivism assumes an objective reality and seeks to generate law-like generalisations and reproduceable results, while constructivism assumes that people, including researchers themselves, construct the perceived realities in which they participate, and focuses more on understanding human feelings, experiences, and attitudes (Guba and Lincoln 1994; Saunders et al. 2016). Saunders et al. (2016) further subdivide these two paradigms into five research philosophies within business research: positivism, and four constructivist approaches including critical realism, interpretivism, postmodernism, and pragmatism.

There are three subsections of the philosophical approach: ontology, epistemology, and axiology each of which will reflect the researchers' view of the world.

5.3.1 Ontology

Ontology considers the nature of reality, and as Gruber (1995, p.908) says,

> *"Ontologies are often equated with taxonomic hierarchies of classes, class definitions and the subsumption relation, but ontologies need not be limited to these forms. Ontologies are also not limited to conservative definitions, that is, definitions in the traditional logic sense that only introduce terminology and do not add any knowledge about the world. To specify conceptualisation, one needs to state axioms that do constrain the possible interpretations for the defined terms."*

Objectivism and subjectivism are two ontologies frequently discussed in the business and management field (Saunders et al. 2016) with objectivism implying "*how social entities exist independent of social actors"* (Saunders et al. 2016, p.110), and it focuses on social existence in the *"reality external to the social actors"* (Saunders et al. 2016, p.110). However, **subjectivism** emphasises that the world relies on individual perceptions and social actions and changes dynamically as the social phenomena is constantly revised and influenced by continuous social interactions (Saunders et al. 2016).

The debate between objectivism and subjectivism in management and organisation research has developed since the 1980s with three key factors highlighted (Barney 1990; Coombs et al. 1992; Fournier 2002; Huyssen 1984; Schwandt 1998):

- The rise of postmodernism: Postmodernist thought emerged in social sciences, questioning objective, universal truths and leading scholars to explore subjectivist approaches in management and organisation studies (Huyssen 1984).
- The influence of interpretive and qualitative research methods: Management and organisational scholars increasingly adopted qualitative and interpretive research methods, prioritizing subjective understanding and focusing on meanings and interpretations of organisational actors, thus foregrounding the subjectivist perspective (Schwandt 1998).
- Critiques of traditional management theories: Scholars challenged traditional management theories that heavily relied on objective, quantifiable measures, leading to the exploration of alternative perspectives emphasizing subjective experiences in organisations (Barney 1990).

For example, management theory has viewed organisational culture objectively as a variable that managers can identify, change and manipulate to create different outcomes (Coombs et al. 1992) and that has an important influence on business models as it is (Bocken et al. 2014). Alternatively, subjectivism may consider this too simple, and it may argue that culture is something experienced differently by individuals and is continuously evolving through a complex pattern of social interactions and physical activities. For example, a sustainable business model is continuously developed and re-created as firms and individuals may respond to a wide range of stakeholders' interests and factors such as environment, policy and society (Bocken et al. 2014).

One could argue that sustainability relates to system states with environmental resources at their heart, and that EV technologies involve specific environmental advantages that could allow EVSS business models to be studied objectively. However, the social dimensions of sustainability, the multi-stakeholder nature of EVSS and the overlap between their operation and success and urban lifestyles and planning policies makes a subjective ontology most suitable for this thesis.

5.3.2 Social constructionism

An influential subjective ontology is social constructionism (SC), which holds that the external world (reality) is socially constructed (Saunders et al. 2016). Different observers of the same physical or social phenomenon can therefore produce different observations and interpretations about it, which will reflect differences in the culture from which the observer comes, their assumptions or past experience, or the time in which the observation is made (Saunders et al. 2016).

This reflects an interpretivist research philosophy which aims to study the subjective meanings and motivations of social actors to help researchers understand a phenomenon. Social actors considered in this thesis, such as consumers, EVS providers, other online-hailing services, government institutions and other stakeholders, may each have different interpretations of the situation in which they find themselves, and the meaning of events within it. Researchers may need to study human action's subjective and in-depth meaning as the social world is complex and Saunders et al. (2016, p. 140) points out, and therefore, *'interpretivists are critical of the positivist attempts to discover definite universal 'laws' that apply to everybody. Rather they believe that rich insights into humanity are lost if such complexity is reduced entirely to a series of law-like generalisations*.

Given SC's characteristics, the SC can be an appropriate philosophical underpinning to explore complex social phenomena and questions such as how sustainable product-service system (SPSS) and business model innovation for sustainability (BMIfS) can promote a sustainable transition in the urban mobility paradigm within a particular context, i.e., China’s Delta Economic Zone. Furthermore, the significance of context in the SC position is helpful for the researcher's study of firms' activities.

5.3.3 Epistemology

Epistemology considers what is appropriate knowledge in a particular research field. Although positivism and interpretivism are often discussed as an epistemological dichotomy that researchers will choose between, there is a third alternative that has become increasingly popular, particularly for complex and emerging phenomena, which is the epistemology of pragmatism (Johnson and Onwuegbuzie 2004; Onwuegbuzie et al. 2009). Pragmatism puts an emphasis on "what works" when trying to answer a research question and is more orientated to interrogating a question or theory rather than finding causal links. For pragmatists the "what?" and "how?" of the research question is the key focus (Creswell and Creswell 2018) and: *"instead of methods being important, the problem is most important, and researchers use all approaches to understand the problem"* (Creswell and Creswell 2018, p.10). Data collection as well as analysis methods are then chosen as a result of their ability to provide explanation of the research question without philosophical commitment to any particular paradigm (Morgan 2007).

Although pragmatism is often considered as close to, or even a variant of SC, it is an appropriate epistemology for this study because it recognises the existence of both physical and social realities (Johnson and Onwuegbuzie 2004) which matches this study's combined focus on the science and technology of climate change and electric vehicles, with the social phenomenon of business models and the policy environment and consumer behaviour that impacts them. Pragmatism differs from pure social constructionism because, although it recognises that the perceptions of individual and groups can construct particular perceived realities, it does not view all those constructed realities as equally valid, and instead recognises certain perspectives (such as those of "experts") as more helpful in answering particular research questions (Bryman 2012). This can make it well-suited to social and management research studies that are particularly "practitioner-based" and cross-disciplinary (Creswell and Creswell 2018) which again suits this subject, as EVSSs represent an emerging phenomenon in which much of the relevant knowledge is held by practitioners and which cuts across disciplines including sustainability studies, operations, consumer behaviour, transport policy and city planning. Although pragmatism is often associated with mixed methods studies (Johnson and Onwuegbuzie 2004) it is also being recognised as relevant to qualitative research involving organisations (Morgan 2007). This study's approach can therefore be summarised as a combination of social constructionism and pragmatism (SC/P).

5.3.4 Axiology

Axiology is a branch of philosophy concerning issues of value and judgement. The chosen philosophy representing the researcher's values will be reflected in the data collection approach and analysis. Heron (1996) frames the key axiological question that underpins research as concerning the value of "human flourishing" and peoples' ability to participate in and shape the systems on which they depend. This thesis is underpinned by values related to sustainability and is therefore similarly concerned with human flourishing.

5.3.5 Research paradigms and the researcher's positionality

The previous section provides an overview of research concepts, and a clear research paradigm is provided by integrating them. The purpose of this research is to understand the transition towards sustainable product-service systems (i.e., car sharing services) by service providers of personal mobility in China through exploring their business models and how they influence stakeholders' acceptance of EVSS (thereby exploring how sustainable business models can evolve beyond a niche market). Achieving this goal involves understanding how stakeholders related to eMaaS act to achieve sustainability via a shared-mobility paradigm within a socially structured world. **Table 5.1** summarises the research paradigm underpinning of this research effort.

Table 5.1 Research paradigm (Developed by the author).

Research Philosophy: Social Constructionism/Pragmatism			
Ontology: the way a researcher looks at the world and reality.	**Epistemology**: the way a researcher chooses relevant and acceptable knowledge in the study.	**Axiology**: the way a researcher understands and examines the value of the study.	Data collection and analysis strategy
The world is socially structured, and the reality can be changed under different situations.	Treat perceived realities subjectively. Giving a primary concern to the in-depth meanings behind perceived realities. Focus on most useful sources and approaches to address research questions.	The researcher should see him-self/herself as a part of the study which may not be subjective. Sustainability focus of topic establishes a clear axiology concerned with human flourishing from the outset.	A focussed sampling strategy using a qualitative approach. Multi-stakeholder approach with an emphasis on expert respondents.

5.3.6 Research development approach

a) Translating a research philosophy into a practical research project can involve adopting either: **A deductive approach** by developing relevant theories and hypotheses and plan a scientific research design to develop and test hypotheses via the collection and analysis of quantitative data; suitable for positivist research.
b) An **inductive approach** by designing a qualitative research design to study the in-depth meaning of the data and generate theories through thematic data coding and analysis; most suitable for interpretivist research and therefore adopted here.

5.3.7 Justification for chosen research paradigm

In summary, the researcher adopts a subjective ontology stance and SC/pragmatism as an epistemological philosophy with a sustainability-based axiology, all of which shape this study. The justification for this research paradigm is as follows:

Firstly, this research concerns **sustainability as a complex research context,** and the **sustainable mobility paradigm** as an **evolving phenomenon**. Next, the researcher narrows this down by applying a sharing economy perspective to investigate how PSS and transition theory are integrated with urban mobility patterns. Finally, the researcher chose EVs in China as a context in which to investigate how these embedded and independent principles are shaping the practices of urban mobility patterns.

Given this research direction, the researcher focused on how the EVSS providers and other stakeholders' business models may be integrated to provide more sustainable urban transportation systems. SC performs well in dealing with complex and continuously changing phenomena and new emerging issues (Cohen et al. 2004) and assists in understanding them because *"knowledge and meaning are historically and culturally constructed through social processes and action"*(Young and Collin 2004, p.373).

Secondly, this study involves intersecting fields with complex backgrounds and stakeholders. For example, how mobility markets and social networking technologies have an impact on personal mobility consumption (Standing et al. 2019). For urban transport sectors, how government and other institutions understand and assess the development of the sharing economy may have an impact on urban mobility demand (Standing et al. 2019). This research also seeks to understand the sustainable mobility paradigm, and the SC approach can provide an in-depth view from different perspectives.

Thirdly, the sustainable mobility paradigm related to various spatial scales, from the global to the local level, makes this research's context specifically. Previous literature (Bergman et al. 2017; Liao and Correia 2022; Sarasini and Langeland 2021) also addresses mobility patterns as not just impacting individuals. Instead, the individual is embedded in, and interacting with, culture, society, and the local community. Therefore, this research may consider various contexts such as societal scale, cultural impact, and geographical elements, which can be specific to the area, people, and time scale (Akyelken et al. 2018; Mouratidis et al. 2021; Standing et al. 2019). Regarding time scale, socio-technical transition theory is used as a fundamental framework in this research to understand how the business model interact with SPPS from niche to regime level. Transition theory has a longer timeline, especially at the landscape level of policies and whole-system change, while a business model and other innovative technologies may operate for a short period (Geels 2002; Moradi and Vagnoni 2018).

EVSS schemes began early in 2012 in China against increasing urbanisation and private vehicle ownership (Li et al. 2021; Niu and Xu 2016). EVSS schemes contribute to shaping resources, efficiency and fairness to create mobility options while simultaneously, EVSS can ease the pressure on urban transportation and reduce private vehicle ownership. However, EVs in the Chinese context are in the initial stage, and a lack of studies have been researched and less empirical support (Hui et al. 2017). This research may explore the in-depth sustainability implication and sustainable mobility system by using EVSS schemes as a lens (Akyelken et al. 2018).

Since EVSS is an emerging context that performs at an early stage in Yangtze River Delta Economic Zone (YRDEZ). SC may provide a technological frame for studying specific contexts with other relevant stakeholders by establishing theoretical knowledge and empirical practice patterns (Rosen 2001).

Finally, the qualitative approach is widely adopted when exploring new concepts in urban mobility behaviour and the transport sector (Poltimäe et al. 2022). This study *"seeks to collect data in naturally occurring situations and environments"* (Bryman 2012, p.52), such as stakeholders' experiences and perceptions relating to urban mobility. Previous literature indicates that a qualitative approach helps to evaluate issues within e-mobility scenarios (Bokolo et al.

2021b). Based on the above research characteristics, the researcher chose to design a qualitative case-based study to achieve an in-depth and rich account.

5.4 The research design

A research design demonstrates a logical plan, from addressing research questions to generating a set of conclusions (Yin 2014). Such a plan will typically consider relevant research questions, relevant data, what data to collect, and how to analyse it. However, a research design is not just a simple work plan (Yin 2014), it helps researchers to focus on appropriate evidence. In a research design, the researcher may clarify three stages: research strategies, research choices and time horizons based on research questions consistent with the chosen research philosophy (Yin 2014).

The term research design can also lead to confusion as it represents different meanings and layers by different authors that may use the research design and strategy differently. For example, Bryman (2012) and Saunders et al. (2016) use them contrarily. According to Bryman (2012), research design can be divided into five types: Experimental design, cross-sectional design, longitudinal design, case study design and comparative design. Then the researcher may bring the research design and strategy (qualitative or quantitative approach) together. In contrast, Saunders et al. (2016) note that research strategy comes prior to research design, and a research strategy can be categorised as experiment, survey, case study, action research, grounded theory, ethnography and archival research. While simultaneously, the research design can be divided into qualitative, quantitative, and mixed-method approaches.

In the following sections, the research design is discussed in detail by firstly addressing the research aims and strategy.

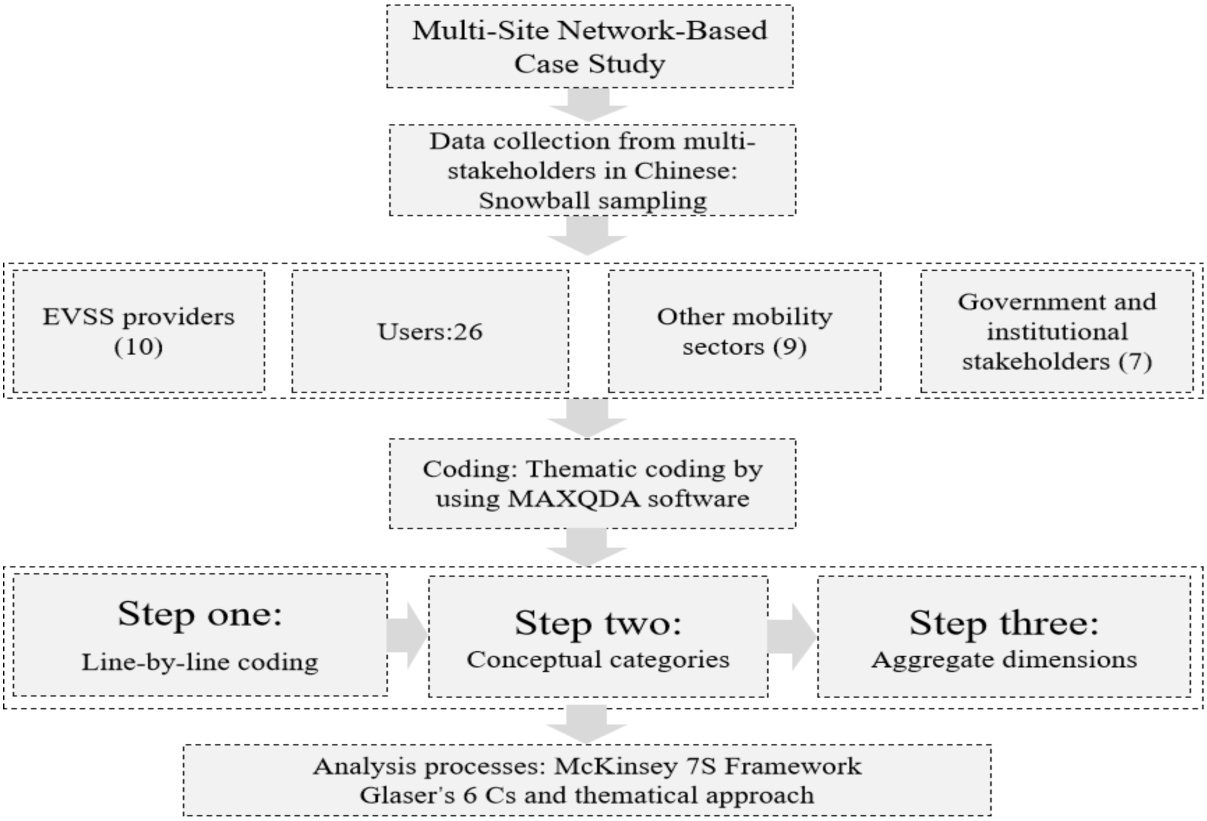


Figure 5.1 Multi-Site Network-Based Case Study: A flowchart of Data Collection, Coding, and Analysis Processes

5.4.1 Research aim

To conclude a research project in business and management studies, a researcher can answer their research questions through a descriptive, explanatory or exploratory result. Therefore, it has been suggested that researchers will evaluate the purpose of the research before making a research plan (Saunders et al. 2016; Yin 2014). **Table 5.2** demonstrates three types of research by its purpose.

Based on **Table 5.2**, this study can be identified as exploratory as it attempts to understand the transition towards sustainable product-service systems (i.e., car sharing services) by service providers of personal mobility in China through exploring how business models influence stakeholders' acceptance of EVSS (thereby exploring how sustainable business models can evolve beyond a niche market). Furthermore, an exploratory study allows for a flexible re-search strategy and appropriate data collection and analyses methods for investigating how sustainable business models evolve in this new mobility market.

Table 5.2 Research types by purpose (Developed by the author).

Exploratory study	Descriptive study	Explanatory study
• To figure out what is happening and gain new rich insights. • Scoping the relevant literature. • Arrange interview with professional experts in relevant fields. • A flexible research approach, the researcher may be willing to change direction when new data and circumstance come up.	• *"To portray an accurate profile of persons, events or situations"* (Robson 2002, p. 59) • The researcher needs to have a clear understanding of the data to be collected for approaching data collection. • Some descriptive studies can be defined as a descripto-explanatory study as the project can be understood as an explanation process.	• Seek to find out the causality between factors. • A statical analysis by examining the correlation between a set of variables to find out a clearer picture of the relationships and answer the research questions. • Collecting quantitative data may apply to research questions like "what", "why", and "who".

5.4.2 Research strategy

Given the exploratory nature of the study, and the focus on EVSS business models which involves understanding a) a new and rapidly evolving market and b) the role and perspectives of a range of relevant stakeholders, a qualitative approach was selected as appropriate. This is in line with Bergman et al.'s (2017) views on the value of qualitative approaches for understanding emerging urban mobility phenomena such as intelligent mobility and smart city developments and the creation of ecosystems for urban transport.

5.4.2.1 Data collection techniques

A range of methods are available to researchers including experiments, surveys, interviews, case studies, action research, grounded theory, ethnography, and archival research which can be used individually or in combination. This research chose to primarily use semi-structured interviews with EVSS directors and managers and other key stakeholders because interviews are frequently used as data collection methods to explore complex phenomena and generate in-depth understandings (Creswell et al. 2007). Data collection began with a literature review exploring sustainability studies, circular economy and mobility as broader themes, then interview questions were generated by gradually narrowing down from broad themes in the literature to create specific questions. After that, these themes will be reinterpreted based on the individuals' perspectives to construct meanings, which will be presented as a theory (see discussion chapter) in order to generate new themes and insights (Creswell 2022).

Although this research principally uses interviews to collect data, because it is focussed in both market and geographic terms, it could also be considered as a case study. A case study is a research approach capable of generating an in-depth, multi-faceted understanding of a complex phenomenon in a specific real-life context. The key research questions of a case study concern “why” “what” and “how”, and case study designs are popular in exploratory research (Saunders et al. 2016). Furthermore, case studies are typically considered to be of four types: *“single case, multiple case, holistic case and embedded case”* (Saunders et al. 2016, p.146). This research however does not exactly fit those conventional case study types.

5.4.2.2 Multi-site network-based case study approach

A single case is frequently utilised in situations in which it is intended to represent either an important case or, alternatively, an extreme or exceptional case (Yin 2014). On the other hand, a single case might be chosen because it is representative of a larger population or because it gives the researcher a chance to observe and investigate a phenomenon that has previously received less attention (Saunders et al 2016). This study aims to explore and understand the Chinese context by investigating EVSS in the YRDEZ as a case study. However, because this encompasses more than one city in which EVSS schemes are operating, it may be more accurately described as a multi-site network-based case.

A multi-site network-based case study approach includes conducting a practical exploration of a specific contemporary phenomenon inside its real-world context involving multiple sites (Robson 2002). Yin (2014) also emphasises the significance of the context, while adding that a boundary’s between the phenomenon being studied and the context in which it is being studied are unclear in such a case study. It seems to be a widely used approach in education, health and IT research rather than for businesses. However, this approach has been successfully applied to operational management by addressing research questions like what are the key themes, variables and patterns as well as those questions like how and what relationships can be identified (Stuart et al. 2002).

Network theory is a key theoretical lens applied to understand network-based cases, and is also commonly applied in marketing management (Gummesson 2007). This study will employ a similar logic of trying to understand a phenomenon by understanding the network of individual stakeholder organisations/individuals involved (as the unit of analysis) rather than focussing on individual organisations as the unit of analysis. However, conducting a full and formal network analysis is beyond the scope of this thesis.

There are two main reasons to choose the YRDEZ (a geographic case context) as a case study including the major cities of Shanghai, Hangzhou and Suzhou. Firstly these cities are emerging as representative of the global cityscape and resulting in extensive economic, cultural, and social effects (Lan et al. 2020). Secondly, the Shanghai Municipal Transportation Committee and Economic and Information Commission launched a policy in January 2016 to guide the development of EV-sharing service (Lan et al. 2020). In January 2018, the local government furthered its commitments under 'Shanghai 2035,' promoting *"green transport as an essential component of an innovative and sustainable city"* (Lan et al. 2020, p.661). This contributes towards an existing set of initiatives aimed at developing a sharing economy in urban transportation, housing, and food, which may have already impacted Shanghai citizens' daily lives (Lan et al. 2020). Furthermore, due to heterogeneity of local government's plan, cooperative ability, transport ecosystem and demographic issues like consumption behaviour, the outcomes can be important (Liao et al. 2020). This research may gain richer insight by using semi-structure interviews among relevant stakeholders.

YRDEZ contains cities representing those in China taking a lead in the introduction of EVSS. Furthermore, these cities involved are representative of contemporary Chinese cityscapes and a further 'pragmatic' justification is that they include the researcher's home city Suzhou which increased the researcher's likelihood of being able to develop research opportunities and to understand the research context clearly. Although this area may not be fully representative of EVSS schemes across the country, and the researcher does not cover all the cities within this area, the chosen cities are interesting due to their involvement in EVSS innovation (including the first self-driving experimental city) or are centres for the internet industry both of which have implications for urban EVSS scheme future development.

5.4.3 Data collection

The research design provides an overview of the method selected as well as the rationale behind that decision (Saunders et al 2016). The data collection strategy provides more detail about the data to be collected of which there are two types (Saunders et al 2016):

- Primary data: newly collected and recorded near the event under study.

- Secondary data: already collected for other purposes.

This study will use both data sources to answer the research questions addressing how business models affect stakeholders' acceptance of EVSS and how sustainable business models can progress beyond niche markets (Melkonyan et al. 2020).

5.4.3.1 Secondary data

In qualitative research, secondary data resources are usually generated from journals, academic articles, book chapters and web databases (Ruggiano and Perry 2019). This research began with scoping the relevant literatures using the Scopus search engine for topics such as sustainability studies, circular economy, sustainable production and consumption, mobility, innovation, ICT, sharing economy business models, transition theory and autonomous driving. This was focussed on sustainable mobility patterns in developed and devolving countries (by inputting key words in Scopus), which were gradually evaluated as conceptual building blocks for this study. **Figure 5.2** demonstrates the international nature of car sharing research and literature by showing the countries that contribute to this literature and how studies within it interconnect. These data guided the researcher in studying sustainable mobility patterns in China as well as in formulating the initial research questions for this study. However, in such an evolving and complex research context, this data is insufficient to answer the research questions; requiring instead, the pursuit of primary data (Jittrapirom et al. 2021).

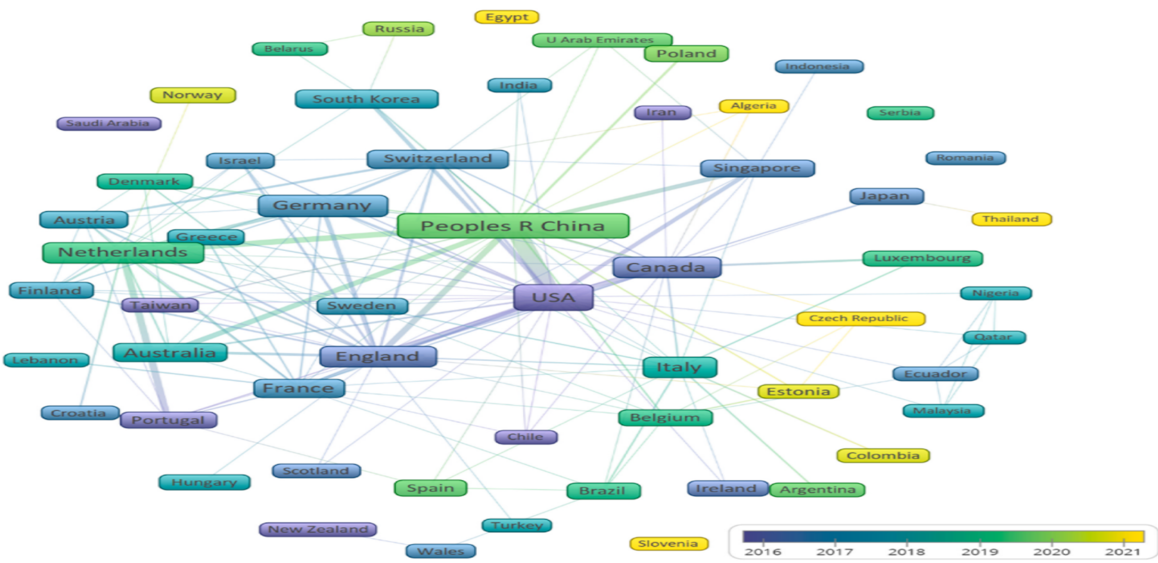


Figure 5.2 Network of international nature of car sharing research and literature (Shams Esfandabadi et al. 2022).

5.4.3.2 Primary data

Qualitative primary data can be collected through observation (with or without participation), semi-structured, in-depth and group interviews, and questionnaires. Interviews, the primary method employed in this study, can be informal and unstructured conversations, or they can be formal and structured, with standardised questions for each participant in the research (often referred to as a respondent) (Saunders et al 2016). Interviews can be categorised according to a number of different criteria, one of which is the level of formality and structure involved in conducting the interview (Saunders et al 2016), into structured, semi-structured or unstructured/in-depth interviews.

Based on the purpose of this research, a semi-structured interview will be used to explore "what is happening" and achieve new insights (Saunders et al. 2016). Although the researcher will have a list of topics and questions to cover, these may change from interview to interview depending on the uncovered information (Bryman 2012). The natural progression of the conversation may also cause the order in which questions are asked to shift (Bryman 2012). In addition, given the evolving nature of the research context, it will be necessary to ask additional questions to investigate the research question and its objectives (Saunders et al. 2016).

Researchers can also differentiate between types of interviews based on the nature of the interaction between the researcher and the individuals participating. For example, one-to-one interviews, in which there is only the researcher and the participant being questioned, are also an option for conducting interviews. A standard method for carrying out interviews of this kind is to meet with the participant "face to face". However, there are some circumstances where the researcher might be required to interview over the phone or in digital format via the Internet or the intranet of an organisation. Although conducting an interview in person may be considered the 'gold standard', online interview may go beyond in-person interview in specific situations and may provide rich information (Johnson et al. 2021).

In this case study, the researcher chose to use online one-to-one and video recording techniques to conduct semi-structured interviews for three reasons. Firstly, it is widely acknowledged that interviews can elicit and uncover 'respondents' individual meanings and interpretations (Warren 2002). Given this opportunity, it is significant for the researcher to interview key people who are professionals in relevant stakeholder groups, such as those responsible for the EVSS schemes. Secondly, the researcher can ask critical follow-up questions providing flexibility

(Bryman 2012; Saunders et al. 2016). Finally, a semi-structured interview provides an opportunity for the researcher to understand stakeholders' practices and experience regarding EVSS schemes, and it also provides the freedom for interviewees to describe new issues as well allowing the researcher to gain new insights and discuss additional content (Collis and Hussey 2003).

Interviews, like other research methodologies, have inherent drawbacks, including time, cost, efficiency, heterogeneity of the population and generalisability (Bryman 2012). The time-intensive nature of interviews reflects the challenges of securing, scheduling and conducting sufficient interviews and transcribing recorded materials (Bennett et al. 2009; Bryman 2012). To overcome these disadvantages, this research used Zoom primarily for online interviews and generated recorded files for transcription. Zoom also has capabilities to transfer audio to text which supports multiple languages. Taking Chinese as the main language for interviewees into consideration, the author checked manually each transcription file to ensure accuracy. Using Zoom (video) recordings not only increased data collection efficiency but also allowed multiple adverse circumstances for interviewees in China to be overcome, such as finding convenient times in the face of work pressures and suffering regional lockdown restrictions during a key period for data collection.

Another potential disadvantage is response bias which may also affect research reliability (Silverman 2013). This bias may be driven by interviewer perceptions or perceived bias and may be especially true for in-depth or semi-structured interviews which analyse circumstances or seek explanations (Bryman 2012). Interviewees may be likely to participate but hesitant due to sensitivity of particular themes (Yin 2014) and may opt not to discuss a topic that researchers seek to investigate since it could lead to inquisitive inquiries that would invade sensitive topics which they do not wish to discuss (Bryman 2012). The interviewees may therefore presents a partial "picture" of the situation that casts themselves or their firm in a "socially desirable" role (Robson 2002).

5.4.4 Theoretical sampling trajectory and data sources

In qualitative research, there are different ways to select samples. SC-based research typically uses non-probability sampling and this study adopts purposive sampling based on the researcher's personal pragmatic judgement concerning the characteristics of potential respondents and whether they could give the researcher valuable information about the topic of the study (Patton 2002).

Purposive sampling benefits qualitative researchers because it allows the research questions to drive the sampling and sampling strategy, allows the researcher to keep the sampling consistent with the study aims, and allows a focus on cases or participants with the greatest potential to address the questions being asked (Bryman 2012; Saunders et al. 2016).

This research targeted interviewees from four key stakeholder groups who play an essential role in the urban mobility paradigm. The primary group is EVSS providers in the Yangtze River Delta Economic Development Zone (China), followed by the second group, which can be understood as online-hailing service providers and other public mobility service providers. The third group is users, divided into four types: users who use EVSSs, potential users, refusers (may use) and refusers who will not use them. Finally, the fourth group include government bodies and institutions with a relationship with EVSSs. This fourth group reflects Miles and Huberman's (1984, p.34) strategy named 'peripheral sampling' which implies the necessity of working in the peripheral with people close to the study.

The researcher conducted initial exploratory research before progressing to formal data collection via discussions with EV providers and users, government departments (e.g., traffic and urban planning departments) and EV manufacturer associations in search of potential interviewees and to better understand the research landscape. Then, based on their understanding of EVs pattern, the researcher finalised the target group, which will be explained in the following sections.

5.4.4.1 Exploratory phase (Initial contact)

From March 2019 to October 2020, the researcher contacted the above stakeholder groups to have a face-to-face meeting for more information. As the researcher planned, the first round of data collection focused on primary stakeholders, i.e., EVSS (Owners/ Managers). Therefore, collecting the right interviewees is essential for this research. A clear definition of EVSS is those who run or work in a service-based firm which provides or owns EVs. Based on the initial meetings, the researcher achieved a list of EVSS providers (provided by those EVSS providers in the initial meetings) and extra information like their company operation status and users' feedback that provided the researcher with an overview of this market. Furthermore, the researcher arranged meetings with other key stakeholders categorised by government, users and other public transport sectors for further information:

- In terms of government departments, the researcher firstly contacted the Urban Traffic Department in Suzhou, Jiangsu province which is core area in the YRDEZ.
- Based on the provided information regarding to the urban mobility paradigm, the researcher decided to contact other governmental departments and associations which also play an important role in EVSSs.
- In terms of the users, the researcher contacted them using details provided by the EVSS firms.
- For other public mobility sectors, the researcher also interviewed marketing managers from the DIDI company, a related service provider that also influences EVSS schemes (Ma et al. 2018).

The exploratory research provided insight into the sampling strategy, particularly in terms of identifying the appropriate stakeholders for conducting interviews. However, securing interviewees can sometimes be challenging due to concerns about trustworthiness and sensitivities. In such cases, snowball sampling may prove beneficial in finding alternative and suitable interviewees.

5.4.4.2 Sampling approach

Based on the experience of the exploratory research, the researcher used a pragmatic mixture of purposive, convenience and snowball sampling strategy to access the respondents and the information that the thesis needed. Purposive sampling, also referred to as subjective, judgmental, or selective sampling, is a non-probability sampling technique (Bryman 2012). It can be used when a specific subset of a population will be studied and when not all potential participants would be relevant or informative for the research (Bryman 2012). Snowball sampling begins by choosing a small group of people who fit the research questions, and then those people suggest others with similar experiences or traits (Bryman 2012). It can also be particularly useful when the focus is on groups of people or networks (Coleman 1958). While a convenience sampling strategy is another type of nonprobability sampling, can be used when a sample is needed quickly and inexpensively, as it requires minimal planning and no specific sampling frame (Bryman 2012; Saunders et al. 2016).

Accordingly, the researcher also pragmatically used his working background (Automotive industry) to verbally make contact with EV providers he had worked with, such as SAIC Motor, to begin the snowballing process. The researcher used this strategy successfully, recruiting ten EV providers' managers, twenty-six EVs users, ten managers of online and call-hailing service providers and seven officers and heads of government departments, respectively, for online interviews. Furthermore, during the data collection period, Shanghai and other areas in the Delta Economic Zone suffered serious lockdowns due to pandemic restrictions. Therefore, using the Zoom virtual recording technique to collect data became an essential and appropriate approach.

In terms of sampling size, it was guided by data saturation (Fusch and Ness 2015) and reaching the point where further interviews ceased to demonstrate new insights. Crouch and McKenzie (2006) promote the advantages of small sample sizes by arguing that samples of less than twenty increase the qualitative researcher's possibility of constructing close relationships with interview-based study participants. Specifying the minimum or maximum sample size can be meaningless if data saturation is used to determine sample size so that the sample size criterion becomes whatever is necessary to achieve saturation (Francis et al. 2010). Saturation was reached after interviewing fifty-one respondents and given that the ten service providers already cover the majority of EVs providers in China the sample can be seen as representative of the industry. **Figure 5.3** shows how the researcher conducted the data collection process.

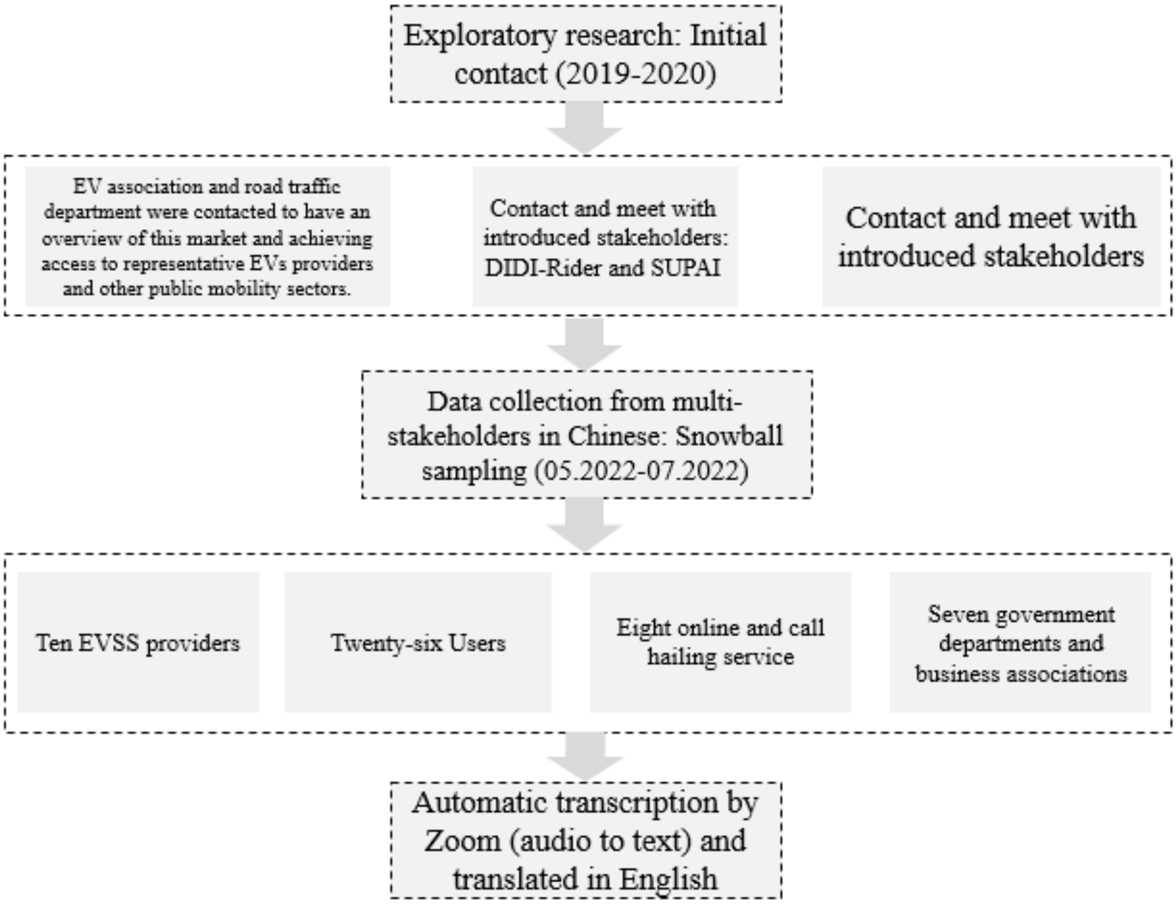


Figure 5.3 Timeline and logic of the data collection procedure.

5.4.5 Research field work

The introductory chapter mentioned that this research is conducted in YRDEZ, a prototypical mega-city and coastal region located in eastern China – which is considerably larger than its apparent counterparts in other parts of the world, such as the Southeast of England and the Dutch Randstad (Zhang et al. 2018). It is also administered by the National Development and Reform Commission, with a total land area of 217,700 km2, and this size is comparable to that of the entire United Kingdom (Zhang et al. 2018; Wang et al. 2019b). **Figure 5.4** shows that YRDEZ consists of Jiangsu, Zhejiang and Anhui provinces, as well as the city of Shanghai (Zhang et al. 2018; Wang et al. 2019b). It consists of 26 cities with a population of 150 million, and a regional GDP of 14,87 trillion yuan in 2016 (Zhang et al. 2018; Wang et al. 2019b). Furthermore, YRDEZ has the intersection of "the Silk Road Economic Belt", the "21st-Century

Maritime Silk Road[1] and "the Yangtze River Economic Belt"; it has a certain vitality, degree of openness and innovation ability, and attractive to businesses in China (Zhang et al. 2018; Wang et al. 2019b).

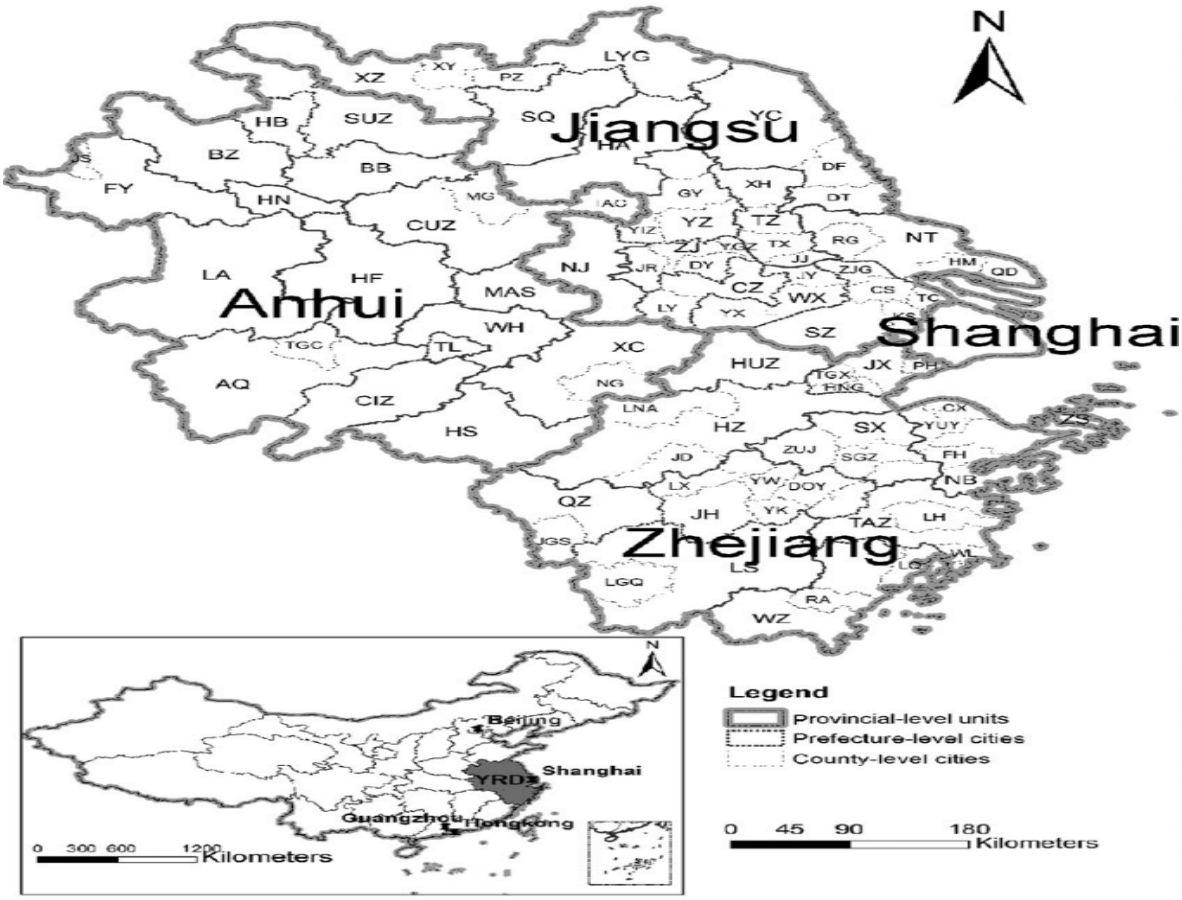


Figure 5.4 Division of administration in YRDEZ (Zhang et al. 2018, p.531).

The researcher contacted participants from four of the megacities: Shanghai, Suzhou, Nanjing and Hangzhou. These are selected because they are highly developed, with numerous innovative enterprises operating within them, and because cities like Shanghai, Suzhou and Hangzhou have acted as the first EV autonomous driving test and experimental centres (Ma et al. 2018). From a local policy standpoint, cities within the YRDEZ provide active support for the development of EVs including innovative networks and operational platforms (Dangelico and Pujari 2010; Zhao et al. 2018). Pragmatically the researcher originates from the area improving the

[1] The 21st-Century Maritime Silk Road is an element of China's broader Belt and Road Initiative which was announced in 2013. This strategic policy aims to improve regional connectivity among countries along the proposed routes. The initiative draws inspiration from the ancient Silk Road, a historic network of trade routes connecting China to various regions across Asia, Europe, and Africa.

chances of respondents being willing to engage with him and making the research resource-efficient for time consumption.

The fieldwork was conducted during April and May 2022 by interviewing four groups of stakeholders including ten EVs providers' managers, twenty-six EVs users, ten managers of online and call-hailing service providers and seven officials and heads of government departments. The pandemic had an impact on the data collection process is two ways. The lockdowns experienced in China prevented travel there and precluded any face-to-face interviews in the main data collection stage. However, the instigation of a strict lockdown during April and May 2022 produced a window of opportunity in which the key respondents were all at home and unable to work, and therefore unusually responsive to finding time to be interviewed on Zoom.

The interviews were semi-structured, virtual and recorded using Zoom, and provided interviewees a chance to express their understanding and views. An interview guideline (Appendix F) was developed to address the themes and questions for the four groups of stakeholders with the aim of making the questions consistent and comparable.

5.4.5.1 Interviews with the first stakeholder (EVSS providers)

The first group of stakeholders were mostly Managers/Owners of EVSS providers who manage firms and their strategic marketing decisions, which will be influenced by their perceptions, understanding and actions. Some also had other working experience (e.g., working in the other public mobility service) relevant to the sustainable mobility paradigm. Nine firms were run by either the founder (3 firms) or a general manager (6 firms) with full authority to make wide-ranging decisions. One interviewee was a marketing manager and was also a strategic decision-maker with considerable experience of sharing schemes and the firm's situation.

Table 5.3 provides an overview of the firms and demographic information about the respondents that may aid comparisons in the next chapter. The respondents were comprised of senior managers in their 30s and included three owners, four general managers, and three chief marketing managers. Based on the information gathered during the exploratory phase, the EVSS in the Chinese context were categorised into three types: mixed, heavy and light assets. Heavy asset firms are those that own EVs, while light asset firms do not. Mixed asset firms own a certain number of cars that operate in the market and also use their online platform in cooperation with other firms. Other descriptive information, such as business models, will be analysed in detail in the next chapter.

Table 5.3 List of the interviewees from EVSS.

S/N	EVSS Name	Year founded	Assets/Operational Type	Company Attribute	OEM Involvement	Vehicle Ownership Model	Platform Type	User Base	Employee/Car Ratio	Representative	Education level
1	SuPai	2009/2017	Mixed/Operational platform	Private	No	Providers and other collaborations	Flexible service-driven EVSS	B&C-side[1]	300/500	Tom	Junior college
2	Universal Motor	2012	Mixed/Operational platform	Private	No	Providers	User-focused vehicle resource allocation	B&C-side	260/600	John	Junior college
3	Baishi EVSS	2015	Light assets/Operational platform	Private	No	Providers and other collaborations	Decentralised Collaborative Marketplace	B&C-side	9/2,000	Jimmy	Junior college
4	Gofun EVSS	2015	Heavy assets/Operational platform	Government led	ShouQi	OEM	Manufacturer-Driven Ecosystem	C-side[2]	1,200/30,000	Edward	BSc
5	LD EVSS	2014	Heavy assets/Operational platform	Government led	Guanzhi	OEM	Manufacturer-Driven Ecosystem	C-side	1,000/30,500	Richard	BSc
6	LD Go	2018	Heavy assets/Operational platform	Government led	Guanzhi	OEM	Manufacturer-Driven Ecosystem	C-side	2084/30,000	Mike	BSc
7	Car Inc	2011	Heavy assets/Operational platform	Mixed	No	Providers	User-focused vehicle resource allocation	B&C-side	2084/30,600	Jack	BSc
8	Evcard (Suzhou)	2016	Heavy assets/Operational platform	Government led	SAIC	OEM	Manufacturer-Driven Ecosystem	C-side	100/5,000	Lee	BSc
9	Evcard (Shanghai)	2016	Heavy assets/Operational platform	Government led	SAIC	OEM	Manufacturer-Driven Ecosystem	C-side	365/5,000	Jason	BSc
10	Aotu Travel	2013	Light assets/Operational platform	Mixed	No	Providers and other collaborations	User-focused vehicle resource allocation	C-side	1000/100,000	Jet	Junior college

[1] Corporate companies and individual customers.
[2] Individual customers only.

5.4.5.2 Interviews with the second stakeholder (Users)

The EVSS providers supplied the researcher with lists of actual and potential users as potential interviewees. From Group A (users), the author selected participants randomly (**Table 5.5**). Group B (potential users) consists of customers who had been contacted by EVSS during promotional campaigns but have not yet used their services. Meanwhile, the author employed a snowball sampling strategy to recruit respondents for Group B for more samples.

During the interviews with Group B respondents' rich insights indicated that sixteen potential users would consider using EVSS if concerns regarding safety, hygiene, convenience, and parking were addressed. Consequently, the authors established three main groups for further investigation: Group A, including of early adopters who already use EVSS; Group B, who may use EVSS in the future. Within the potential users, varying levels of enthusiasm correspond to stages of the innovation diffusion model (Wells and Nieuwenhuis 2018), including early majority, late majority, and laggards. Therefore, Group B (**Table 5.6**) is subdivided into Group B1, who are more likely to use EVSS, and Group B2, who are less likely to adopt EVSS, while B3 (**Table 5.7**) are those laggards who may take a lot of persuading at the moment in term of using EVSS. **Table 5.4** below provides a list of the overall interviewee groups:

Table 5.4 List of the interviewee groups.

Groups	Type	Amount
Group A	Users	10
Group B	Potential Users	16
Overall	For all respondents	26

Table 5.5 Group A: Users.

Serial number	English Name	Gender	Age	Education level	Occupation	City/Province or Municipalities	EVSS brand	Service type	Purpose	Main concern
1	David	Male	52	BA	Entrepreneur in Civil Engineering Consultancy	Shanghai	EVCARD/ Gofun	Time sharing	Business	Convenience
2	Daniel	Male	42	BA	Entrepreneur in Home Appliances Trade	Yancheng/Jiangsu	EVCARD/ Gofun	Time sharing	Business	Convenience; Low-cost; Efficiency
3	Dylan	Male	32	BA	Company manager in Internet Finance	Suzhou/Jiangsu	EVCARD/ Gofun	Week/Day package	Business	Convenience; Low-cost; Efficiency; Safety; Hygiene
4	Daisy	Female	32	BA	Sales manager	Suzhou/Jiangsu	LD Go	Time sharing	Leisure	Convenience; Low-cost; Efficiency
5	Derek	Male	36	BA	General manager	Nanjing/Jiangsu	LD EVSS	Time sharing	Experi-ence	Driving experience
6	Darren	Male	36	BA	General manager	Shanghai/Kun-shan/Jiangsu	EVCARD/ Xiaoma Yi	Time sharing	Experi-ence	Low-cost; Conven-ience
7	Dixie	Female	28	MSc	Company manager	Hangzhou/Zhejiang	Aotu Go	Time sharing	Travel	Convenience; Low-cost; Efficiency
8	Desiree	Female	30	BA	High school teacher	WuJiang/Jiangsu	Car Inc	Time sharing	Travel	Convenience; low-cost; Efficiency; Safety; Hygiene
9	Denver	Female	36	MSc	Manager in supply chain industry	Changzhou/Jiangsu	SuPai	Time sharing	Business	Convenience; Low-cost; Efficiency; Safety
10	Dalia	Female	36	MSc	Manager in supply chain industry	Zhangjia gang/Jiangsu	Universal Motor	Time sharing	Business	Convenience; Low-cost; Efficiency; Safety; hygiene

Table 5.6 Group B: Potential Users.

Content / Detailed grouping	Serial number	English Name	Gender	Age	Education level	Occupation	City/Province or Municipalities	Preferred EVSS brand	Purpose	Main concern
Group B1: Early majority	1	Gia	Female	30	MSc	Marketing manager	Ningbo/Zhejiang	Non brand	Leisure	Safety; Hygiene
	2	Gary	Male	32	MSc	Manager in medical system	Hangzhou/ Zhejiang	Non brand	Travel	Safety; Hygiene
	3	Gail	Female	32	MSc	HR manager in industry	Shanghai	EVCARD	Business	Safety
Group B2: Late majority	1	Evan	Male	50	Undergraduate	Entrepreneur	Suzhou/Jiangsu	EVCARD/ Gofun	Business	Convenience; Low-cost; Efficiency; Safety
	2	Eli	Male	38	Undergraduate	CEO	Suzhou/Jiangsu	EVCARD/ Gofun	Experience	Convenience; Low-cost; Efficiency; Safety; hygiene
	3	Elias	Male	35	MSc	Company manager	Suzhou/Jiangsu	EVCARD/ Gofun	Travel	Convenience; Low-cost; Efficiency; Safety
	4	Ethan	Male	32	MSc	Company manager	Hangzhou/Zhejiang	EVCARD/ Gofun	Leisure	Low-cost; Convenience
	5	Erica	Female	26	MSc	student	Yancheng/Jiangsu	EVCARD/ Gofun	Experience	Convenience; Low-cost; Efficiency; Safety
	6	Erin	Female	31	MSc	Manager in industry	Shanghai	EVCARD/ Gofun	Experience	Convenience; Low-cost; Efficiency; Safety; hygiene
	7	Eve	Female	31	BA	Primary school teacher	Hangzhou/Zhejiang	EVCARD/ Gofun	Travel	Convenience; Low-cost; Efficiency; Safety
	8	Ellen	Female	30	PhD	Student	Changzhou/Jiangsu	EVCARD/ Gofun	Travel	Convenience
	9	Elsa	Female	27	BA	High school teacher	Wujiang/Jiangsu	EVCARD/ Gofun	Business	Convenience; low-cost; Efficiency; Safety
	10	Elsie	Female	26	BA	HR in industry	Suzhou/Jiangsu	EVCARD/ Gofun	Business	Convenience; Low-cost; Efficiency; Safety

Table 5.7 Group B3: Laggards.

Serial number	Name (English)	Male	Age	Education level	Occupation	City/Province or Municipalities	Main concern
1	Harry	Male	28	BA	Marketing manager	Suzhou/Jiangsu	Safety; Hygiene; Preference
2	Helen	Female	28	MSc	student	Yancheng/Jiangsu	Safety; Preference
3	Holly	Female	29	MSc	student	Kunshan/Jiangsu	Convenience; Preference

5.4.5.3 Interviews with the third stakeholder (Other mobility sectors)

The third stakeholder group for EVSSs are other mobility sector actors that can be categorised into two types. The first are representatives of public transport departments, which operate taxis, buses, subways and trams. The second type are online and call-hailing service providers who provide journeys on a similar basis to taxis. The author selected seven popular hailing service providers based on the exploratory research, and these firms are broad national services. **Table 5.8** provide an overview of these sectors. The respondents were restricted to roles were all senior managers, in included two owners, five general managers, and two chief marketing managers.

Table 5.8 List of other mobility sectors.

Serial number	Name of the sector	Mobility tool	Service location	Interviewee's Name
1	Public transport department	Bus, taxi, underground and tram	Suzhou	Bond
2	Baishi Shunxin	Car	Suzhou	Bennett
3	Baidu (Jidu automotive)	Car	Shanghai	Bill
4	Xiaopeng Car	Car	Suzhou	Bella
5	ShouQi hailing service	Car	Suzhou	Bob
6	Che Xiaodong hailing service	Car	Suzhou	Brian
7	Tubu hailing service	Car	Suzhou	Billy
8	DIDI hailing service	Car	Suzhou, Wuxi and Lianyun gang	Betty
9	T3 mobility	Car	Hangzhou	Ben

5.4.5.4 Interviews with the fourth stakeholder group (Government and institutions)

Table 5.9 provides the relevant government department and institutions interested in the EVSS schemes, which are essential in building a sustainable urban transport ecosystem. Seven interviewees are either heads or in a critical position dealing with EVSS issues.

Table 5.9 List of government and institutional stakeholders.

Serial number	Department	Position	Interviewee's Name
1	Traffic & Roads Department	Head	Carter
2	New Energy Vehicles (NEV) Association	Chairman	Clinton
3	Traffic Police	Head	Chris
4	EV Association	Chairman	Case
5	Deputy-Mayor	Vice Mayor	Charles
6	Public Transport Department	Head	Cal
7	National Development and Reform Commission (NDRC)	Head	Corbin

5.4.6 Analytical strategy

Earlier sections mentioned that the qualitative approach is likely to produce rich data, particularly via semi-structured interviews, which can make it difficult for the researcher to reach valuable results. According to Yin (2018), data analysis can be a challenging phase of qualitative research as a large amount of information is achieved during data collection. This was the case for this study since the interviews generated 186,373 words of data for analysis (105,268 words for EVSS, 17,201 for ride-hailing service providers, 24,435 for government and other institutions and 39,469 for users). With 165,373 words in total for post translation (95,268 words for EVSS, 15,201 for ride-hailing service providers, 21,435 for government and other institutions and 33,469 for users. The researcher needed to ensure that the data analysis methods aligned with the study's ontological and epistemological stance (May 2002), and to achieve the research objectives, it is important to conduct data analysis effectively (Saunders et al. 2016).

Software for computers to assist qualitative analysis and manual analysis of data methods were utilised in the data analysis of this study since such software programmes can aid researchers in analysing qualitative data. This thesis integrated manual and computerised analysis methods to ensure a comprehensive examination of the qualitative data. The computerised analysis was conducted using the MAXQDA, a widely recognised software for qualitative study (Kuckartz and Rädiker 2019). Manual analysis was performed through thematic analysis, which is a popular technique among qualitative researchers (Bryman 2012).

The relationship between manual and computerised analysis is complementary in this thesis. Both methods contributing towards an in-depth understanding of the data. The computerised analysis, by using MAXQDA software, allows for efficient organisation, coding, and visualisation of the data, facilitating the identification of patterns and trends (Kuckartz and Rädiker 2019; Schönfelder 2011).

On the other hand, manual analysis through thematic analysis provides an in-depth approach, allowing the researcher to become immersed in the data, identifying subtle themes, and make sense of the relationships among those themes. By using both methods, the researcher can not only capitalise on the strengths of each method but also ensure a comprehensive examination of the data, thereby enhancing the quality and validity of the findings. The use of both analytic tools in this research is explained in the following sections.

5.4.6.1 MAXQDA data analysis

The interviews were video-recorded and firstly transcribed in Chinese (audio to text), the language the interviewees were most comfortable with, before being translated into English. Before importing data into MAXQDA the researcher manually checked all the conversations to ensure the translation was consistent with interviewees' explanation (Kuckartz and Rädiker 2019). Documents were categorised by different stakeholders in MAXQDA for the researcher to review, organise and code (Kuckartz and Rädiker 2019). An example of a document in MAXQDA to illustrate the coding strategy (Strauss et al. 1999; Saunders et al. 2016): Open coding, code in vivo, and code by lists (**Appendix G 1.**), is shown below:

This section will explain how the research uses MAXQDA by illustrating a step-by-step approach. MAXQDA has an advantageous coding feature supporting a hybrid coding strategy that allows codes from open coding and codes from documents of expert reports to be combined to make the codes (Kuckartz and Rädiker 2019). Hybrid codes are using those codes that came out of the first round of open coding (line-by-line coding). **Appendix G 1.** and **Appendix G 2.** show how the author used MAXQDA to do line-by-line coding process.

Therefore, the first step is to create codes by using open coding and narrowing them down by merging codes (See **Appendix G 2.**). **Appendix G 2.** shows how the conceptual category "business model" was created through open coding. The second step is to create a coding scheme table in a network view by labelling codes and creating links if they have relationships. The third step is to develop a hierarchy code based on the coding scheme (see **Appendix G 3.** and **Appendix G 4.)** **Appendix G 2.** And **Figure 5.5** shows how the author used conceptual categories to generate the aggregate dimension of "business model evolution". Lastly, **Figure 5.6** shows all six aggregate dimensions and related conceptual categories.

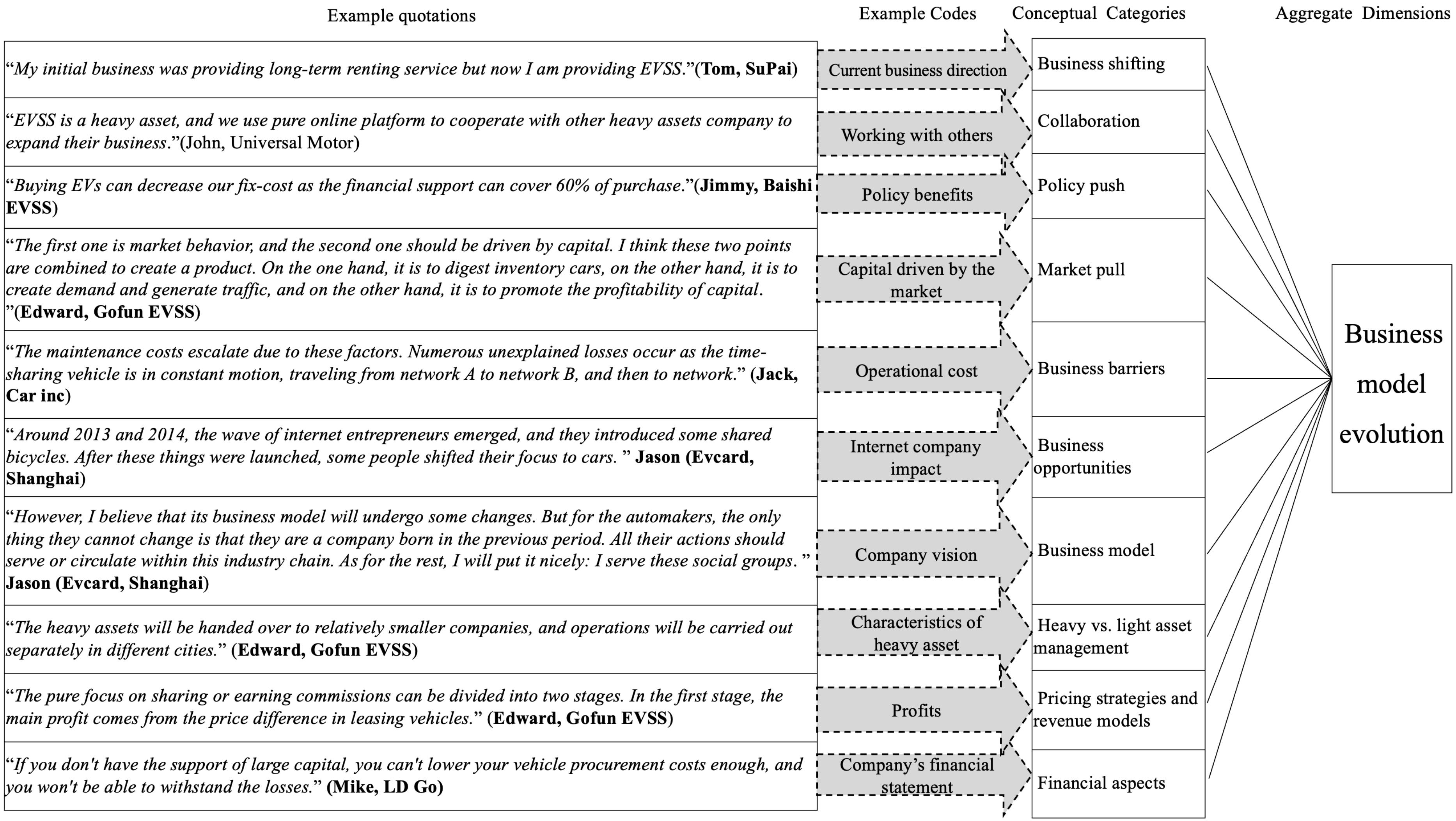


Figure 5.5 Example of data coding for identifying "business model evolution" as aggregate dimension of EVSS towards sustainability (Made by the author).

Conceptual Categories				Aggregate Dimensions
▪ Business shifting ▪ Collaboration	▪ Policy push ▪ Market pull	▪ Business barriers ▪ Business opportunities ▪ Business model	▪ Heavy vs. light asset management ▪ Pricing strategies and revenue models ▪ Financial aspects	Business model evolution
▪ Large market and hard to form a competition ▪ Leading car sharing companies ▪ Other car sharing companies ▪ Elimination of start-ups	▪ EVSS providers' market perspective ▪ Supplement ▪ Profit solution ▪ Additional business opportunities: Internet-online business	▪ Customer segmentation ▪ Target markets and demographics ▪ Promotional solutions ▪ Marketing and promotion ▪ Competitor relationships	▪ E-scooter integration ▪ Collaboration: expansion and partnerships ▪ Annual rent VS in time rent ▪ Customer education and awareness ▪ Platform development and maintenance	Market evolution
▪ Government policies and support ▪ Stakeholder relationships (OEMs, insurance companies, repair services) ▪ Corporate social responsibility ▪ Environmental concerns	▪ Collaboration with policy departments and city governments ▪ Legal and regulatory compliance ▪ Government relations and policy advocacy ▪ Urban infrastructure and planning	▪ Inconsistency of policies ▪ EVSS has internet business background ▪ Pandemic ▪ Vehicles' repair service providers ▪ EVSS and stakeholder integration ▪ Stakeholder Charging station: Monopolize	▪ Cooperate with policy department to secure road safety ▪ Considered the introduction of China Mobile as a major shareholder ▪ Cities have requirements and ratios for operational vehicles	Policy and Stakeholder Integration
▪ Technologies (AV, AI, innovation and ICT) ▪ eMaaS	▪ Charging infrastructure and battery recycling ▪ UAM	▪ Wireless charging solutions ▪ Integration with renewable energy sources	▪ Vehicle Intelligence (IV) ▪ Integrated cloud systems	Future Urban Mobility
▪ Reasons and willingness to use EVSS ▪ User concerns and needs	▪ User attitudes and perceptions ▪ Service quality	▪ Customer education and training ▪ Customer segmentation	▪ Customer satisfaction ▪ EVSS meets customer demand ▪ Users' misbehavior	User Preferences
▪ Fleet management and optimisation ▪ Balancing supply and demand ▪ Predictive maintenance	▪ Remote monitoring and control ▪ Employee training and development ▪ Social support ▪ Increasing vehicle utilization	▪ Efficiency ▪ Staff responsibilities ▪ Operational challenges ▪ Customer relationships	▪ Inefficient supporting infrastructure ▪ Difficult to manage stakeholders ▪ Limitation and barriers ▪ Enhance internal regulatory	Management and Operations

Figure 5.6 Six aggregate dimensions and related conceptual categories (Made by the author).

5.4.6.2 Thematic data analysis

Thematic analysis can be a useful technique for analysing open-ended interview question due to its realism in reporting participant experiences in actual situations (Robson 2002; Saunders et al. 2016 and Bryman 2012). A definition of thematic analysis is as follows: *'Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data. It minimally organises and describes your data set in (rich) detail'* (Braun and Clarke 2006, p. 79). Braun and Clarke (2006) also mention that thematic analysis is a widely used method that seeks to find and explain patterns across qualitative data. Additionally, the research may go beyond this by generating hybrid codes and hierarchy themes.

To achieve the aims above, two approaches to thematic data analysis were adopted. The first involved using Glaser's Six Cs (Glaser 1978) as an additional theoretical coding strategy that uses generic high-level theoretical codes to cluster more individual line-by-line type codes together when trying to understand a target phenomenon such as EVSS schemes. This step was carried out after all data had been subjected to line-by-line and focused coding. Glaser (1978 p. 74) describes "The Six Cs," which stand for causes, contexts, contingencies, consequences, conveniences, and conditions, as the "bread and butter theoretical code" (Samuel and Peattie 2016). Using this approach ensured that the codes emerging from open coding were analysed to identify consequences, dependent variables, causes, and their "process" (Samuel and Peattie 2016). Glaser's Six Cs can be applied to better understand EVSS as a business phenomenon (**Table 5.10**):

- Conditions (or antecedents) - what needs to be in place for the EVSS to develop?
- Causes (including sources) - what, more directly, causes EVSS to develop?
- Consequences - what happens because of the EVSSs?
- Context - when and where do EVSS develop?
- Contingencies (or variables) - what things change the way that EVSSs develop and operate?
- Covariances (variables which are connected, changing together, without a causal connection) - what things are connected to EVSS's development and operation, but not part of a cause-and-effect relationship?

Glaser's Six Cs can also be applied to an aggregate dimension such as “market evolution” to generate a story (**Table 5.11**)

The second thematic approach involved analysing the interviews with EVSS stakeholders, using the McKinsey 7S Framework (Peters and Waterman 1982; Singh 2013) as a lens to analyse EVSSs’ business models (See Fig. 5.5). This helped to create a firm-level focus for the analysis encompassing strategic and the operational perspectives and both the 'hard' (business structure, systems) and 'soft' (style, skills) elements of the firms involved (Peters and Waterman 1982 pp 9-11). Although this model has been criticised for being light on non-human resources, too inward-looking, and unable to capture the full value of external relationships (Saunders and Wong 1985) it provided pragmatic benefits when seeking to understand how the business model EVS schemes operate and how they can help shift urban mobility system towards sustainability. This framework has been subject to a number of criticisms, including concerning the methodology behind it, and the limitations of focussing only on the internal aspects of an organisation (D’Aveni 1995). However this latter feature is arguably a strength when using the framework to understand the role of internal factors in strategic effectiveness, and it remains a popular analytical tool, partly because of its emphasis on interactions and synergies between different organisational elements and its balancing of ‘hard’ and ‘soft’ elements (D’Aveni 1995; Singh 2013).

The above analytical strategy provides an appropriate approach for structuring the analysis and finding high-level codes/categories in order to group elements and identify the most important ‘stories’ within a large quantity of rich data.

Table 5.10 EVSS business phenomena (Using Glaser's Six C's).

Conditions	Causes	Consequences	Context	Contingencies	Covariances
• Growing environmental concerns • Advancements in EV technology • Supportive government policies • Increasing consumer awareness • Development of charging infrastructure	• Market demand for shared mobility • Need for urban mobility solutions • Capital investment • Technological Collaboration between stakeholders	• Increased EV adoption • Shift towards sustainable urban transportation • New business opportunities • Enhanced user experiences • Potential challenges	• Urban areas with high population density • Regions with supportive government policies • Markets with growing consumer awareness	• Government support and policy stability • Technological advancements • Competitive landscape • Consumer preferences • Availability of financing and investment	• Growth of the overall EV market • Development of autonomous driving technology • Expansion of charging infrastructure • Focus on sustainability • Emergence of new business models and revenue streams

Table 5.11 Aggregate dimension (Using Glaser's Six C's).

Conditions	Causes	Consequences	Context	Contingencies	Covariances
• Growing EV market • Need for sustainable urban mobility solutions • Government support • Technological advancements • Demand for shared mobility services	• Market demand for shared mobility • Environmental concerns • Availability of various car-sharing options • Advancements in technology • Shift towards online business	• Market evolution • Elimination of start-ups • Growth of leading car-sharing companies • Emergence of new business opportunities • Changes in customer preferences	• Urban areas with high population density • Regions with supportive government policies • Markets with growing EV adoption	• Competitive landscape • Technological advancements • Consumer preferences • Changes in government policies • Market dynamics	• Integration of e-scooters • Expansion and partnerships • Customer education and awareness • Development of marketing and promotional strategies • Platform development and maintenance

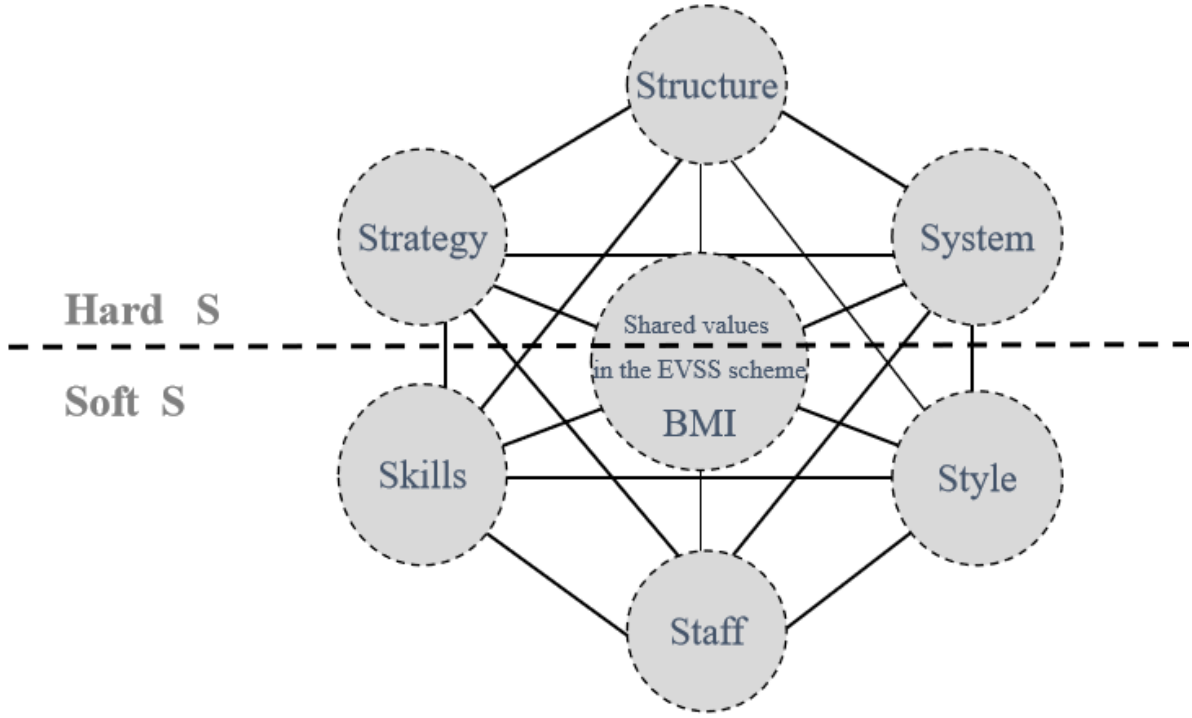


Figure 5.7 Use McKinsey 7S Framework to understand EVSS's business models (See section 6.2.3's analysis)

5.4.7 Credibility, transferability, dependability and confirmability

Reliability, replication, and validity are three fundamental criteria for evaluating social science research (Saunders et al. 2016) but are most strongly associated with quantitative approaches (Lincoln and Guba 1985). Lincoln and Guba (1985) suggest other terms and methods for examining qualitative research (e.g., they state trustworthiness as a measure of a qualitative study's validity) and propose credibility, transferability, dependability, and confirmability as key criteria to use.

5.4.7.1 Credibility

Credibility is a parallel of internal validity that can evaluate the reliability of findings, and it can also be described as 'activities that increase the probability that credible findings will be produced' (Lincoln and Guba 1985, p. 301). Establishing the credibility of findings requires making sure that research is conducted following scientific practice and checking research findings with the people in the "social world" studied. This helps to ensure that the researcher is correctly interpreting their data and have understood it correctly in relation to the research context (Lincoln and Guba 1985). Furthermore, credibility can be considered in relation to the degree of representativeness, testing competitive explanations, evidence weighing and the replicability of results (Miles and Huberman 1994). Therefore, credibility can be applied to this research by conducting interviews with multiple stakeholders such as EVSS, users, other mobility sectors, and governmental institutions that may help the researcher to increase the weight of the evidence and generate data validity. Furthermore, interviewing multiple stakeholders may shape an in-depth understanding of sustainable urban transportation systems that goes beyond EVSS schemes in the Chinese context (Ma et al. 2019; Shams Esfandabadi et al. 2022).

Data accuracy can be improved by using appropriate interviewees with professional experience on the topic of the study (Miles and Huberman 1994). In this case represented by EVSS Owners or managers, and respondents from the third and fourth stakeholder group with working experience in dealing with EVS issues. Even the users' group "refusers" who may not have used EVS, will have a perception and understanding of EVSSs that may help us shape this research.

Conducting data analysis while collecting the data allowed the researcher to compare the differences and similarities among the evidence collected from the different stakeholders. Previous sections explained that the researcher modified users' groups when conducting interviews.

The researcher also conducted 'Member checking' to enhance credibility by contacting interviewees after interviews for confirmation and further insight, viewed as a good research practice in evaluating initial reports from stakeholder reviews (Lincoln and Guba 1985; Guba and Lincoln 1989; Koelsch 2013). Therefore, the researcher discussed interviewees' feedback on the transcription to ensure the interpretation precisely reflected their meanings.

5.4.7.2 Transferability

External validity is also labelled as transferability in parallel with quantitative studies (Lincoln and Guba 1985). It refers to the findings being applicable in other similar contexts. Achieving high transferability is not the primary purpose of this research, as this research was exploratory and entailed an intensive study of small groups by focusing on their "thick" descriptions and detailed accounts of EVSS as a phenomenon. However, this research can potentially generate insights that may be transferable to other similar contexts such as EVSS development in other countries and cultures.

5.4.7.3 Dependability and confirmability

These are similar to reliability and objectivity in quantitative research. Dependability can be achieved by conducting an 'auditing' approach, while confirmability indicates that the researcher should behave in good faith (Bryman 2012). The data collection process is guided by a step-by-step plan to enhance dependability. Moreover, the supervisory research team reviewed and revised the research aims and objectives and interview questions to increase the research process's confidence and reliability. Additionally, transcriptions are safely stored in university hardware.

5.4.7.4 The triangulation to validate results

The term triangulation, has been employed broadly by Denzin (2012) and Bryman (2012, p.392) states it is *"using more than one method or source of data in the study of social phenomena."* It is a robust method to validate the research findings and ensure their reliability and validity. This study primarily achieved triangulation by interviewing multiple types of EVSS stakeholders (See section 5.4.5) to cross-validate the findings. This diversity in data sources provides a more comprehensive understanding of the phenomenon. Regarding theoretical triangulation, socio-technical transition and business theory are applied to interpret the data. In Chapter 6, the author also uses the 7S framework to interpret data, which helps to understand the phenomena from different angles and increases the validity of the findings.

5.4.8 Ethical considerations

Research involving human "subjects"—those who will participate in the study or about whom the researcher may review previously collected data—gives rise to particular ethical considerations (Yin 2014). As a researcher, it is essential to consider ethical considerations when designing the research by demonstrating how to protect human subjects (Bryman and Bell 2015). Therefore, the researcher should achieve formal approval for the plan, which should not be considered a mere formality (Yin 2014).

Diener and Crandall (1978) provided a helpful breakdown of these discussions into four primary themes. Firstly, discussions regarding ethical principles in social science research, and perhaps more precisely potential transgressions of them, tend to focus on particular issues that repeat in numerous forms:

- Is there a risk of harming participants?
- Does the absence of informed consent exist?
- Is there a violation of privacy?
- Is there deceit involved?

Based on the above ethical considerations and with reference to Cardiff University's ethical codes the researcher achieved ethical approval from the Ethics Committee of Cardiff Business School before commencing fieldwork. Appendix D demonstrates ethical approval in detail, while participants were provided with information sheets that briefly explained the study and provided contact details of the research team (see Appendix A and B) before the interview. They were required to sign a consent form (Appendix E) allowing them to withdraw at any time in the interview and highlighting that the interviews are voluntary. Participants were also informed that the interview was being video recorded, transcribed, and securely stored in the university network by the researcher. Furthermore, they were informed that the interview outcome will be used for PhD project.

5.5 Chapter Summary

In this chapter, the author examines the methodological approach employed in this thesis. The chapter begins by addressing the ontological and epistemological perspectives and then adopts a social constructivist/pragmatist stance to investigate the interactions between urban shared mobility paradigms and socio-technical transitions. Recognising the underexplored role of empirical firms in transition theory, the author employs a multisite case study as a qualitative method for conducting an in-depth analysis of the EVSS schemes and their associated stakeholders. The chapter concludes by outlining the use of the 7S framework and Glaser's Six Cs to synthesise and analyse interview findings as presented in the following chapters.

Chapter 6. Business model orientated findings

6.1 Chapter introduction

This chapter presents the findings of the study, highlighting the dynamics of business model evolution, marketing and promotion strategies, and customer segmentation and user needs within the electric vehicle sharing service (EVSS) schemes studied. Furthermore, the chapter explores the role of transition theory and business model innovation in fostering more sustainable forms of production and consumption, offering an in-depth understanding of the multifaceted aspects influencing EVSS schemes. The insights garnered from this analysis provide valuable guidance for stakeholders and policymakers aiming to promote sustainable urban mobility.

This chapter aims to provide an in-depth analysis of the business models of electric car sharing services, the role of multi-stakeholders in shaping the urban mobility system, and the impact of these services on consumer behaviour and preferences. This research explores EVSS within the context of the Yangtze River Delta Economic Zone (YRDEZ) in China, one of China's most important economic zones, where the adoption of EVSS is increasing rapidly. It comprises Shanghai, Jiangsu, and Zhejiang provinces, and is home to approximately 200 million people, and serves as a major hub for manufacturing and innovation (Luo et al. 2018).

This chapter also places its emphasis on the findings oriented toward business models, which are systematically organised into three main parts. The first part explores the evolution of the business models applied within EVSS schemes and assesses how this evolution contributes to the transition toward a sustainable urban mobility paradigm. The second part investigates the strategic shift towards utilising marketing as a means to adapt to the evolving market and capture the mobility habits of urban citizens. The last part examines the integration of government policy with other stakeholders and their important role in EVSS schemes.

6.2 Business model evolution: The dynamic transition of EVSS schemes

This section explores the dynamic transition of business models used within the EVSS schemes of the YRDEZ, exploring the factors influencing this transition and the challenges faced by EVSS providers within the current urban mobility paradigm. To accomplish this, the author adopts a qualitative approach, utilising analytical frameworks such as Geels' transition theory (Geels 2018; Geels 2002), sustainability initiative mapping approach (Hopwood et al. 2005), and McKinsey's 7S framework (Peters and Waterman 1982) .

Based on the interviews conducted, the EVSS business models has are shown to have adapted to the transitions in driving technology, consumer preferences, local government policies, and the evolving market. The adoption of ICT has enabled the development of efficient and customer-centric services, facilitating the transition from traditional business models to innovative and data-driven business models (Mouratidis et al. 2021).

During initial market development from 2010, EVSS providers sought market share and resources by being early adopters and capitalising on government support and public interest in electric vehicles (e.g., SuPai). As the market evolved, the emphasis switched to addressing barriers such as costly parking and operation fees, managing personnel and large assets, and guaranteeing acceptable profit margins (e.g., Gofun EVSS).

Collaboration with multiple stakeholders, such as OEMs, charging station operators, government departments, insurance companies, competitors, online-hailing services, urban infrastructure entities (parking outlets and charging stations), repair service providers, and consumers, became an important success factor for EVSS providers, mentioned by John:

> *"Because sharing should be a system-wide collaboration and be led at the national level, it can only be achieved when every link in the chain is connected."*

John (Universal Motor)

This integration may lead to think about the importance to maintain operational efficiency and customer satisfaction while navigating the evolving EVSS schemes' challenges (e.g., Gofun EVSS).

This section attempts to provide an overview of the variables that have propelled development and the problems encountered by the industry by exploring the dynamics of business model evolution in EVSS schemes as well as the interplay among stakeholders (Hu and Creutzig 2022). This analysis will provide stakeholders and policymakers with vital insights for promoting sustainable urban mobility and fostering further innovation in this rapidly emerging industry.

6.2.1 Current five types of business model of the EVSS

In contemporary EVSS schemes, the complexities of their operations extend far beyond those of companies selling vehicles or providing conventional taxi services, as they require significant financial and technological support. EVSS providers have their business plans in the internet business sector (e.g., EVCARD). Based on the qualitative research conducted, it is helpful to distinguish the characteristic features of EVSS based on the required investment. Companies with 'heavy' assets[1], such as ownership of SEVs, include both OEMs and asset-intensive EVSS providers. Conversely, 'light' asset'[2] EVSS firms may operate as online platform companies[3].

Moreover, distinct business models cater to diverse user segments and serve different purposes. Consequently, within the YRDEZ, five business models have emerged. These models exhibit varying levels of investment in assets and display unique strategies for addressing consumer needs within particular EVSS schemes. By examining these business models in-depth, stakeholders can gain valuable insights into the dynamics of EVSS schemes and identify opportunities for innovation and growth in the rapidly evolving sustainable mobility sector. Tom provided an overview of the different EVSS business models operating in YREDZ:

> *"There are five distinct operational models within the shared vehicle market. The first model involves original equipment manufacturers (OEMs) operating the service themselves. This approach is primarily aimed at digesting unsold vehicle inventory and promoting their brand. Through customers' experiences with shared vehicles, OEMs hope to stimulate interest and ultimately boost vehicle sales. The second model involves mobility platforms or shared vehicle operating companies. Their primary focus is on the platform itself, generating data flow and cash flow by genuinely engaging in shared vehicle services. The third model, which the interviewee's company falls under, focuses on providing convenience to customers by making vehicles available for sharing. This approach primarily targets customer satisfaction and accessibility. The fourth model is a purely platform-based operation. It functions as an internet platform, akin to vehicle connectivity services, where idle vehicles are made available for sharing by the public. The fifth model*

[1] Heavy assets: The EVSS providers owns its SEVs, Capital-intensive, the OEM needs to finance the vehicles in the market and does not get the cash flow benefit of selling the car outright (e.g., EVCARD).
[2] Light assets: The EVSS providers partially owns its SEVs (e.g., Baishi EVSS).
[3] Online platform companies: the EVSS providers are likely using online platform to capture consumers (e.g., AOTU Travel).

primarily revolves around these different players in the shared vehicle market: OEMs, vehicle dealers, those who focus on providing transportation services, and those with an internet platform at their core. Each of these groups adopts a unique approach to operating shared vehicle services, catering to their specific goals and objectives within the sector.”

Tom (SuPai)

Table 6.1 Five business models for EVSS in YRDEZ (Made by the author).

Business Model Type	Required investment	Vehicle Ownership	Rental Duration	Target Market	Additional Objectives
Manufacturer-Driven Ecosystem	Heavy Assets	Manufacturer	Short-term	C-Side[1]	Brand value enhancement and inventory management
Decentralised Collaborative Marketplace	Mixed	Independent Owners	Long-term & Short-term	C-Side and B-Side[2]	Exploiting the synergies of Internet of Vehicles
Comprehensive Integrated Mobility System	Light Assets	Pure Platform Operator	Long-term & Short-term	C-Side	Streamlining data and financial value chains
User-Focused Vehicle Resource Allocation	Mixed	Independent Owners	Long-term & Short-term	C-Side and B-Side	Maximising underutilised vehicle assets
Flexible Service-Driven EVSS	Light Assets	Platform Operator	Long-term & Short-term	C-Side and B-Side	Adapting and tailoring services to cater to varied customer demands

6.2.1.1 Manufacturer-driven ecosystem

This business model is characterised by a sophisticated ecosystem operated directly by the OEM to provide short-term rental options for individual consumers. The primary objective is to strengthen brand equity while effectively managing inventory levels. By maintaining direct control over vehicle quality and availability, OEMs can showcase their products and foster a favourable brand perception among end-users. EVCARD, operated by SAIC (OEM) is a representative company for this business model:

[1] Individual customers (Capture from the society).
[2] Corporate companies.

"The initial concept for this model originated within the Fudan University campus in Shanghai. It was designed to facilitate transportation between student dormitories, classrooms, and various campus locations. For example, the service might have been available across three or four campuses, with students using the vehicles to move between them.

Over time, this model was expanded and scaled up to cover the entire city of Shanghai. Eventually, it extended to the provinces of Jiangsu and Zhejiang, as well as southern regions and other areas such as Chongqing, Wuhan, and Sichuan. At its peak, the service was operating in over 60 cities across the country."

EVCARD (Jason)

Another representative of a heavy-asset EVSS driven by an OEM is LD Go. This company operates a fleet of vehicles under its own brand and has established designated parking outlets in various high-demand areas. Moreover, LD Go maintains a self-operated online platform that utilises an internet media strategy to capture user preferences and monitor the conditions of their shared electric vehicles. Nevertheless, LD Go, with its foundation in the internet sector, acquired an OEM without possessing intrinsic domain knowledge. The OEM, GuanZhi, concentrates on the production of internal combustion engines, which compels LD Go to source EVs from other manufacturers. This case exemplifies the integration of advanced technologies and strategic approaches within the EVSS market where the aim is to provide an efficient service experience for users.

LD Go's business model emphasis on convenience, including features such as flexible route changes, pay-as-you-go options, and user-friendly mobile app operation. By eliminating core elements such as human services, the company enables a connection between mobile devices and the demand side, granting users greater freedom in utilising shared vehicles. This approach underscores the importance of adapting and tailoring services to meet diverse customer needs and preferences within the electric vehicle sharing market.

"Our genuine profit model is primarily based on the traditional car rental approach, where success is achieved through scale. As our customer traffic increases and our fleet size reaches a sufficient volume, our vehicle procurement costs gradually decrease. By providing exceptional service to our customers and continually iterating on our offerings, we aim to generate additional revenue streams through our EVs. The primary goal is to

attract and channel customer traffic towards our other associated industries, thereby utilising this model to achieve profitability."

LD Go (Mike)

6.2.1.2 Decentralised collaborative marketplace

Under this model, a decentralised platform connects independent EV owners with customers seeking long-term and short-term rental options. The platform operator does not own the vehicles but instead facilitates a peer-to-peer (P2P) marketplace, mediating transactions between EV owners and customers. By harnessing the potential of the internet of vehicles (Shen et al. 2020), this model can exploit the emerging trend of connected vehicles, thus creating new opportunities for value creation and monetisation.

Baishi EVSS serves as an example of a company employing this business model by using an online platform to manage SEVs operations. While a portion of their SEV fleet is owned directly by the company, the remaining idle vehicles are integrated through collaborations with various stakeholders, such as OEMs and other online platforms. This approach demonstrates a sophisticated business model to meet the evolving demands of the EV-sharing market:

"In 2017, a friend of mine became a distributor for several electric vehicle brands, which sparked my interest and led me to explore the field. At that time, these EV brands were promoting their products, and they suggested that distributors could use some of the vehicles for operations and publicity. As a result, we obtained a portion of these vehicles and began our endeavour. Initially, we collaborated with Cao Cao, a platform that provided a fleet of electric vehicles. Later, we worked with a Shanghai-based research and development company and Hua Ren Yun Tong. In terms of business model development, growth-oriented companies like ours rely on building networks and accumulating resources over time. As our database grows and our involvement with various partners and collaborators increases, we expand our operations and learn from our peers and friends who seek to exchange insights and experiences. The business model I devised is based on accumulating networks, expanding data volume, and earning commissions. This approach leads to increased overall volume and is primarily data-driven. Before 2014, I had

spent half a year working on a data information platform and even started my own business in the media sector. I eventually realised that the impact of data dissemination was quite significant."

Baishi EVSS (Jimmy)

6.2.1.3 Comprehensive integrated mobility system

This business model centres around a platform provider that does not own electric vehicles, yet offers an extensive range of rental options tailored to the diverse needs of both business and consumer clients. The model relies mostly on online platforms and social media tools to attract users, resembling the initial approach of the DIDI platform (a mobility technology platform). The primary focus is on orchestrating an efficient and responsive value chain through proactive fleet management, dynamic pricing strategies, and targeted marketing initiatives. For instance, the model utilises idle cars from individuals or companies to meet real-time mobility needs (e.g., DIDI).

Additionally, the majority of EVSS providers, which operates via an online platform, bears a resemblance to the DIDI platform, as both offer mobility technology solutions and app-based services, as highlighted below by Betty. By utilizing advanced technological capabilities and app-based solutions, these platforms exemplify the innovative approaches being adopted in the field of urban mobility and transportation to improve service provision:

"As a mobility technology platform, this service delivers a broad spectrum of app-based solutions. The platform caters to car owners, drivers, and delivery partners, providing them with adaptable work opportunities and income streams. By working closely with policymakers, the taxi industry, the automotive sector, and local communities, the platform aims to address global transportation, environmental, and employment challenges through AI technology and localised smart transportation innovations."

"The ultimate goal is to enhance life experiences and generate greater societal value by developing a secure, inclusive, and sustainable transportation and local services ecosystem for the cities of the future. This approach underscores the importance of harnessing advanced technology and forging strategic partnerships to create lasting and meaningful change in urban mobility."

Betty (DIDI)

By integrating complementary transport solutions, such as public transit and online-hailing services, this model aims to establish a mobility ecosystem that addresses multiple dimensions of urban transportation needs. This approach demonstrates the importance of creating innovative and adaptive services within the electric vehicle sharing market, catering to a wide array of user preferences and requirements (Sarasini and Langeland 2021).

6.2.1.4 User-focused vehicle resource allocation

This consumer-oriented model emphasises the optimisation of privately-owned electric vehicle assets by offering long-term and short-term rental options specifically tailored for individual consumers. The platform operator may only partially own the vehicles but rather creates a conduit for transactions between private EV owners seeking to monetise their underutilised vehicles and consumers in need of rental alternatives. With a focus on delivering a user experience and an array of customisable vehicle options, this model effectively addresses the unique preferences and demands of its target market. Mike (LD Go) stated that *"AOTU Travel emerged as a pioneer in vehicle sharing within the Chinese market, offering a mobility technology platform catering to both idle car owners and users."* By addressing the personalised mobility requirements of its customers, such as vehicle types, colours, and brands, AOTU Travel has established a user-centric solution, as highlighted by Helen. This approach has not only transformed the way people access and utilise vehicles, but also contributed towards the broader goals of reducing traffic congestion and vehicle ownerships.:

> *"AOTU Travel is honoured to observe the mutually beneficial results that its products and services generate. Renters can enjoy a better driving experience with reduced rental costs, while car owners can economically utilise their idle assets. AOTU Travel is particularly enthusiastic about the potential for vehicle sharing to reduce traffic congestion and carbon emissions, ultimately contributing to a cleaner and more pleasant environment. Through the secure platform established by AOTU, car owners can confidently rent out their idle vehicles to others. Meanwhile, renters have the advantage of accessing better-conditioned vehicles with a more diverse selection at a more economical price. By embracing their customers and providing a reliable and straightforward service, AOTU Travel fosters connections between people, lowers the cost of vehicle usage for both parties, optimises resources, and aligns with the broader goal of leveraging technology to*

bring about positive societal change. Starting with small steps, AOTU Travel aims to alleviate road traffic pressure, reduce the environmental burden on the planet, and work together towards a better world. With a simple one-click order, users can enjoy a happy travel experience. After registering and verifying their valid ID and driving license on the official website, users have access to thousands of vehicle models to choose from. By downloading the AOTU Travel app, users can select shared vehicles from car owners and place an order with just one click, enjoying the convenience of vehicle delivery and pickup services provided by dedicated car stewards."

Helen (AOTU Travel)

Table 6.2 Comparison between traditional rental and AOTU Travel.

Comparison Elements	**Traditional Rental**	**AOTU Travel**
Vehicle Selection	Limited variety and slower vehicle updates	Weekly updates and variety suited for different scenarios
Vehicle Pick-up and Return	Pick-up and return at designated locations	Designated locations for pick-up and return
Vehicle Condition	Older vehicles with varying quality	Regularly maintained and carefully selected vehicles by vehicle managers
Rental Deposit	1-2 months refundable deposit required	No deposit required for users with a Zhima Credit Score of 600 or above
Usage Protection	Separate purchases required	Comprehensive 2.55 million insurance coverage, with same-day payout
App	Limited functionality	Travelogues, evaluations, and other engaging content

6.2.1.5 Flexible service-driven EVSS

The Flexible Service-Driven EVSS represents the fifth business model. This approach emphasises providing customisable and adaptive services to accommodate various customer requirements and preferences. The primary goal of this model is to create a user experience orientated service that meets the diverse needs of its customer base. Furthermore, firms embracing this business model tend to be self-financed and characterised by a smaller scale of operation. This indicates that entrepreneurial efforts and innovation play an important role in the successful implementation of such strategies within the context of the emerging vehicle sharing market (See Tom's quotation below).

In this model, EVSS providers aim to have a continuous improvement and innovation in their offerings. The providers monitor user feedback and market trends to address evolving demands and preferences. By adapting to the evolving market, these providers can ensure they remain relevant and competitive as the market matures and customer numbers and the variety of uses expands and diversifies. However, these providers cannot guarantee to meet all kinds of consumer mobility needs.

In terms of achieving a certain degree of flexibility, the Service-Driven EVSS model relies upon the use of information technology and data analytics (Hernandez et al. 2013). These tools allow providers to gain insights into customer behaviour patterns, preferences, and usage habits (Hernandez et al. 2013). In turn, they use this information to optimise their service offerings, making them more attractive and valuable to users (e.g., AOTU Travel).

Collaboration with various stakeholders, such as charging infrastructure providers, insurance companies, and local governments, is also a critical aspect of this model. By forging strategic partnerships, Flexible Service-Driven EVSS providers can enhance their service offerings, improve the overall user experience, and address potential barriers to adoption.

Some examples of flexible services in this business model include offering various pricing plans, personalised vehicle recommendations based on customer preferences, and integrating additional mobility options (e.g., long-term, short-term and timely travel needs) into their platform. Tom's, explanation of SUPAI EVSS's business model combines a customer-centric approach with asset value maximising:

> *"At the time when I decided to develop this business model, my primary motivation stemmed from the high idle rate of traditional vehicles. I wanted to transform these idle vehicles into shared resources. My existing customer base mainly consisted of B2B customers, and I saw an opportunity to allow B2C customers to share the idle vehicles from the B2B segment. This approach would cater to both B2B and B2C markets, which led me to consider the concept of vehicle sharing. In addition to devising a profitable business model, I also needed to address the associated risks. To mitigate and manage these risks, I turned to vehicle telematics and connected car technology. These tools allowed me to*

monitor vehicle usage and minimise potential hazards effectively. The primary profit-generating aspect of this model relied on maximising revenue during the vehicles' downtime. By enabling B2C customers to access and share idle vehicles from the B2B segment, I could generate additional income, thus making the most of an otherwise underutilised resource."

Tom (SUPAI EVSS)

Additionally, in the initial stages of Auto Travel, they are inclined to offer a bespoke personal mobility service tailored to individual customer needs, as highlighted by Jet:

"P2P Business model, commission on each transaction, new market development, a wide range of vehicle choices; competitive pricing, primarily self-operated, vehicles are mainly self-operated, online promotion, car shows, car enthusiast groups, and local promotions."

Jet (AOTU Travel)

Nonetheless, smaller-scale EVSS providers such as SUPAI may prioritise maximizing asset value over adopting a more customer-centric approach from the outset. In contrast, larger-scale companies, like LD GO, may be better able to strike a balance between meeting customer needs and optimising asset management.

6.2.1.6 Reflection on business model success (Addressing research question A)

Success using any of the five business models outlined above can be contingent on factors like the ability to develop technology, build an effective ecosystem, adapt to evolving customer needs, and strike strategic collaborations. Business models for EVSS schemes will be continuously evolving as they are impacted by new technologies, policies, user needs, as well as the developing of urban infrastructure system.

At present, the most successful business model appears to combine a manufacturer-driven ecosystem coupled with a comprehensive integrated mobility system. This approach effectively optimises resources, prioritizing scalability over heavy asset ownership. However, the choice of a business model often depends on the company's scale, its target market, and the role it plays in contributing towards more sustainable development (Bidmon and Knab 2018). For instance, the business model employed by SUPAI EVSS may be ideal for companies in the start-up stage. On the other hand, EVCARD benefits from the support of OMEs in various aspects such as providing financial backing, local government support, and a more effective operational team. The comprehensive integrated mobility system might resemble the business model of pure online platform companies, like DIDI, which is well-known for its ride-hailing service and has a large user base. Consequently, by launching the Xiao Car rental service and joining the EVSS market, DIDI may stand to reap advantages based on its existing business (Wesseling et al. 2020).

The least successful business models appear to be those that emphasise user-focused vehicle resource allocation. The reason for this could be the inherent difficulty in providing consistent, standardised services given that idle vehicles may not be maintained regularly. While adopting a user-centric approach can be a company's vision, it may not always translate into practical success for an EVSS scheme. Schemes themselves could foster the conditions to promote more sustainable mobility by educating urban users about the impacts of their mobility choices and leading them towards adopting more sustainable lifestyles. Such an approach might contribute more effectively to both the company's success and the broader goal of sustainable development.

Table 6.3 Evaluating Business Models in current EVSS Schemes.

Business Model	Key Characteristics	Representative Company	Extent of Success	Success Factors
Manufacturer-Driven Ecosystem	Direct operation by the OEM providing short-term rentals. Focus on brand strengthening and inventory management.	EVCARD (SAIC), LD Go	Extensive reach across 60+ cities in China.	Direct control over vehicle quality and availability, brand perception, effective inventory management.
Decentralised Collaborative Marketplace	A platform connecting independent EV owners with customers for long and short term rentals. The operator doesn't own the vehicles.	Baishi EVSS	Successful engagement with various partners and collaborators, increasing operations over time.	Utilisation of network building, data-driven operations, and earning through commissions.
Comprehensive Integrated Mobility System	A platform provider offering a range of rental options without owning the vehicles. Utilisation of online platforms and social media tools for attracting users.	DIDI (e.g., Xiaoji Car rental service)	Widespread adoption and recognition, with a broad spectrum of app-based solutions.	Proactive fleet management, dynamic pricing, targeted marketing, utilisation of idle cars to meet real-time mobility needs.
User-Focused Vehicle Resource Allocation	Focus on optimisation of privately-owned electric vehicle assets by offering long-term and short-term rental options tailored for individual consumers.	AOTU Travel	Successful establishment of a comprehensive and user-centric solution.	Addressing personalised mobility requirements of customers, optimisation of resources, alignment with broader environmental goals.
Flexible Service-Driven EVSS	Emphasis on providing customisable and adaptive services to meet diverse customer needs. Characterised by smaller scale of operation and self-financing.	SUPAI EVSS	Not explicitly mentioned, but implied through continuous improvement and innovation in offerings.	Use of information technology and data analytics, collaboration with various stakeholders, customer-centric approach.

6.2.2 Business model evolution

The varied and evolving nature of business models in the EVSS is attributable to several factors, including market demand, policy interventions, and the involvement of diverse stakeholders. Factors such as evolving customer preferences, innovative promotional strategies, local government attitudes, insurance company policies, urban infrastructures, innovative technologies, and other stakeholders contribute to the dynamic adaptation of these business models. Lee mentioned that the business model is evolving:

> *"In the future, the industry may eventually be dominated by only two or three companies across the country. However, I believe that their business models will undergo some changes. As for the main manufacturers, the one thing they cannot change is their commitment to a single company from the previous period. All their actions must be aimed at serving or integrating into this industry chain. The rest of their efforts should be focused on providing services to these social groups in a more appealing manner."*

Lee (EVCARD Suzhou)

Table 6.4 provides a comparative overview of ten EVSS operating in YRDEZ. These ten cases emphasise user satisfaction and improved resource allocation, highlighting the need to address consumer demands effectively. These entities face comparable external challenges, including insurance, regulations, and user behaviors, which are industry-wide hurdles affecting their operational activities.

Nevertheless, it is important to note that each service has its strategy and operational scale. Certain businesses focus on local markets and establish connections with communities, while others seek to grow their operations nationally and encounter a wide range of regional challenges. Particular EVSS providers face challenges related to elevated management costs and operational inefficiencies, which hinder their capacity to expand and adapt to market dynamics.

Table 6.4 An overview of ten EVSS cases' business models and market integration dynamics.

S/N	EVSS Name	Business Model	Partnership & Alliances	Barriers: External	Barriers: self-imposed	Target Users	Geographical Reach	Marketing Strategy
1	SuPai	Flexible service-driven EVSS	Other Platforms	Insurance, regulations and user misbehaviour	Weak financial shortage of capital and resources	Students, B2B customers, travellers and social loiterers	Suhou, Wuxi and Changzhou	Generating leads on social media Fixed parternership
2	Univseral Motor	User-focused vehicle resource allocation	Other Platforms	Insurance, regulations and user misbehaviour	Weak financial shortage of capital and resources	Students, B2B customers and travellers	JiangSu province	Fixed partnership
3	Baishi EVSS	Decentralised Collaborative Marketplace	Places of interests and other platforms	Insurance, regulations and user misbehaviour	Weak financial shortage	Students, coperated places of interests， travellers and social loiterers	JiangSu province	Fixed partnership
4	Gofun EVSS	Manufacturer-Driven Ecosystem	Local government departments	Insurance, regulations and user misbehaviour	Significant managerial overheads	All members of society	National urban	Ground promotion, Generating leads on social media
5	LD EVSS	Manufacturer-Driven Ecosystem	Governments	Insurance, regulations and user misbehaviour	Shortage of resources	All members of society	JiangXi and JiangSU province	Ground promotion and Fixed partnership
6	LD Go	Manufacturer-Driven Ecosystem	Governments	Insurance, regulations and user misbehaviour	Significant managerial overheads	All members of society	National urban	Ground promotion, Generating leads on social media
7	Car Inc	User-focused vehicle resource allocation	Governments	Insurance, regulations and user misbehaviour	Vehicle operational management	All members of society	National urban	Ground promotion, Generating leads on social media
8	Evcard (Suzhou)	Manufacturer-Driven Ecosystem	Governments (Partially)	Insurance, regulations and user misbehaviour	Significant managerial overheads	All members of society	Suhou, Wuxi and Changzhou	Ground promotion, Generating leads on social media
9	Evcard (Shanghai)	Manufacturer-Driven Ecosystem	Governments and local communities	Insurance and user misbehaviour	Significant managerial overheads	Students, travellers and urban citizens	Shanghai	Ground promotion, Generating leads on social media
10	Aotu Travel	User-focused vehicle resource allocation Flexible service-driven EVSS	Other vehicle owners (Similar with Uber and DIDI)	Insurance, regulations and user misbehaviour	Vehicle operational management	All members of society	National urban	Ground promotion, Generating leads on social media

The research findings suggest that although EVSS providers share a common goal of addressing consumers' basic mobility needs, their success in meeting those needs and ability to develop a successful business relies on their ability to handle both external regulatory challenges and internal operational barriers. Understanding this can be important for identifying potential opportunities and strategies within EVSS schemes.

6.2.2.1 Inconsistency between central government policies and local attitudes pertaining to EVSS

Central government's policies and regulations promoting the development and adoption of EVSS include subsidies, tax incentives, and other support mechanisms (Hu and Creutzig 2022; Niu and Xu 2016; Wang et al. 2019; Wilson and Mason 2020). However local governments and their respective policies may differ from central government policies, leading to potential inconsistencies in the overall regulatory landscape (Sun et al. 2019; Wilson and Mason 2020). This may include local preferences for specific EV technologies, infrastructure development, or differing levels of support for EVSS.

Using Shanghai as an example, EVCARD has experienced rapid growth with support from the local government concerning provision of charging and parking infrastructure, as highlighted by Jason:

> *"In Shanghai, the local government allocates a certain number of parking spaces in designated areas specifically for shared vehicles. As a result, social vehicles generally do not occupy these parking spots. The parking situation in Shanghai is undoubtedly more strained than in Suzhou, with vehicle costs possibly far exceeding those in Suzhou. However, Shanghai's government has been more effective in addressing this issue, mainly due to their clear and strong support for the shared vehicle initiative, including support from local communities."*

Jason (EVCARD Shanghai)

Even grassroots communities exhibited robust support for EVCARD, boosting its reputation among the citizens of Shanghai and allowing it to emerge as a major local EVSS brand:

"Even at the grassroots level, community support for this initiative is substantial. The approach in Shanghai, from top to bottom, is more supportive and cooperative, which contributes to a better outcome."

Jason (EVCARD Shanghai)

Despite the central government maintaining a favourable and supportive stance towards low-carbon, and sharing-oriented products, attitudes towards EVSS differ among cities (Sun et al. 2019; Wilson and Mason 2020). For instance, Suzhou, a city nearby Shanghai, with its industrial background, places greater emphasis on the manufacturing sector, while Hangzhou is more receptive to the internet economy. Furthermore, the development of EVSS relies on support from the internet economy as mentioned by Chris and Corbin:

"Moreover, the city's attitude towards and support for internet products also plays a role, such as Hangzhou's emphasis on the tertiary industry."

Chris (Traffic Police)

"With regard to policy push, although national-level policy orientations serve as strategic guidelines, local policies at the city level can differ significantly. In cities like Hangzhou, the tertiary sector, such as the internet industry, strongly supports the EVSS market, and this support is reinforced by local policies. We can also observe the emergence of other markets, such as bike-sharing and various sharing initiatives, as well as live streaming with goods. Policies can be categorised into landscape and niche levels. Consequently, we can witness the rapid popularity of EVSS in Hangzhou within a short period."

Corbin (National Development and Reform Commission)

Corbin also highlighted why some cities are worried about new sharing products like EVSS:

"However, Suzhou adopts a conservative attitude towards new products like EVSS or Sharing-bikes in order to avoid causing urban chaos. For instance, in the past, there were issues with disorderly parking of shared bicycles in other cities. As a result, shared cars have not experienced rapid development in Suzhou within a short period."

Corbin (National Development and Reform Commission)

6.2.2.2 Interactions of diverse stakeholders in the context of EVSS

Stakeholder interactions play an important role in shaping the EVSS schemes, as they contribute to the establishment of norms and influence industry practices. Each stakeholder group has its unique interests, priorities, and expectations, which can lead to both synergies and conflicts among them.

For instance, insurance companies may impact on EVSS schemes by determining how shared electric vehicles (SEVs) are classified, such as whether they are considered operating vehicles or private cars. This classification can significantly affect insurance costs and, consequently, the overall business model, as mentioned by John:

> *"From the perspective of insurance companies, they may be unwilling to settle claims for car-sharing services, and this issue becomes difficult to resolve, leading to a series of problems. For instance, what would happen in the case of a severe traffic accident? Insurance companies could potentially refuse to pay out."*

John (Universal Motor)

John also mentioned that there is a conflict between insurance companies and EVSS providers:

> *"How do insurance companies differentiate these vehicles? Naturally, insurance companies are profit-oriented organisations; they need to make money. Depending on the risk associated with car-sharing services, the insurance premium for a non-commercial vehicle might be CNY 3,000, while that of a commercial vehicle could be CNY10,000. How would they handle this situation for a fleet of commercial vehicles, where the difference in premiums is significant, with more than CNY 3,500 at stake?"*

John (Universal Motor)

This conflict can surface when accidents occur, with insurance companies interpreting SEVs as commercial vehicles, thus denying coverage or disputing claims based on the belief that the vehicles should have been insured under a commercial policy according to the interview.

Similarly, the regulatory landscape concerning EVSS schemes is still in its nascent stage, without mature laws and regulations to address challenges and opportunities presented by this emerging industry as highlighted by John:

> *"The true essence of car-sharing lies in utilising idle vehicles. However, in this regard, many laws and regulations are not well-developed. If you try to operate a car-sharing service legitimately, you might be considered as operating illegally. In reality, it is difficult to share a vehicle because, from a legal perspective, it is classified as a non-commercial vehicle."*

John (Universal Motor)

This conflict between EVSS providers' expectations and insurance companies' practices may require further investigation to better understand the underlying factors. Clearer insurance policies, their classification criteria, and the legal framework governing vehicle insurance could help identify potential areas for improvement, ensuring fair and sustainable practices that benefit both EVSS providers and insurance companies.

Additionally, technology companies may advocate for rapid innovation within EVSS schemes, while car manufacturers might adopt a more cautious approach due to concerns about consumer adoption and profitability, mentioned by Jimmy:

> *"For electric vehicles, they have integrated modules with positioning features that cannot be dismantled or tampered with. In other words, new energy vehicles have a higher level of safety compared to traditional vehicles."*

Jimmy (Baishi EVSS)

By understanding these complex dynamics, EVSS providers can better anticipate market changes, adapt their strategies, and capture opportunities for growth and innovation. This understanding enables them to refine and enhance their business models, ensuring a more sustainable and efficient development of the EVSS sector. In-depth analysis of stakeholder interactions can thus provide valuable insights for both practitioners and researchers interested in the ongoing evolution of the EVSS industry.

6.2.2.3 The influence of urban infrastructure on EVSS's business model

EVSS's business models are influenced by a variety of factors, including charging and parking facilities, urban planning, and traffic restrictions (Duarte and Ratti 2018). The availability and accessibility of charging and parking facilities play an important role in shaping EVSS schemes (Liao and Correia 2022). Adequate charging and parking infrastructure is essential for ensuring the efficient operation and adoption of schemes. Similarly, the allocation of designated parking spaces for SEVs can encourage their usage by offering convenience to users (Davenport and Davenport 2006; Ma et al. 2018), mentioned by Edward:

> *"From a business perspective, there is definitely a need for parking spaces and support in urban planning. Indeed, the government has already provided the necessary support. When the government plans a city, it has already designated appropriate parking areas. These parking areas are typically operated commercially and may be assigned to a parking company, which is often a property management company in China. In essence, as the vehicle rental platform, one would sign an agreement with the property management company to rent their parking spaces."*

Edward (Gofun)

Mike also emphasised that more public charging outlets may reduce a company's fixed-costs and help to build up a more sustainable mobility system:

> *"In our later planning stages, within our network planning, there is a need for charging stations. So, in the electric vehicle industry, for the specific segment of shared mobility, it is definitely a favourable factor, as its cost is sufficiently low."*

Mike (LD go)

A well-structured approach to urban planning and transportation policies that integrates EVSS can contribute significantly to the improvement of operational efficiency (Santos et al. 2010) and enhancement of user experience, as mentioned by John:

> *"Regarding the influence at the urban planning level, for example, if the government has a reasonable layout of parking lots and charging stations, it might be difficult for me to utilise them. If I want to use a car from the east side and park it in the west, how do I do*

it? It's not feasible. I hope that future urban planning and transportation policies will be helpful."

John (Universal Motor)

6.2.2.4 The role of innovative technologies in shaping the EVSS' business model

The ongoing incorporation of new energy sources, autonomous driving, and automated services will continue to drive the evolution of business models in the EVSS domain, ultimately shaping the future of sustainable urban transportation (Shen et al. 2020). These elements can enable EVSS providers to explore new service offerings, develop novel revenue streams, and better adapt to the rapidly changing dynamics of the mobility sector, mentioned by Bill:

"In the future, there may be a focus on developing clean energy vehicles, such as new energy vehicles, and incorporating technologies like autonomous driving. For instance, Baidu is currently concentrating on the development of autonomous driving technology and utilising its capabilities in areas like Baidu Maps to integrate these features into new energy vehicles."

Bill (Baidu-Jidu automotive)

Concurrently, OEMs may focus on developing and implementing relevant technologies to enhance their service offerings and SEVs by adopting and integrating evolving business models in order to attain regime-level impact. By strategically aligning with emerging trends and continuously adapting their business strategies, OEMs can better position themselves to address the dynamic challenges and opportunities in the rapidly transforming mobility sector. By combining their expertise with various automotive brands, they aim to work on projects related to automation and commercialisation, such as fully autonomous vehicles operating on online-hailing platforms in a manner similar to local online-hailing services. In fact, the future of Baidu's JiDu Car as an autonomous ride-hailing service aligns closely with the concepts of SEVs and eMaaS.

6.2.2.5 The impact of consumer behaviour and perception on EVSS's business model

Consumer attitudes can be one of the elements that contributes towards the evolution of EVSS business models (Fagnant and Kockelman 2018; Sarasini and Linder 2018; Sarasini and Langeland 2021). This study examines the impact of consumer attitudes towards EVSS (e.g., EVCARD and LD Go) such as preferences, and potential barriers to adoption. Key considerations for EVSS users include convenience, safety, efficiency, vehicle types, low-cost and attitudes to green mobility are coming from the research (Hu and Creutzig 2022; Liao and Correia 2022; Standing et al. 2019). The findings align with the literature:

> *"Young people with innovative mindsets may inherently prefer not to take crowded buses or trains. Instead, they might lean towards options that offer greater freedom in terms of time and personal space."*

Jason (EVCARD Shanghai)

> *"Their primary considerations for all shared electric vehicles would likely be convenience and affordability."*

Jack (Car Inc)

> *"At the time, it seemed quite affordable, cheaper than taking a taxi, and also aligned with the promotion of environmentally friendly and green travel. It offered great freedom."*

David (Group A: User)

For example, instances of consumer misconduct (Srivastava et al. 2022), such as damaging the SEVs, neglecting vehicle hygiene, and engaging in illegal driving practices, may also have implications both for short-term customer satisfaction and for the adaptation and development of the EVSS business model:

> *"They may dismantle parts from your car, rent the car for illegal activities, and many other things."*

Jack (Car Inc)

> *"There are some individuals who intentionally damage our vehicles out of malice."*

Mike (LD go)

> *"There may be a missing component or the interior of the vehicle might be rather dirty, leading to a lower retention rate for the supplier. This could cause the vehicle to be unable*

to start, consequently resulting in a lower Net Promoter Score (NPS)[1]*. In such a scenario, users may be less likely to make repeat purchases."*

Edward (Go fun)

The adoption of EVSS is influenced by various demographic factors, with younger individuals being more likely to utilise social media platforms to gather information about EVSS, while others may rely on physical channels (e.g., LD Go). As digital payment methods (e.g., QR-code scanning) and internet accessibility continue to expand, EVSS providers have the opportunity to employ a diverse range of channels to understand consumer preferences effectively and allows for the development of tailored strategies to enhance the adoption of EVSSs:

"Customer demand information should be gathered through the app, phone follow-ups, and conducting surveys."

Mike (LD go)

6.2.2.6 The evolution of management and operational strategies within EVSS schemes

Previous sections mentioned the inherent operational challenges within the EVSS schemes, particularly with respect to the maintenance and management of SEVs (e. g., LD Go and EVCARD). Ensuring that SEVs are consistently clean, well-maintained, and readily available for users can be important (Liao and Correia 2022) for the long-term success of the EVSS business model:

"Managing drivers (customers) can be quite challenging because individuals can be difficult to control."

Tom (SuPai)

"From the perspective of self-imposed operational pressures, it's evident that before fully entering the market, investing in a large number of vehicles can create issues. For example, if you deploy 500 vehicles in a quarter but discover that the utilisation rate is low, the vehicles end up piling up at the service points, causing significant operational stress. Some specific operational challenges include the regular maintenance of SEVs, timely cleaning and sanitisation, and efficient fleet management to ensure optimal availability

[1] Net Promoter Score (NPS) refers to a metric used to measure customer satisfaction and loyalty.

during periods of high demand. Unexpected circumstances, such as large-scale events or emergencies, can exacerbate these challenges, placing additional strain on the EVSS infrastructure and resources."

Lee (EVCARD Suzhou)

"In extreme cases, such as a large sporting event, it's not feasible to mobilise 100 people to replenish the vehicle fleet."

Jason (EVCARD Shanghai)

The limitations of parking facilities and the lack of integrated urban infrastructure further compound these operational issues, making it difficult for EVSS providers to effectively address the diverse needs of their users. Additionally, the interactions between elements of urban infrastructure, such as parking limitations, and sub-optimal customer behaviours, can combine to create operational challenges.

"Such actions can lead to management chaos within the city, with shared vehicles, including shared electric cars, being parked haphazardly and causing disorder."

John (Universal Motor)

6.2.2.7 Influences on EVSS business model success

Returning to research question A: To what extent, and how, are new sustainable business models providing successful EVSS businesses in China?

Table 6.5shows the interrelatedness of various components shaping the sustainable business models of EVSS in China. Each of these categories intertwines with others, creating a complex business ecosystem that drives the success and sustainability of these models. For instance, the evolution of business models may not be only determined by market demands and strategic considerations but also can be highly influenced by policy interventions and stakeholders' interactions. The adoption and integration of innovative technologies can be both influenced by and influence urban infrastructure and consumer behaviour.

The table also demonstrates the systemic nature of these influencing factors, by highlighting an approach towards designing and implementing sustainable business models for EVSS. Understanding the interplay among these factors can provide valuable insights for policymakers, city planners, and EVSS providers for the ongoing evolution and success of the EVSS industry.

The success of EVSS businesses in China can be attributed to their ability to adaptively navigate this complex situation. Through strategic alignment of their business models with the changing landscape of policies, stakeholder interests, urban infrastructure, technological innovations, and consumer behaviours, they have managed to create and maintain their success. Their sustainable business models, therefore, can be seen as a dynamic outcome of this systemic interplay, rather than a static design.

Table 6.5 Factors shaping the sustainable business models of EVSS in YRDEZ

Component	Description
Business model evolution	Dynamic adaptation driven by market demand, promotional strategies, stakeholder engagement, local government attitudes, insurance policies, and urban infrastructure.
Policy interventions	Interplay between central government policies and local attitudes, leading to potential inconsistencies in the EVSS landscape.
Stakeholder interactions	Interests, priorities, and expectations of stakeholders, such as insurance companies, regulatory bodies, technology firms, and car manufacturers, can lead to synergies and conflicts.
Urban infrastructure	The availability and accessibility of charging and parking facilities, urban planning, and traffic restrictions can shape the operational efficiency and adoption of EVSS.
Innovative technologies	New energy sources, autonomous driving, and automated services contribute to the transformation of the EVSS sector, enabling providers to explore new service offerings and develop novel revenue streams.
Consumer preference	Factors such as convenience, safety, efficiency, vehicle types, and attitudes towards green mobility shape consumer attitudes towards EVSS.

6.2.3 Dynamic elements that contribute to business model evolving: A qualitative analysis utilising the McKinsey's 7S Framework

Previous sections demonstrate the dynamic elements contributing to the business model types and evolution within EVSS schemes and some of the immediate external influences on them. Understanding the firm-level organisational elements of and influences on business model innovation and evolution of EVSS in YRDEZ can be facilitated by using the McKinsey 7S Framework (Peters and Waterman 1982). This section aims to provide an in-depth and analytical perspective to understand the intricacies of the various factors influencing the innovation and evolution of the EVSS business model by analysis the respondents emphasised the following factors under each of the 7S factors.

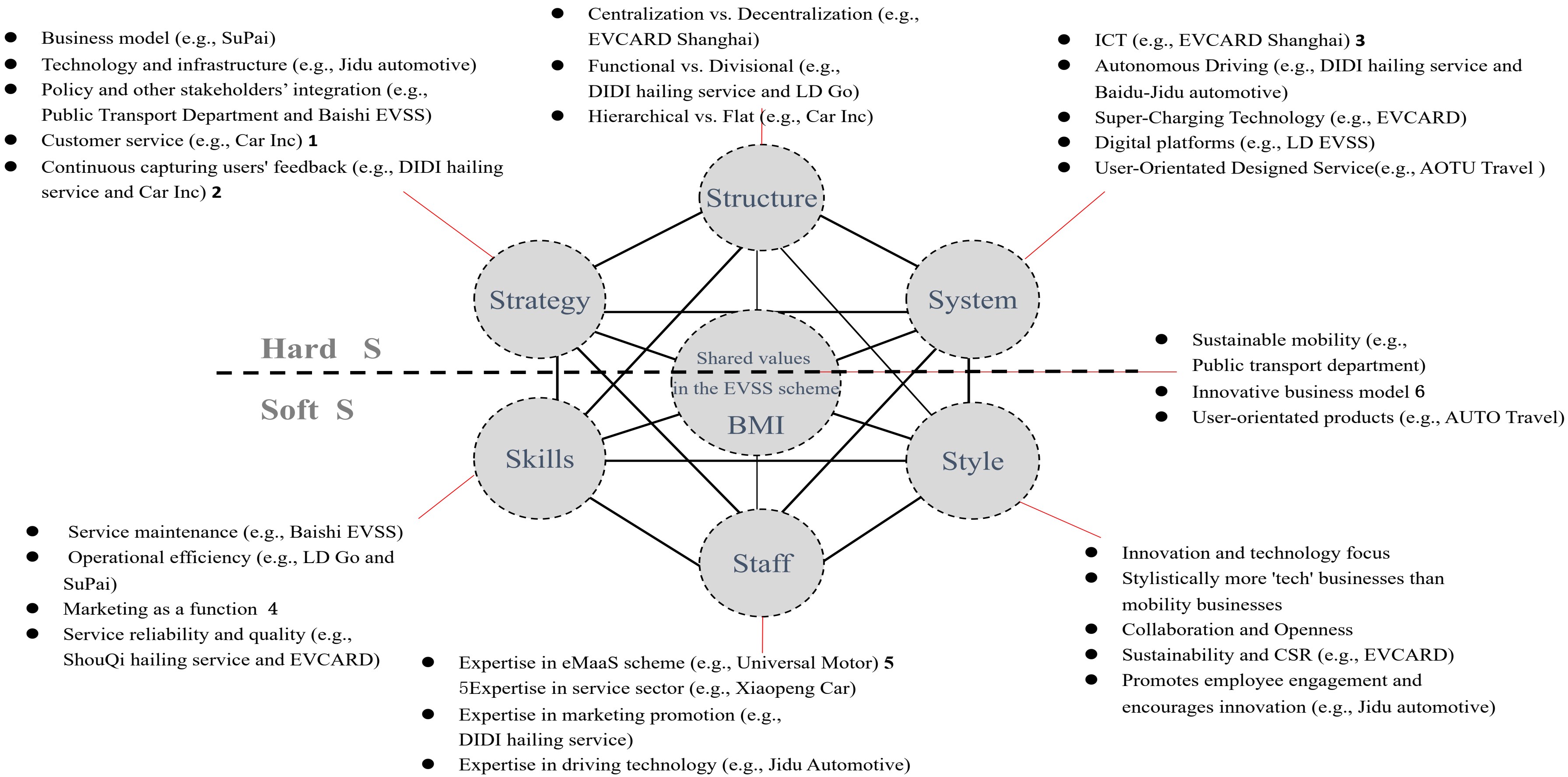


Figure 6.1 Exploring the key factors emphasised by respondents across McKinsey's 7S Framework ([123456] references are in the footnote).

[1] (Wu et al. 2019; Verganti 2008)
[2] (Haboucha et al. 2017; Acheampong et al. 2021)
[3] (García-Fuentes and de Torre 2017; Vecchio and Tricarico 2019）
[4] (Bartels 1974)
[5] (Johansson et al. 2019; Luo et al. 2021)
[6] (Sarasini and Linder 2018; Ruhrort 2020; Sarasini and Langeland 2021)

6.2.3.1 The "hard" elements of McKinsey's 7S Framework

Strategy: It highlights the importance of customer-centric approaches (Verganti 2008), collaboration with key stakeholders, and adaptability to enhance the company's overall performance and success in the market.

a. Business model (e.g., SuPai): This EVSS provider's current business model involves generating profits through commissions, sales' profits and advertisement for other companies which are interested in online promotions, while focusing on marketing strategies such as coupons and online promotions. EVSS providers may consider to continuously assess their target customer segments and adapt profit schemes and marketing initiatives accordingly.

b. Technology and infrastructure (e.g., Jidu automotive): These EVSS providers focus on the use of ICT, big data, and AI to improve their services, from vehicle tracking to autonomous driving technology. To maintain a competitive position, the EVSS providers, particularly those whose strategy emphasises technology, will need to keep up with the latest technological advancements (e.g., autonomous driving) and invest in research and development to ensure its technological infrastructure is effective and efficient.

c. Policy and other stakeholders' integration (e.g., Public Transport Department and Baishi EVSS): EVSS providers may actively align operations with government policies and collaborate with stakeholders such as OEMs, insurance companies, repair services, and public transport departments to ensure efficient service (e.g., LD Go). By engaging with stakeholders and staying informed about regulatory changes, the EVSS provider can adapt its strategy and operations to comply with legal requirements and create mutually beneficial partnerships. This collaboration can also be useful for developing a sustainable urban mobility ecosystem that benefits all parties involved.

d. Customer service (e.g., Car Inc) (Wu et al. 2019): Capturing the target customers' main concern such as convenience, low-cost and efficiency (e.g., Darren) can solidate a company's reputation and improve their Net Promoter Score (NPS) (e.g., Go fun). This includes offering prompt support, addressing customer evolving concerns, and providing clear communication channels to foster trust and loyalty among users.

"The service is convenient, and the price is reasonable, and I also had several vouchers for free of charge."

Darren (Group A: Users)

e. Continuously capturing users' feedback (e.g., DIDI hailing service and Car Inc) (Acheampong et al. 2021; Haboucha et al. 2017): Actively gathering and incorporating user feedback is critical for improving the organisation's services and maintaining a competitive advantage. By regularly engaging with users, the company can identify areas for improvement and adapt its offerings to better serve its customers mentioned by Jack:

"Post-purchase service involves conducting telephone interviews. There are various approaches to this. I think this is a common feature in the service industry; it is necessary to conduct follow-up calls; otherwise, we won't know whether the customer had a good experience or not."

Jack (Car Inc)

Structure: It plays an important role in the success of an EVSS provider by enabling it to adapt and innovate in a rapidly changing market. By considering the factors below, the EVSS provider's structure can be designed to facilitate the adoption and implementation of innovative business models. This may involve creating cross-functional teams, establishing partnerships with stakeholders, and allocating resources for in house research and development.

a. Centralisation vs. Decentralisation (e.g., Car Inc in Jiangxi province): The EVSS provider might lean towards a decentralised structure, where local branches operate with a certain degree of autonomy. This enables better adaptability to local market transitions and customer preferences.

b. Functional vs. Divisional (e.g., DIDI hailing service and LD Go): The EVSS organisation might adopt a divisional structure, with separate divisions or business units responsible for different aspects of the business, such as marketing, operations, technology, and policy. This allows for better focus on each aspect and facilitates specialisation.

c. Hierarchical vs. Flat (e.g., Car Inc): The EVSS organisation could reduce management layers, to encourage faster decision-making and better communication within the company.

This can be beneficial for adapting to the fast-paced and dynamic nature of the EVSS market.

Systems: investing in and integrating technologies and user-centric designs such as advanced ICT systems, data analytics, and digital platforms allows service providers to optimise their offerings, enhance customer experiences, and improve operational efficiencies. Furthermore, companies can explore emerging technologies, such as autonomous driving and vehicle intelligence, to stay ahead of the competition and differentiate their services. By focusing on these elements, providers can optimise services, enhance customer experiences, and maintain a competitive advantage in the rapidly evolving EVSS schemes.

a. ICT (e.g., EVCARD Shanghai) (García-Fuentes and de Torre 2017; Vecchio and Tricarico 2019): By using ICT systems, such as those used by EVCARD Shanghai, the company can improve its services, operations, and improve overall customer experience.

b. Autonomous Driving (e.g., DIDI hailing service and Baidu-Jidu automotive): Investing in autonomous driving technologies, like those employed by DIDI hailing service and Jidu automotive, can help the organisation stay competitive and differentiate its services in EVSS schemes and contribute to the evolution of urban mobility infrastructure:

"Therefore, just from the perspective of autonomous driving EVs, it is very likely to disrupt the existing traditional urban planning and urban transportation infrastructure."

Bill (Baidu-Jidu automotive)

c. Super-Charging Technology (e.g., EVCARD): Adopting faster super-charging technology, such as that used by Gofun EVSS, the company can improve operational efficiency, enhancing the user experience and increasing the attractiveness of its services.

"We can place some of our cars at fast charging stations, where they can be fully charged in half an hour. After charging, we can quickly distribute the cars to their designated locations."

Jason (EVCARD Shanghai)

d. Digital Platforms (e.g., LD EVSS): Utilizing digital platforms like LD EVSS allows the organisation to offer user-friendly booking and vehicle tracking systems, making the EVSS experience more convenient for customers.
e. User-Orientated Designed Service (e.g., AOTU Travel): By focusing on user-orientated designed services, such as those offered by AOTU Travel, the company can tailor its offerings to better meet customer needs and preferences, further enhancing the overall user experience (Verganti 2008).

6.2.3.2 The "soft" elements of McKinsey's 7S Framework

Skills: The mixture of 'critical' skills includes the technical maintenance, operational efficiency, strategic marketing and service delivery (online and offline). These skills ensure long-term vehicle performance, cost minimisation, effective marketing campaigns, and addressing customer concerns:

a. Technical maintenance (e.g., Car Inc): Effective service maintenance is important for ensuring the long-term performance and efficiency of electric vehicles. Companies like Car Inc specialise in providing routine maintenance, repair, and upgrades to electric vehicles, ensuring that customers are using optimal performance and extending EV lifespans. Skills in diagnostics, troubleshooting, and repair are important for the service teams.

b. Operational efficiency (e.g., LD Go and SuPai): Operational efficiency is one of the important aspects of the EVSS industry to minimise costs and maximise utilisation. Service providers like LD Go focus on processes, optimising resources, and implementing innovative technologies to enhance the efficiency of their operations. Skills in process improvement, logistics, and resource management are also important for achieving operational efficiency in EVSS schemes.

"First of all, you need to have this operational capability."

Tom (SuPai)

c. Strategic marketing: Marketing plays a functional role in promoting EVSS and reaching the target audience. A successful marketing strategy in EVSS schemes involves understanding customer needs, positioning products and services effectively, and communicating the benefits of electric vehicles and related services. Skills in market research, branding, digital marketing, and public relations are important for creating impactful marketing campaigns within EVSS schemes.

d. Service reliability and quality (e.g., ShouQi hailing service and EVCARD): Service reliability and quality are essential factors that determine customer satisfaction and loyalty in the EVSS industry. Companies like ShouQi hailing service and EVCARD prioritise delivering reliable, high-quality services to their customers. Skills in quality assurance, customer service, and performance monitoring can be important for maintaining service reliability and quality in EVSS schemes.

Staff: Combining expertise concerning eMaaS schemes, the service sector, marketing promotion, and driving technology can be important for the success of an EVSS provider. The dual aim of augmenting customer service while simultaneously responding to, and driving forward, innovation within the EVSS may create a particular mixture of challenges. The emphasis on providing a service based around using a product whose technology and capabilities are rapidly evolving, arguably makes the market for EVSS resemble, more than any other mobility market, that for consumer telecoms services.

a. Expertise in eMaaS schemes (e.g., Universal Motor) (Johansson et al. 2019; Luo et al. 2021): Employees with a deep understanding of eMaaS schemes are essential for the success of an EVSS business. They will have knowledge about the latest trends in the electric vehicle market, charging infrastructure, and mobility services. Their expertise will be instrumental in designing and implementing effective eMaaS solutions to meet the evolving needs of customers and stakeholders.

"The eMaaS is transportation is electric service travel, such as electric cars, electric bicycles, shared bicycles, and shared electric bicycles. These are already being implemented now in my company."

John (Universal motor)

b. Expertise in the service sector (e.g., Xiaopeng Car): Staff with experience in the service sector, particularly in companies like Xiaopeng Car, can bring valuable insights into customer service, user experience, and operations management. Their expertise can be important in creating a convenient experience for users of the EVSS platform, which may lead to higher customer satisfaction and retention.

c. Expertise in marketing promotion (e.g., DIDI hailing service): Having employees skilled in marketing and promotional strategies, especially with experience in companies like DIDI, is vital for the growth and visibility of the EVSS business. They will be responsible for developing and executing targeted marketing campaigns to attract and retain customers, as well as to create brand awareness and credibility in the market.

d. Expertise in driving technology (e.g., Jidu Automotive) (Asgari and Jin 2019; Haboucha et al. 2017): Staff with a strong background in driving technology, such as those with experience in companies like Jidu Automotive, can contribute to the development and integration of driving technologies in EVSS schemes. Their knowledge can be important in improving the driving experience for users, ensuring the safe and efficient operation of the shared vehicles, and keeping the business at the forefront of the rapidly evolving automotive technology landscape. However, the development of driving technologies typically involves cross-company skills and cooperation and is not necessarily the product of one individual company's efforts and skills.

Style: This component refers to the leadership and management style and culture within an EVSS organisation. It includes the way for managers to interact with their employees, make decisions, and foster a culture that supports innovation, customer-centricity, and sustainability, etc. The “style” within EVSS schemes can be characterised by the following attributes:

a. Innovation and technology focus: In terms of the organisation's culture, the style aspect emphasise creativity, adaptability, and a forward-thinking perspective. To stay competitive in the mobility market, EVSS providers are fostering an environment where employees are encouraged to explore new ideas, learn from failures, and collaborate on innovative solutions.

b. Customer-centricity (Verganti 2008): The style aspect may also promote a customer-centric culture. This means that employees at all levels of the organisation prioritise customer satisfaction and meet their mobility needs. Encouraging open communication and responsiveness among employees will further help drive this culture.

c. Collaboration and Openness: A culture of collaboration and openness can be important within EVSS schemes. This entails promoting open communication, shared goals, and respect among employees, thereby encouraging them to collaborate effectively with relevant stakeholders and partners. This collaborative environment will encourage innovation and improve service quality.

d. Sustainability and corporate social responsibility (CSR) (e.g., EVCARD): The organisation's culture may prioritise sustainability and CSR by promoting environmentally advantages practices, resource efficiency, and ethical decision-making among employees. Encouraging employees to consider the environmental impact and social consequences of their actions will help create a green organisation.

"Our company aims to reduce the emissions and help urban citizens to have a more sustainable mobility lifestyle. Also, we have responsibility to avoid criminal behaviour by having wider cooperation with the police department. These are reflected in this sense of social responsibility."

Lee (EVCARD Suzhou)

e. Promotes employee engagement and encourages innovation (e.g., Jidu automotive): Lastly, the Style aspect can create an ecosystem that supports employee engagement and motivation. This can be achieved by recognizing and rewarding innovative ideas, providing opportunities for personal and professional growth, and fostering a positive work atmosphere. Engaged and motivated employees are more likely to contribute to the organisation's success and drive innovation.

The business style of EVSS can vary to reflect their different types of origin. For example, technology-oriented businesses (e.g., Baidu car) may primarily focus on advancing the technology of EVs or the digital platforms that support sharing services. They may invest heavily in R&D (Wells 2013a) as well as develop proprietary technology or platforms (e.g., Jidu automotive). Mobility-oriented businesses, on the other hand, may focus less on the on-line element of the customer experience and more on the in-car element. So, while they may also utilise advanced technology, their primary focus may be on ensuring accessible and efficient transportation (such as flexible vehicle availability, competitive pricing models, and wide geographic coverage) for their users (e.g., LD Go).

Seeking a balance between and/or integrating these elements of advancing technology, improving mobility services, and enhancing customer experiences was evident in companies' strategy and likely to impact its competitive positioning and success. For example, Baidu introduced autonomous EVSS by utilising this technology to increase efficiency and success. Xpeng introduced its 'big data' technology for optimising routes and schedules. This was shaped by the company's specific context, including its resources, capabilities, market demands, and strategic vision.

6.2.3.3 Shared values

It can be principles and beliefs that steer an organisation's culture and actions, play an important role within EVSS schemes. Centred on sustainability and BMI (Ruhrort 2020; Sarasini and Langeland 2021; Sarasini and Linder 2018), these values underscore to environmental preservation and might be ingrained in EVSS business models. By proactively promoting and embodying these values, companies can effectively communicate their devotion to reducing carbon emissions, improving urban mobility ecosystem, create a brand identity and differentiate themselves from competitors. Aligning business models with shared values empowers EVSS providers to secure the backing of customers, government agencies, and other key stakeholders.

Further discussion of interactions between the different elements of the 'S' factors of EVSS providers if provided in Appendix H.

6.2.4 Barriers and opportunities for the evolution of EVSS business models: A qualitative exploration

Table 6.6 highlights the complex interplay of barriers and opportunities that influence the evolution of SEV business models in the Chinese market. By addressing these factors, policymakers, industry stakeholders, and service providers can work together to create a conducive environment for future growth and innovation of SEV business models. Additionally, these findings can serve as a basis for future research and provide valuable insights for other markets experiencing similar challenges and opportunities to EVSS schemes.

Table 6.6 Summary SWOT analysis for current EVSS business models in YREDZ.

Category	Strengths	Weaknesses/Barriers	Opportunities	Threats
Regulatory Challenges	Encourage in general with financial support	Inconsistent regulations, insufficient incentives, lack of infrastructure support	Streamline regulations, provide incentives for EV adoption, promote infrastructure development	Inflexible government policies and local regulations
Technological Limitations	Rapid pace of technological advancements	High costs, limited driving range, inadequate charging infrastructure	Foster technological innovation, support R&D in battery technology, autonomous driving, and V2G solutions	Competing technologies or slow technological progress
Insurance Companies	No	Stringent conditions, limited control over clients' actions	Understand regulatory landscape and its implications, adapt insurance offerings accordingly	Changing insurance regulations or unanticipated risks
Consumer Behaviours	Willing to choose green mobility	Range anxiety, unfamiliarity with EV technology, vehicle reliability concerns	Raise consumer awareness and educate consumers about the benefits of SEVs and shared mobility services	Changing consumer preferences or low adoption rates
Urban Infrastructure	Positive attitudes	Infrastructure not designed for EVSS schemes	Analyses impact of existing infrastructure and regulations on EVSS, modify regulations to support successful integration	Inadequate urban planning or unanticipated infrastructure challenges
Supporting Facilities (See 6.2.2.3)	Positive attitudes	Insufficient parking and charging outlets	Collaborate with stakeholders, invest in parking facilities and charging infrastructure development	Competing demands for limited resources or changing mobility requirements
National Credit System	No	Underdeveloped national credit system	Strengthen national credit system, monitor consumer creditworthiness, and foster responsible behaviour	Financial instability or unanticipated changes in the national credit landscape

6.2.4.1 Barriers to SEV business model evolution

The SWOT analysis is structured to evaluate internal and external factors affecting an organisation. Strengths and weaknesses are intended to be internally focused, while opportunities and threats are externally oriented. A barrier signifies an underlying weakness, as the presence of a strength would negate the issue as a barrier. Rather than directly exacerbating a situation, a barrier impedes the improvement of organisational performance. Such barriers occupy an intermediary position within the SWOT framework. A comprehensive examination of barriers can be found in Table 6.3, shedding light on areas that require attention in order to bolster the organisation's overall strategy and effectiveness:

1. Regulatory challenges (e.g., SuPai): Local government policies, attitudes and regulations can either facilitate or impede the growth of the EVSS market. Inconsistent regulations, insufficient incentives, and lack of infrastructure support create challenges for service providers in developing and implementing their business models and strategies.

"Because the policies in this field are not very clear at the moment, the government may have a general framework. This policy supports and encourages, but not too many people are entering this field."

Tom (SuPai)

2. Technological limitations (e.g., LD go and Group A): The rapid pace of technological advancements requires SEV service providers to continually innovate and adapt their offerings. However, factors such as high costs, limited driving range, and inadequate charging infrastructure can hinder the adoption and development of technologies.

"Vehicle space and mileage (range) are limited, so users can only use it within the urban area."

Mike (LD go)

"This means that the range anxiety will make you feel anxious because the charging process in between is not very convenient."

David (Group A: Users)

3. Insurance company (e.g., LD go): It is conceivable that Chinese insurance regulations may be comparatively lenient or encompass relatively comprehensive requirements. However, there are instances where certain insurable actions or behaviours can be taken, which may not be permitted by the insurance providers. These providers could impose rather stringent conditions, primarily because they have limited control over their clients' actions. This necessitates a thorough analysis and understanding of the regulatory and policy landscape as well as its implications for both insurance providers and their clientele within the Chinese market.

“There is a higher likelihood that, according to the current Chinese insurance regulations, they may be relatively broad or have more comprehensive requirements. However, many times there are some insurable situations or actions to take out insurance. But the insurance side does not allow it and may impose some relatively stringent conditions because, in reality, we cannot control the customers' behaviour.”

Mike (LD go)

“What if you're involved in a serious traffic accident? Insurance companies can refuse to pay compensation because it's a non-commercial vehicle.”

John (Universal motor)

4. Consumer behaviour and preferences (e.g., Group B2) (Nazari et al. 2018): The success of EVSS may depends on the willingness of consumers to adopt EVSS. Factors such as range anxiety, unfamiliarity with EV technology, and concerns about vehicle reliability can negatively impact consumer adoption rates.

“The driving and riding experience is not good.”

Harry (Group B3: Laggards)

5. Urban Infrastructure traffic regulation (e.g., EVCARD and Universal Motor): As they currently stand, have not been explicitly tailored for EVSS schemes. Consequently, this misalignment may give rise to an array of issues pertaining to users' experiences and the overall development of EVSS. A thorough, in-depth, and analytical examination of the impact of existing urban infrastructure and traffic regulations on the adoption and evolution of EVSS is essential to identify potential barriers, opportunities, and requisite

modifications to support the successful integration of these services within the urban planning.

"Traffic regulations can also impose fines because you are using a non-commercial vehicle."

John (Universal motor)

6. The Underdeveloped National/Social Credit System (Kshetri 2020) (e.g., LD go): The national credit system plays an important role in shaping the consumer sector, particularly in terms of establishing trust and responsible behaviour, The current state of the national/social credit system, characterised by inadequate infrastructure and a lack of robustness, leaves much to be desired. This weakness undermines the system's ability to effectively assess and monitor consumer creditworthiness and behaviour, potentially exacerbating the risks associated with EVSS quality.

"Due to the imperfection of the shared credit system, it becomes difficult for us to hold these customers accountable and deal with them when we try to track them down later."

Mike (LD go)

6.2.4.2 Opportunities for EVSS business model evolution

The evolution of EVSS business models can be shaped by a myriad of factors. This section critically addresses the following opportunities that can facilitate the development and implementation of innovative and sustainable EVSS business models:

1. Government support and incentives (e.g., Public Transport Department and EVCARD): Governments can play an important role in promoting the adoption of SEVs by offering incentives, tax breaks, and subsidies, as well as supporting the development of charging infrastructure which may contribute to building up a sustainable urban mobility ecosystem.

2. Technological advancements (e.g., Jiudu Automotive): Emerging technologies, such as autonomous driving, connected vehicles, and vehicle-to-grid (V2G) solutions, may enhance the value proposition of EVSS business models and user drive market growth.

3. Collaboration and partnerships (e.g., EVCARD): By forming strategic alliances with other stakeholders, such as automakers, charging infrastructure providers, and technology companies, the EVSS providers can overcome some of the barriers and accelerate the development and implementation of innovative business models.

4. Consumer awareness and education (e.g., Public Transport Department): Raising awareness and educating consumers about the benefits of SEVs and shared mobility services can foster a shift in consumer behaviour and preferences, facilitating the widespread adoption of EVSS business models.

> *"Diversify travel methods to guide and transform the way people travel, shifting from personal private car travel to low-carbon and environmentally friendly public transportation."*

Cal (Public Transport Department)

6.2.4.3 Several recommendations from the interviewees to facilitate the evolution of EVSS business models

1. Enhancing regulatory and policy support: The interviews with EVSS providers (e.g., EVCARD and Go fun) suggested that governments can consider refining regulations and policies to create a consistent and supportive framework for the growth of the EVSS market. This could involve providing incentives for EV adoption, promoting the development of charging infrastructure, and encouraging investment in research and development.

2. Supporting technological innovation (e.g., Jidu automotive and Public Transport Department): Stakeholders expressed the importance of investing in the development and implementation of new technologies that can enhance the performance, efficiency, and convenience of SEVs. This might encompass supporting research and development in areas such as battery technology, autonomous driving, and vehicle-to-grid solutions.

3. Fostering collaboration and partnerships (e.g., SuPai): Tom used NIO as an example which refers to the value of actively seeking opportunities to form strategic alliances with other companies, both within and outside EVSS schemes. Collaborative efforts could help overcome some of the barriers and create synergies that accelerate the development and implementation of innovative SEV business models.

"NIO, a Chinese electric vehicle company, has a well-designed top-level shareholder structure that includes well-known domestic internet enterprises like Baidu, JD.com, state-owned capital, and Xiaomi. In the future, NIO's vehicles will utilise Baidu's voice intelligence system for their smart features, as Baidu is a shareholder, ensuring the integration of its brand and shareholder products. Additionally, JD.com, as a shareholder, could potentially leverage NIO's vehicles to achieve unmanned delivery services in the future."

Tom (SuPai)

4. Raising consumer awareness and education (Asgari and Jin 2019; Haboucha et al. 2017) (see section 6.2.4.2): Public and private sectors were advised to work together to develop targeted campaigns that raise awareness of the benefits of SEVs and shared mobility services. Such initiatives might contribute to changing consumer behaviour and preferences, resulting in increased adoption rates and market growth.

6.3 Market evolution: Marketing as a function to capture user-segment synergy

The majority of EVSS providers have an online platform department or internet company background. Tom mentioned that EVSS's expansion comes after a period of hyper-production of EVs which may force OEMs to release their stocks. The EVSS providers use marketing as a function to capture users. Considering EVSS schemes from a marketing perspective can help to understand how Chinese EVSS providers can create user-segment synergy through effective marketing and promotional strategies.

6.3.1 Segment-Need interplay dynamics

6.3.1.1 Understanding user needs and preferences within various segments (B-side and C-side customers) and their implications on marketing strategies

Drawing from the literature on innovation service and ICT, eco-innovation, sustainable mobility and smart mobility, and eMaaS, this section seeks to understand the user needs and preferences within both B-side and C-side segments and their implications on marketing strategies.

Integrating ICT within EVSS schemes allows for the design and implementation of advanced mobility solutions, such as real-time vehicle tracking and data analytics, to better serve the demands of both business and individual customers. Furthermore, it enables the development of targeted marketing strategies based on customer insights and usage patterns, facilitating more effective and tailored communication to each audience segment, improving customer engagement and retention (e.g., NPS). For instance, B-side customers might prioritise cost-efficiency, scalability, and fleet management capabilities, while C-side customers may seek convenience, flexibility, safety, efficiency and environmental benefits, mentioned by David:

> *"With the iteration of intelligence, the promotion of unmanned or precision-assisted driving, the increase of EV charging stations, and the availability of more vehicle models, especially the high-tech electric vehicles produced by domestic OEMs, I will use EVs more frequently."*
>
> David (Group A: Users)

Empirically, in the context of shared mobility platforms, customers can be primarily categorised into three segments: large B-side (corporate customer), small B-side (employees of corporate customer), and C-side (individual consumers). C-side can also be divided into high-end, mid-range and low-end customers (e.g., SuPai). Each segment presents distinct risk profiles, profitability, and behavioural characteristics.

Table 6.7 User-segment synergy.

	User Segments	Potential customer occupation	Main concern	Mobility needs	Service type
B-side	Large B-side	Corporate customer	Convenience; low-cost; Efficiency; Safety; Luxury; Hygiene	Business	Time sharing; Week/Day package
	Small B-side	Employees of corporate customer	Convenience; low-cost; Efficiency; Safety; Hygiene	Business; travel; leisure	Time sharing; Week/Day package
C-side	High-end C-side	High income people with pursuing a high quality of life	Convenience; low-cost; Efficiency; Safety; Luxury; Hygiene	Business; travel	Time sharing
	Mid-range C-side	Middle class	Convenience; low-cost; Efficiency; Safety; Hygiene	Working: leisure	Time sharing; Week/Day package
	Low-end C-side	Idle members of society; student	Convenience; low-cost	Travel; practice; house moving; small business	Time sharing

The distinction between B-side and C-side segments, along with the lower risks they present compared to the C-side segment. In terms of profitability, both large and small B-side markets yield higher returns than C-side. Tom (SuPai) offers a concise explanation of the difference between these two B-side segments, emphasizing the nature of the interactions with the sharing platform:

> *"The big B-side mainly refers to corporate behaviour and the cooperation between the enterprise and our sharing platform. The small B-side, on the other hand, refers to individual behaviours of employees within the enterprise."*

These employees initially pay for the EVSS themselves and later claim reimbursement from their company. This arrangement allows them to flexibly manage their time, as opposed to traditional car rental models with chauffeurs, which may lead to increased costs and driver dissatisfaction due to unforeseen changes in schedules, mentioned by Tom:

> *“Small B-side belongs to the flow brought by the enterprise because they are collaborating with us. Therefore, their behaviour is considered as belonging to the company, and they can claim reimbursement through the company."*

Tom (SuPai)

The majority of customers seek convenient efficient and low-cost mobility however, parking outlets and SEVs’ types currently is not always sufficient, mentioned by Daniel, Daisy, Darren and Evan:

> *“This is a cheap and convenient service, with the advantage of having many parking spots available. However, the downside is that there are few vehicle models to choose from. The parking spots are mostly located in large parking lots near subway stations.”*

Daniel (Group A: Users)

> *“Sharing this service is also very convenient and cheap, with timely access.”*

Daisy (Group A: Users)

> *“I will still use shared cars, and sometimes consider their convenience and economic benefits.”*

Darren (Group A: Users)

> *"I think it's all about convenience and efficiency, as when I travel frequently, my first consideration is always reaching the destination in the shortest time possible."*

Evan (Group B2: Late majority)

Corporate demand, such as from small B-side clients, typically occurs on working days when the demand is relatively high. In contrast, the C-side market experiences more significant demand during weekends and holidays. On workdays, individual consumers may have better options for commuting journeys (such as hailing service and private cars) than EVSS (e.g., Group

B). Additionally, with well-developed public transportation, focusing on the C-side segment for shared travel may not yield ideal results in terms of revenue generation. Considering these factors, the high-end market is targeted for shared mobility services, with an emphasis on the B-side and C-side segments. For sales of EVs, although some OEMs have already established a share in C-side market, it may not be their sole target. These OEMs may display an interest in the B-side segment, making it a more strategic focus for shared mobility platforms.

Vehicles possess symbolic value and can shape individuals' perceptions of brand image, and it is noteworthy that, in China, vehicle brands such as BMW, Mercedes, and Audi exert a considerable influence on customers' brand choices (e.g., Group A). However, advancements in electric vehicle technology, including enhanced human-computer interfaces and autonomous driving features (e.g., lane-keeping, pilot driving, and remote control), appear to be mitigating this effect as consumers are tending to differentiate less on the basis of vehicle brand, and more on the basis of the vehicle technology and functional mobility needs. Additionally, although OEM vehicles have not traditionally been popular, the emergence of electric and new energy concepts are changing the landscape. Consequently, local OEMs' EVs are gaining popularity due to their innovative interior designs and advanced driving technologies, which contribute to an improved user experience. As a result, users are increasingly prioritising the functionality of SEVs over brand prestige, mentioned by Evan and Eli:

> *"I believe that shared vehicles should be relatively simple, easy to drive, and eco-friendly with energy-saving features. If these shared vehicles offer more options, such as a range of luxury car models, as well as advanced autonomous driving or high-end assisted driving modes, it would greatly enhance their appeal."*

Evan (Group B2: Late majority)

> *"Undoubtedly, electric vehicles represent the future direction of development, as they combine aspects of vehicle connectivity, intelligence, and smart networking, including subsequent autonomous driving, all of which integrate into the endpoint direction of intelligent transportation systems. In light of national macro policies such as "carbon neutrality and carbon peak," the government is also promoting new energy vehicles. As a result, this sector will definitely gain market recognition and enjoy a promising outlook*

in the subsequent market. Furthermore, the future development space for new energy vehicles will be vast. Thus, new energy vehicles will inevitably become a new domain within the automotive industry."

Eli (Group B2: Late majority)

6.3.1.2 Elaborating on the concept of user-segment synergy: Aligning service offerings with segment needs and preferences

The concept of user-segment synergy involves aligning service offerings with the specific needs and preferences of each customer segment. This is particularly relevant in the context of eMaaS, where service providers aim to offer comprehensive, sustainable, and user-centric transportation solutions. This may involve providing B-side customers with flexible fleet management options, robust reporting and analytics tools, and integration with existing systems. For C-side customers, service offerings may focus on user experience, ease of access, and eco-friendly solutions that promote sustainable mobility.

Empirically, B-side customers require a heterogeneous assortment of SEVs, while C-side customers seek convenient, low-cost, and timely services highlighted by Tom:

"For the B-side market segment, the focus is on providing standard consumption options, while also offering an array of specialised, high-end vehicle models to attract the more discerning, affluent clientele. The strategy emphasises vehicle diversity, primarily centred around mid-range models with a high cost-performance ratio, and catering to the business market."

Tom (SuPai)

"As people's pursuit of a higher quality of life continues to grow, I have chosen mid-range vehicle models to cater to this demand. Through offering a combination of quality services and a diverse range of vehicle models, the goal is to increase customer loyalty and long-term stability."

Tom (SuPai)

6.3.1.3 Analysing the role of marketing and promotion in fostering user-segment synergy and driving EVSS adoption

EVSS providers were aware of marketing and promotion to draw in users, given the unique challenges associated with EVs and shared services (Ye et al. 2020). This involves educating a broad range of stakeholders to facilitate a shift towards EVs (Bergman et al. 2017). However, acceptance of EVs, as compared to internal combustion engines(Wells and Nieuwenhuis 2018), is limited, often due to existing biases hindering widespread adoption (Ye et al. 2020). To release this situation, EVSS providers play an intermediate role by bridging the gap between individual mobility needs and EV functionality. This involves enhancing user understanding through tailored marketing efforts to increase acceptance and use of EVs. Further exploration of the potential synergies between marketing, promotion, and user-segment alignment within the context of EVSS adoption is necessary, as stated by Erin:

> *"There are three main channels for obtaining information: firstly, social media platforms such as TikTok, Weibo, and Bilibili. Secondly, commercial advertisements encountered in daily life, such as elevator advertisements, television, public square screens, and roadside billboards. A small portion of the time, information comes from conversations among acquaintances."*

Erin (Group B2: Late majority)

Users typically acquire information about EVSS through a tripartite process encompassing social media, physical advertisements, and word of mouth (e.g., EVCARD and Universal Motor). Given that EVSS is not a conventional consumption item, it represents a complex and tangible product whose utilisation extends beyond individual user experiences and may, if employed improperly, induce significant societal disruption. For example, from the perspective of a consumer, being unfamiliar with driving SEVs may cause accident.

> *"The second source is the mutual promotion among friends, where people promote to each other within their social circles."*

Lee (EVCARD Suzhou)

> *"Free trial, discount coupons, encouraging users to promote and introduce."*

John (Universal Motor)

In this context, well-designed marketing strategies can serve as an effective means to foster trustworthiness within society, thereby facilitating the adoption of EVSS.

6.3.2 Marketing and promotion strategies: A qualitative exploration of EVSS providers in YREDZ

EVSS providers in YEDZ employ a dual marketing/promotion approach – both physical and online—to bolster their services, initially enticing potential users with free trials and subsequently creating mobility needs by fostering demand and supply. This section first explores the promotion strategies utilised by EVSS companies, followed by an examination of marketing's role in user satisfaction through personalised services. Subsequently, the challenges and barriers in marketing and promotion are discussed, culminating in a vignette concerning a successful small EVSS company's marketing strategy. **Table 6.8** shows the EVSS's physical and online promotion strategies and will be discussed in detail by following sections.

Table 6.8 Physical and online marketing promotional strategies.

Marketing Strategies	Marketing Tools	Specific Activities	Main Purpose	Customer segmentation	Advantage	Disadvantage
Online Promotion	Social media App like Tiktok, Kuaishou and Wechat	widely spread the EVSS among app's users	Catch users' eyes	General public	Broad reach; cost-effective	Limited control over content; potential negative comments
	live streaming	Invite internet influencers for live streaming; offer vouchers	Promote specific services; create mobility needs	C-side	Time-sensitive; high dependence on influencers; Direct engagement with target audience	Time-sensitive; high dependence on influencers
	Online news	Broadly distribute EVSS news	Educate customers on mobility behaviours	General public	Builds credibility; raises brand awareness	Requires constant updates; competition for visibility
	Corporate public channel	Update information and communicate with customers	Foster customer relationships	B-side and C-side	Enhances customer loyalty; increases trust	Requires resources; potential conflicts with partners
Physical Promotion	Billboards	Display large billboards on roads, motorways, CBD areas	Catch users' eyes	General public	High-impact visibility	Expensive; limited engagement
	Regional promotion	Shopping mall and CBD	Promote specific service and create mobility needs	C-side	Targets specific geographical areas	Limited reach; may require multiple locations
	Corporate with places of interest	Place parking and charging outlets of EVSS	Create mobility needs and provide driving opportunities	B-side and C--side	Increases convenience; enhances accessibility	possible infrastructure constraints
	Stickers	Well-designed stickers on SEVs	Catch other potential users' eyes	C-side	eye-catching visuals	limited space for information

6.3.2.1 Navigating the world of social media and digital channels: An analytical perspective on customer engagement and service visibility

Table 6.8 shows the multifaceted marketing strategies utilised by EVSS providers to engage diverse customer segments and fulfil specific objectives. Navigating the world of social media and digital channels, as well as traditional advertising, play important roles in fostering customer engagement, visibility and normalising this innovative service among the customers. As advances in ICT and mobile internet technology proliferate, social media tools and digital channels have increasingly become integral to people's lives. The majority of individuals utilise social media applications, such as TikTok, Kuaishou, and WeChat, for communication and entertainment purposes, including watching short videos. Consequently, the popularity of live streaming has grown with companies engaging internet influencers to promote specific services and create demand from C-side customers. Online news also aims to educate the general public about changing mobility behaviours, while corporate public channels foster customer relationships for both B-side and C-side clients. Significantly, a majority of the EVSS providers had backgrounds in internet-based enterprises, which inspired them to develop promotional strategies that exploited digital media.

Tom mentioned the importance of attracting data traffic through digital channels:

> *"We use online methods to spend money to attract traffic and promote through various online channels."*
>
> Tom (SuPai)

Online platforms were seen as able to promote the service and also capture users' preferences:

“Nowadays, promotions are done through App platforms. That's right, isn't it? They provide feedback and suggestions through the App, right? Everything is on the APP, which offers suggestions and experiences, and you can give feedback.”

John (Universal motor)

“Electric vehicle sharing aims to seize the personal mobility market. It attracts customers by promoting the brand, and then promoting shared vehicles through e-commerce platforms and WeChat public accounts, using traffic to attract customers.”

Jimmy (Baishi EVSS)

Utilising the presence of internet influencers through marketing campaigns such as live streaming events can effectively amplify word-of-mouth marketing, fostering a greater reach and potentially enhancing customer engagement within the target audience:

“They didn't put as much into advertising as you mentioned. At least we didn't see many ads, right? I remember they did quite well on live streaming platforms and such.”

Richard *(LD EVSS)*

Lastly, Lee mentioned that the majority of EVSS companies has internet company ground as transition are based on huge amount of internet data:

“Yes, this is electric vehicle sharing service, because it inherently has a strong connection to the internet.”

Lee (EVCARD Suzhou)

By integrating online marketing strategies with ICT, EVSS providers can create a more comprehensive and effective approach to customer engagement. Combining these marketing lenses enables a more in-depth understanding of customer needs and preferences, ultimately driving better user satisfaction and EVSS adoption.

6.3.2.2 Investigating the role of physical advertising in fostering customer engagement

In EVSS schemes, digital channels such as social media apps, online promotions, and corporate public channels have become increasingly popular for their cost-effective and targeted approaches. However, physical advertising continues to hold its own as a powerful tool to foster customer engagement. This section aims to analyse the role of physical advertising in customer engagement, with a focus on various marketing strategies, tools, activities, and their advantages and disadvantages in comparison to digital marketing methods.

1. Physical displays: Billboards have been a staple of advertising for decades, providing high-impact visibility on roads, motorways, and central business district (CBD) areas (Donthu et al. 1993; Qader et al. 2022). While they can capture the attention of the general public, their high cost and limited direct engagement with customers can pose challenges, however, vehicles themselves can be used as a physical billboard to improve brand recognition:

“Colourful little cars placed at the entrance of shopping malls can easily tell people that they are available for short-term rentals without the need for signing contracts or paying deposits. They can use App registration and credit score, allowing users to drive away any time. This introduces a new concept in the market.”

Jason (EVCARD Shanghai)

2. Regional Promotion: Promotions in shopping malls and CBD areas, businesses can target specific geographical regions and demographics. Despite a limited reach compared to online channels, regional promotions can generate a strong localised impact and help businesses gain a foothold in their target market:

“If the order volume in the vicinity of a particular location is high enough, we might directly engage in on-the-ground promotions, as it is part of regular operations and regional promotion – an offline marketing strategy.”

Mike (LD go)

However, achieving broad coverage may require investment in multiple locations, increasing overall marketing costs.

3. Collaboration with Places of Interest: Partnering with popular tourist spots, cultural centres, or recreational areas can provide businesses with unique opportunities to create mobility needs and offer driving experiences to both B-side and C-side segments. By placing parking and charging outlets for EVSS in these locations, companies can in-

crease convenience and enhance accessibility for potential customers. While this strategy can foster customer engagement, it may also face infrastructure constraints and require considerable investment in physical assets:

"However, in specific areas such as tourist attractions or high-speed railway stations, there are EV (Electric Vehicle) rental points available."

Bob (ShouQi hailing service)

"Alternatively, some parking spaces in tourist attractions or shopping centres allow for spontaneous usage and departure, contributing to a portion of the revenue known as time-based income."

Jason (EVCARD Shanghai)

4. Stickers: Utilizing well-designed stickers on SEVs can serve as a simple mobile advertisement, providing eye-catching visuals although offering limited space for information:

"Vehicle body stickers are essential, right? It's because they help attract more customers and increase visibility."

Jack (Car Inc)

Physical advertising strategies, despite their limitations, still help in fostering customer engagement. By understanding their advantages and disadvantages, businesses can make informed decisions on the most effective marketing mix that includes both digital and physical channels.

6.3.2.3 Evaluating the influence of service customisation (SEV types, pick-up locations and pricing models) on user mobility needs and marketing effectiveness

Service customisation has become an important component for EVSS seeking to differentiate themselves in competitive markets. By tailoring their offerings to meet specific customer needs, companies can enhance its service experience. By understanding the importance of vehicle types, pick-up locations, and pricing models, EVSS providers can improve their offerings and marketing efforts to optimise user mobility needs. The insights gained from this research can help guide EVSS providers in adopting effective service and customisation strategies and drive the future growth of EVSS schemes.

Vehicle Types: A diverse range of vehicle types is important to capture the varying needs and preferences of customers. User satisfaction is influenced by the availability of suitable vehicle options, including electric scooters, compact cars, and luxury electric vehicles. By offering a wide selection of vehicle types, EVSS providers can increase user satisfaction as stated by Lee, Daniel and David:

> *"In recent years, a decrease in the number of charging outlets, which also impacts the compatibility of charging infrastructure and leads to some vehicle models being replaced."*

Lee (EVCARD Suzhou)

> *"The increase in EV charging outlets provides more vehicle types to choose."*

Daniel (Group A: Users)

> *"A negative consideration is the limited range of vehicle types."*

David (Group A: Users)

Pick-up Locations: A convenient pick-up location can have an impact on service experience. By placing pick-up and parking outlets in high-traffic areas such as shopping malls, central business districts, and place of interest, EVSS providers can enhance user satisfaction. Additionally, collaborating with local businesses and tourist attractions to provide convenient parking and charging outlets for EVSS can help better meet mobility needs and offer driving experiences for both B-side and C-side segments as stated by Daniel:

> *"With an increase in EV charging outlets and a broader selection of vehicle models, especially with the high-tech electric vehicles produced by domestic OEMs, I would use EVs more frequently."*

Daniel (Group A: Users)

Pricing Models: Pricing models can greatly influence user satisfaction (e.g., Group A), as customers are more likely to engage with services they perceive as affordable and offering value for money. Implementing flexible and competitive pricing models, such as pay-per-use, membership discounts, and promotional offers, can enhance user satisfaction and contribute to marketing effectiveness. By understanding the market dynamics and customer preferences, businesses can develop pricing strategies that cater to different customer segments, driving user satisfaction and ultimately increasing EVSS adoption:

> *"Extremely convenient, at the time it felt very cheap, cheaper than taking a taxi."*

David (Group A: Users)

6.3.2.4 Fostering sustainable urban mobility: Promotional strategies and normalisation approaches for transforming citizens' travel habits

Fostering sustainable urban mobility necessitates the implementation of promotional strategies and normalisation approaches that can transform citizens' travel habits (Rettie et al. 2012; Rettie et al. 2014). The majority of consumers tend to conform to societal norms and engage in activities that can be deemed conventional. While some individuals may appreciate standing out by using a unique brand or product as highlighted by Go fun, others prefer sticking to a sense of normalcy in their actions.

In this context, EVSS providers use a dual approach (e.g., LD go), utilising both digital and physical promotional methods to promote EVSS among potential customers. The aim is to normalise the adoption of EVSS and encourage its widespread use (e.g., EVCARD Shanghai). Additionally, educating (while Jason uses the term "*domesticated")* and raising customer awareness about transitioning towards sustainable travel habits can be important for fostering a shift in travel behaviour.

> *"It is the consumers who have gradually changed their way of traveling, and they have been somewhat domesticated by the companies, which in turn shape the consumers' travel methods and concepts. In other words, those who have used our product, or those who have experienced our shared car service with a single card, may continue to use it."*

Jason (EVCARD Shanghai)

When introducing new services, such as EVSS, creating a perception of normalcy around their adoption can be important. Although innovative services may initially attract early adopters, reaching the mass market and engaging those hesitant to try new services requires portraying the innovation as a standard practice within the community (Vargo et al. 2020).

In the context of sustainability, challenges may arise when attempting to alter the behaviour of the broader population (Hopwood et al. 2005; Peattie and Crane 2005). While sustainability initiatives often succeed in engaging the interested and enthusiastic individuals, true progress can be achieved when the mass market also embraces change (Peattie and Crane 2005). The objective may not solely focus on motivating the already inclined, but rather on encouraging a shift in behaviour across the entire market.

Promoting EVSS will require establishing a sense of normalcy around such sustainable urban mobility solutions, through policy incentivisation, technology integration, the sharing of (positive) user experiences, and visible infrastructure development. By such means EVSS providers and policymakers can encourage more individuals to adopt EVSS use, even if they were previously unfamiliar or hesitant. By normalizing such innovations, a larger segment of the population can be enticed to adopt sustainable travel habits, contributing to a more sustainable urban environment.

6.3.3 Addressing challenges and barriers in marketing and promotion

This section aims explores the complexities and intricacies of the challenges and barriers faced by both EVSS providers and users in marketing and promotion and uses a vignette example of an EVSS company to better understand the critical factors that contribute to overcoming these obstacles and achieving success.

From the EVSS providers' perspective, several marketing challenges may arise, such as stickers (which is physical sticker to demonstrate SEVs' brand and its service information) on the SEVs, managing functional concerns related to SEVs, and addressing user misbehaviour. Moreover, providers may face difficulties in effectively segmenting and targeting their audience, as well as balancing the investment in online and offline marketing channels.

On the users' side, concerns may include convenience, efficiency, safety, hygiene, sufficient parking outlets and the accessibility of charging infrastructure. Additionally, users may experience apprehensions related to SEVs' performance, reliability, and the overall user experience.

Furthermore, the author will shed light on a company's ability to create and satisfy user experiences, which is instrumental in fostering customer loyalty, positive word-of-mouth, and ultimately, a robust brand reputation.

6.3.4 Exploring solutions to SEVs' functional concerns and user misbehaviour in the context of EVSS marketing and promotion

In the context of marketing and promotion for EVSS, addressing functional concerns related to sharing electric vehicles (SEVs) and user misbehaviour is critical. Functional concerns encompass a wide range of issues, including regular vehicle maintenance, and inspection of SEVs to ensure optimal performance and safety; and developing a robust charging infrastructure with strategically placed charging stations to enhance user convenience and alleviate range anxiety. Collaborating with local governments and stakeholders can facilitate improvements in charging infrastructure and the development of policies that support the growth of EVSS. And Appendix C provides another lens for understanding the EVSS business environment.

User misbehaviour in the context of EVSS can manifest itself in various forms, such as illegal vehicle misuse, vandalism, or non-compliance with usage guidelines. To mitigate user misbehaviour, strategies employed include establishing clear terms of use, penalties for misuse or damage, digital tracking system (with ICT technology) and implementing educational campaigns to promote responsible behaviour. Digital platforms and social media channels can facilitate the dissemination of information on proper SEV usage and foster a culture of accountability among users. Mike mentions the users' misbehaviours in detail:

> *"Some people would maliciously damage our vehicles."*
>
> Mike (LD Go)

> *"In fact, a large part of it is the loss of vehicles. As we just mentioned, losing vehicle components is also a type of behaviour, and it falls into the same category."*
>
> Mike (LD Go)

User misbehaviour can have detrimental consequences for operators and failure to discourage such misconduct is attributable to the inadequacy of the prevailing national or social credit system (Creemers 2018; Kshetri 2020). A thorough analysis of the relationship between user behaviour and the credit system's development may imply insights into potential mitigation strategies for addressing these issues, as mentioned by Jack and Mike:

> *"Many incidents involve renting vehicles for illegal activities."*
>
> Jack (Car Inc)

> *"The overall quality of the customers is not very high. However, I think it cannot be determined solely based on this quality. I think the more critical issue is that our current credit system is not comprehensive enough. I believe this is the most crucial aspect; if it significantly affects their credit."*
>
> Mike (LD Go)

6.3.5 Vignette: A qualitative analysis of successful marketing initiatives within EVSS schemes

The previous sections outline key elements of the customer-centric approach to successful EVSS business models, including the thorough examination of diverse needs and expectations across various user segments.

This section presents interview findings from EVSS providers, online-hailing services, and users integrated with a vignette example of a successful local EVSS service provider, SuPai, to discuss its marketing strategy. SuPai, a local EVSS provider without an OEM background, offers valuable insights into how a small EVSS company can achieve its marketing goals and provides both practical and theoretical implications.

6.3.5.1 SuPai EVSS company background

Established in 2009 by entrepreneur Tom, SuPai is a prominent EVSS provider in Suzhou and Wuxi. The company has approximately 300 individuals and operates a fleet of 500 cars, primarily targeting university students (See appendix A).

In 2017, SUPAI transitioned from a traditional car rental business to EVSS, capitalising on the growing NEV market and improving operational efficiency. The company's profit is generated from various rental plans, including hourly, daily, monthly, and annual plans. However, a timely rental plan aligns better with the shared mobility concept and caters to the basic mobility needs of urban citizens.

6.3.5.2 Qualitative dimensions of SuPai EVSS's marketing strategies enhancing user engagement and loyalty

1. User-orientated approach: SuPai's marketing success is rooted in its ability to cater to the diverse needs of its users, primarily university students. By understanding its target audience's preferences and requirements, SUPAI has been able to deliver a tailored and satisfying user experience.

2. Capability to address customer segmentation: SuPai's marketing strategy includes focusing on individual customers (C-side) and business clients (B-side) by providing mid-range vehicles that achieve a balance between affordability and quality. This segmentation approach enables the company to attract a wider user while maintaining a sustainable and profitable business model.

3. Technological integration: ICT has been a key factor in SUPAI's marketing success. The company invests in search engine optimisation and popular online platforms such as Tiktok and Kuaishou for promotional purposes, generating user interest and driving traffic to their services.

4. Collaboration with partners: SuPai collaborates with various platforms, including 58.com (a tourism online-platform), to access specific customer segments and increase brand awareness.

5. Word-of-mouth promotion: The power of personal networks and social circles to spread awareness of its reputation. To deliver a positive user experience and capture more users, the company encourages customers to share their experiences with friends and family, and attracting new users by providing promotional vouchers.

6. Government policies and city-level planning: It has navigated the challenges and opportunities presented by government policies and city-level planning to its advantage. By staying informed about the shifting landscape, it has been able to adapt its marketing strategy accordingly and maintain its competitive edge in the EVSS market.

In conclusion, SuPai's marketing strategies in the EVSS landscape are underscored by a customer-centric focus, precise customer segmentation, technology integration, strategic alliances, organic promotion through word-of-mouth, and adaptability to governmental policies and urban planning. These elements cohesively contribute to the company's proficiency in engaging users and cultivating loyalty, propelling its success within the competitive EVSS industry. SuPai's achievements can be ascribed to its inventive marketing efforts, accurate customer segmentation, strategic collaborations, and responsiveness to policy and planning influences. As the EVSS market undergoes continual transformation, SuPai's commitment to providing convenient and accessible mobility solutions prepares the company for sustained competitiveness and success.

6.3.6 Addressing the research question B: What is the potential of EVSS to reduce individual car travel and minimise vehicle ownership, and how is this affected by its attributes?

EVSS may have its potential to reduce individual car travel and minimise vehicle ownership due to five attributes:

1. **Environmental sustainability**: EVSS uses electric vehicles, which produce low carbon emissions. Environmental benefit makes them an attractive towards traditional vehicle with internal combustion engines for concerned consumers, especially the growing concerns about climate change.

2. **Cost-effectiveness**: EVSS can be more affordable than owning a private car as users do not need to worry about maintenance, insurance, parking, and fuel (or charging for electric vehicles). This cost-effectiveness can encourage more people to shift from private car ownership to EVSS.

3. **Convenience and accessibility**: By strategically placing parking outlets in high mobility demand areas, EVSS can provide convenient and easy access to mobility, thereby reducing the need for private car trips.

4. **Variety of rental plans**: EVSS typically offer a variety of rental plans (hourly, daily, monthly, etc.) that can meet diverse user mobility needs, making them an alternative to private car trips. Service variety from different EVSS providers does create a risk of confusion among potential users, but ‘user-friendly’ solutions including App use and ‘Scan as you go’ functionality can mitigate these risks by ensuring clarity and ease of adoption.

5. **Technological integration**: The majority of EVSS are integrated with digital platforms that provide real-time information on vehicle availability and charging station locations. It provides an easy access for users to get information.

However, the potential for using EVSS to replace private car trips and reduce car ownership can also be influenced by several factors:

1. **Functional aspects**: Regular vehicle maintenance, safety inspections, and the development of a robust charging technologies are important for the SEV's performance and safety. If these functional concerns are not adequately addressed, it may hinder potential users.

2. **User misbehaviour**: Issues such as vehicle misuse, vandalism, or non-compliance with usage guidelines can also affect the attractiveness of EVSS. Strategies can be in place to mitigate such misbehaviour, including clear terms of use, penalties for misuse, and educational campaigns to promote responsible behaviour.

3. **National/social credit system**: In Chinese context, user behaviour is influenced by the prevailing national/social credit system. A robust and comprehensive credit system can-deter misconduct and promote responsible use of EVSS.

4. **Competing against private vehicle immediacy**: The instant availability and perceived convenience of private vehicles may create a challenge to the adoption of EVSS. Overcoming this requires highlighting the benefits and convenience of EVSS, such as parking issues and maintenance responsibilities.

5. **Negative perceptions regarding shared vehicles:** Traditionally, owning a vehicle is associated with status and high symbolic value, creating a risk that the use of sharing services will be perceived as low status. This can potentially be tackled through marketing campaigns that emphasise the environmental and economic benefits of EVSS and their positioning as a 'smart' solution. Increasing use of sharing services in different aspects of Chinese society in line with government policy should also act to normalise sharing as a practice, and the link between EVSS and technological innovation can create an alternative source of status and symbolic value. A second negative potential perception is of a high perceived per kilometre cost for EVSS use. Transparent communi-

cation regarding the actual costs and savings of EVSS compared to private vehicle ownership can help in altering this perception, as has been the case for Mobility Car-sharing's positioning as a cost-effective solution.

6.4 Symbiosis: Policy and stakeholders' interactions in EVSS

The success of PSS, such as EVSS, depends on the effective alignment of business models with stakeholder needs and preferences, as well as supportive government policies. This section explores the relationship between policy and stakeholders' interaction within EVSS schemes, thereby investigating how sustainable business models can evolve beyond a niche market, from a policy and stakeholder interaction lens.

6.4.1 Government policies and their impacts on EVSS

The growth and integration of shared mobility solutions within the urban transportation landscape are shaped by a multifaceted interplay between policy push and market pull factors. Policy push factors include government initiatives and macro-level policy support, while market pull factors consist of consumer demand, technological advancements, and capital investments. This complex relationship significantly impacts the trajectory of shared mobility services, affecting their development and adoption in various contexts.

Since 2012, the Chinese government has launched the policy promoting the circular economy and encouraging OEMs to produce EVs rather than internal combustion vehicles (Baars et al. 2021). This policy includes financial support and tax reductions for OEMs. Therefore, OEMs have begun to produce an increasing number of EVs, leading to a supply that exceed the demand. This over-production can be attributed to two main factors: consumers' unfamiliarity with new EVs and the EVs' stock by OEMs. The success of shared mobility solutions, such as EVSS, suggests that they can serve as a new market to solve these problems.

This section analyses the integration of government policies within EVSS schemes to explore the various ways these policies contribute to the growth and success of shared mobility services. By examining the specific policy measures and their impacts, it can contribute towards an in-depth understanding how the interplay of policy push and market pull influence the development and adoption of sustainable mobility solutions in the urban context.

6.4.1.1 The interaction between policy push and market pull

Policy push factors include the government's commitment to fostering the circular economy, and “carbon neutrality, carbon peak” which includes promoting low-carbon emissions and the adoption of new energy technologies such as EVs. These macro-level policies, however, may not always be effectively implemented at the city level or for specific products. Therefore, the EVSS in various regions depend on the alignment of national policies with local government actions and support.

Market pulls’ factors, on the other hand, involve the dynamics of supply and demand, consumer preferences, and capital investment. Shared mobility services seek to address the underutilisation of traditional rental cars, create demand, and generate traffic for the industry. The influx of capital investments in early funding rounds enables companies to enter the market, scale their operations, and ultimately drive market demand. Also, the success of PSS products such as sharing-bikes and shared power banks inspire the entrepreneurs to shifting into EVSS schemes. The dynamic interplay between market forces and policy guidance results in the evolution of shared mobility solutions, aligning them with contemporary trends and consumer preferences.

6.4.1.2 Traffic policies: Vehicle license plate restrictions and their implications for EVSS adoption

The national public transportation department's positive attitude towards EVSS reflects a growing recognition of shared cars as an integral part of future green public transportation systems. By prioritizing the development of public transportation and promoting the development of shared cars, authorities aim to create a comprehensive transportation network:

> *“Our public transportation department adopts a tolerant attitude towards shared cars, as we believe that they are an integral part of the future green public transportation system. While prioritizing the development of public transportation, we also aim to promote the scientific development of shared cars and enhance their regulatory oversight. In the future, it is essential to design shared car services to better serve the public, complementing subways, buses, and traditional taxis to address citizens' "last-ten-mile" transportation needs.”*

Cal (Public Transport Department)

However, certain existing traffic policies, such as foreign license plate restrictions and odd-even number plate restrictions, may hinder the widespread adoption of EVSS. For instance, in Shanghai, shared cars use local license plates, which may pose challenges due to the city's license plate restrictions:

> *"In Shanghai, shared cars use local "Hu" license plates, with all vehicles bearing these plates. This inevitably raises issues related to license plate restrictions, which serve as a significant factor. Furthermore, new energy vehicles in Shanghai may not be subject to such restrictions, making it potentially more inconvenient for some non-local plates, such as "Hu C" plates, to operate within the city."*

Tom (SuPai)

> *"I believe that clear policy support, such as subsidies or license plate exemptions, is crucial for the promotion of shared cars. In major cities like Beijing, Shanghai, Guangzhou, and Shenzhen, where obtaining a license plate requires participating in a lottery or auction system, shared cars become especially important as an alternative mobility solution."*

Jason (EVCARD Shanghai)

To facilitate the growth and success of EVSS, policymakers can provide vital support through targeted measures, such as subsidies or license plate exemptions.

6.4.1.3 Financial support, incentives, and funding mechanisms for EVSS providers

Government financial support plays an important role in encouraging firms to produce EVs and fostering the growth of the EVSS industry.

Firstly, the government offers financial support to OEMs to promote the production of EVs, with a penalty system for OEMs that fail to meet EV production targets, thereby reinforcing the shift towards sustainable transportation:

> *"Vehicle manufacturers want subsidies, as well as to promote their vehicles and sell them quickly."*

John (Universal Motor)

"Manufacturers aim to earn national subsidies, and if their vehicles don't sell, they still need to register them. At that time, the subsidies were high, and receiving subsidies was a priority."

John (Universal Motor)

Secondly, to stimulate consumer demand for EVs, the government provides financial incentives for individuals purchasing EVs to make them more affordable and accessible to a wider range of consumers:

"At that time, the electric vehicle sharing service was developed in response to the national electric vehicle subsidy policy."

John (Universal Motor)

By accessing these government support measures, EVSS providers can acquire EVs at lower costs and introduce them into the shared mobility market as SEVs:

"This should refer to the time when new energy vehicles were first introduced, and the subsidies were substantial. When the subsidy programme was well-implemented, the national and local subsidies combined covered the vehicle costs."

Chris (Traffic Police)

Additionally, the government has introduced a mileage credit policy to prevent hyper-production and hyper-consumption, which were problems with previous financial policies. Under this policy, financial support is provided based on actual mileage, with funds only disbursed once the vehicle is in operation on the road:

"In order to achieve carbon neutrality and peak carbon emissions, the government has provided massive subsidies for passenger vehicles, commonly known as "dual credits." Dual credits are a new energy policy in China[1]*."*

Case (EV Association)

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[1] "Dual credits" refer to China's regulatory policy that assigns OEMs both corporate average fuel consumption (CAFC) credits and electric vehicle (EV) credits. Companies gain CAFC credits by producing vehicles that exceed fuel efficiency standards and EV credits by manufacturing approved EVs, such as electric cars.

6.4.1.4 Urban infrastructure development, planning, and integration of EVSS facilities (charging stations, parking spaces, and outlets)

The interviews (e.g., Traffic Police) highlight urban infrastructure development, planning, and integration of EVSS facilities, including parking and charging outlets.

In many cities, parking scarcity poses challenges for the expansion of shared mobility services, confining them to peripheral urban areas or specific locations such as high-speed rail stations and tourist attractions. Consequently, users may experience inconvenience due to insufficiently distributed EVSS facilities. Urban planning departments can address this by adapting and revising future plans to accommodate the emerging shared mobility era. Several measures have not adequately addressed the challenges faced by EVSS in terms of parking space provision:

1. Urban planning and parking outlets (e.g., EVCARD and Traffic Police): In many cities, parking scarcity poses challenges for the expansion of shared mobility services, confining them to peripheral urban areas or specific locations such as high-speed rail stations and tourist attractions. Consequently, users may experience inconvenience due to insufficiently distributed EVSS facilities. Chris noted that the availability of parking spaces in some cities is constrained, as the original urban planning did not account for the development of EVSS. Urban planning departments can address this by adapting and revising future plans to accommodate the emerging shared mobility era.

"For instance, when urban planning does not consider shared vehicles, it raises the question of why larger parking lots are needed for shared cars. Nowadays, many cities face parking space shortages, which has resulted in a bottleneck for the development of shared vehicles. They can only be placed on the outskirts of cities or near high-speed railway stations."

Chris (Traffic Police)

2. Profitability and parking costs (e.g., SuPai): Interviewees mentioned that parking costs significantly impact the profitability of EVSS providers. In larger cities, parking fees can be expensive, while in smaller cities, parking spaces may be scarce, leading to increased operational costs for EVSS companies.

3. Government support and public parking (e.g., Gofun): Governments are offering some support by allocating parking spaces for EVSS providers, but the level of support is limited, and most parking spaces are not free. Providers need to negotiate agreements with property management companies to secure parking spaces, which contributes to their expenses.

4. Convenience and accessibility (e.g., Group B): Interviewees have also raised concerns about the convenience and accessibility of parking spaces for EVSS users. In some popular locations, parking spots can be hard to find, reducing the attractiveness of EVSS for potential users.

5. Public acceptance and parking availability (e.g., Group A): The availability of parking spaces plays an important role in public acceptance of EVSS. Interviewees suggested that if high-quality, convenient parking options were available, more people might opt for EVSS instead of owning a car.

Additionally, Derek emphasised that the availability of sufficient charging outlets and well-designed parking spaces integrated with EVSS is essential for its sustainable development:

"The issue of convenient charging also arises, as the accessibility of charging stations plays a crucial role. Thus, it seems that without an adequate number of charging stations at service points, the development may not be sustainable. "

Derek (Group A Users)

Consequently, Jason noted that petrol stations have been making efforts to install supercharging outlets for electric vehicles, which simultaneously assists EVSS companies in enhancing their management efficiency:

"Oil giants like PetroChina are investing in direct current (DC) charging stations, similar to the prevalence of petrol stations. Now, with the increasing number of charging stations, shared vehicles can be placed at fast-charging stations for about half an hour to recharge. Once recharged, the vehicles can quickly be moved to designated service points. Consequently, the government's support for new energy infrastructure."

Jason (EVCARD Shanghai)

Effective urban planning and policy support are important for the successful implementation and growth of EVSS facilities. Collaboration between businesses and government agencies is vital for optimizing profit and cost structures while ensuring the development of shared mobility services. Subsidy policies are beneficial, and future urban planning and transportation policies can provide assistance in addressing challenges related to parking, charging infrastructure, and legal frameworks.

6.4.1.5 Regulatory frameworks and the role of insurance companies in EVSS

The development and growth of EVSS encompassing charging stations, parking spaces, and outlets, are significantly influenced by regulatory frameworks and the role of insurance companies. In the interview, the interviewees highlight the challenges faced by stakeholders in the Chinese EVSS market due to the evolving legal and regulatory environment, as well as the insurance sector's influence on the sharing of vehicles.

Firstly, it is important to recognise that the regulatory framework for EVSS is still under development. Existing laws and regulations may not be comprehensive, leading to ambiguities and potential legal challenges. For instance, sharing private vehicles for commercial purposes may be considered illegal in certain jurisdictions. Therefore, creating a regulatory environment conducive to the growth of EVSS requires close collaboration between government authorities, transportation departments, and other stakeholders:

> *"For insurance companies, the definition of shared cars as either operational vehicles or private vehicles remains unclear. In the event of insurance claims in the future, disputes may easily arise due to this ambiguity."*

Cal (Public Transport Department)

The role of insurance companies in the EVSS landscape can be important as profit-oriented institutions, insurance companies need to evaluate the risks associated with insuring shared electric vehicles. The interviewees pointed out that insurance companies may be reluctant to provide coverage for shared vehicles due to the associated risks, such as the possibility of the vehicle being used by unauthorised drivers or being involved in accidents, mentioned by Clinton：

"There is also the issue of insurance rates. As Mr. Yu mentioned earlier, there is a distinction between operational vehicles and non-operational vehicles in terms of insurance coverage and rates. From a conceptual standpoint, shared cars are considered operational vehicles, not private vehicles, right? So their insurance rates should be higher. However, many shared cars currently purchase non-operational vehicle insurance, which makes it difficult for insurance companies to handle the delicate relationship between the two."

Clinton (NEV Association)

In addition, insurance companies may impose strict conditions for coverage, further complicating the process of insuring shared electric vehicles and ensuring EVSS customers are adequately protected:

"In many cases, customer A might lend the car to customer B for returning or driving. This could potentially lead to certain behaviours that result in the insurance company refusing to process the claim. These situations could pose significant challenges for us."

Mike (LD go)

Moreover, the interviewees noted that the cooperation between automakers, insurance companies, and EVSS operators is essential for achieving cost reduction and increased efficiency. This requires a more integrated approach towards SEVs that is driven by the national government, with integration across various elements of the EVSS ecosystem:

"Because sharing should be integrated with urban mobility system, and it should be led at the national level. Also, the government should implement all the relevant resource and stakeholders such as insurance company to support this business."

John (Universal Motor)

6.4.1.6 Collaboration with regulation and public transportation departments

In this context, cross-departmental collaboration between regulation department and public transportation departments is important for tackling various aspects of EVSS implementation and ensuring its successful integration within the urban mobility infrastructure. The interview findings provide insight perspectives on specific concerns and expectations related to EVSS in urban mobility system.

During the EVSS transition period, a potential challenge lies in balancing the increasing number of traditional fuel-powered vehicles and EVSS. As highlighted in the interview, this issue will create contradictions throughout the transition phase. Law enforcement agencies, public transportation departments, and urban planning authorities need to collaborate to develop and implement policies that effectively regulate the expansion of EVSS while minimizing potential negative effects on traffic congestion and pollution levels, as stated by Cal:

> *"EVSS have made it more convenient for urban citizens to travel, and in the future, they will also help to solve urban traffic congestion issues."*

Cal (Public Transport Department)

Another factor of EVSS involves the availability and management of parking outlets. The interviewees emphasise the importance of addressing parking and charging issues for SEVs. Therefore, the 'convenience' of EVSS is an important factor in promoting its widespread adoption (Shove 2012). The interviewees also indicate that as EVSS schemes become more convenient for the public, they will achieve higher acceptance. While the findings suggest that the regulation and public transportation departments should take the responsibility of creating a user-centric environment (Verganti 2008), For example, addressing concerns in terms of accessibility of charging and parking outlets as well as insurance barriers for SEVs.

6.4.2 Bridging the gap for stakeholders' collaborations

This section explores the role of associations and other stakeholders with an interest in EVSS schemes. These associations include NEV and EV business association which may provide an alliance for EVSS providers in between local governments, and other relevant stakeholders, such as charging facility providers, and electricity providers. The collaborations seek to create a positive environment for the EVSS ecosystem, facilitating an efficient operations and access to get resources and support.

6.4.2.1 The role of the NEV and EV business association in supporting EVSSs' development

The NEV and EVSS business association also play as a link between the government and EVSS providers in terms of exchanging information, resources, and support among relevant stakeholders. As a communication bridge, the association allows EVSS providers to raise their concerns and needs, to make sure that the government understands the business's realities as well as potential barriers. This dialogue promotes a well-informed decision-making process, which is important for the implementation of policies (e.g., EV Association)

In addition, the NEV and EVSS business association also provide the government evidence-based recommendations because the association seeks to ensure that policymakers make informed decisions that meet the specific needs of EVSS schemes. This information-driven approach to decision-making is important for creating a favourable environment, as stated by Case:

> *"We always support, guide, and advise the government in promoting SEVs, and provide recommendations and data basis for government decision-making in this regard. This allows the government to make better decisions to serve the EVSS businesses."*
>
> *Case (EV Association)*

The association also promotes interdepartmental collaboration and policy coordination, highlighting the importance of aligning local policies with central policies in supporting EVSS schemes. Through these collaborative efforts, the association ensures that the government creates comprehensive and cohesive policies that address the various aspects of the EVSS ecosystem, contributing towards the broader goals of energy conservation and emission reduction, as state by Clinton:

> *"In fact, I still have a certain degree of optimism about it, as it has not yet truly entered the market in some aspects. We can only raise this issue in appropriate occasions and with the appropriate departmental leaders, such as the National Development and Reform Commission and our Transportation Bureau, who sometimes hold discussions with us. At the right time, we will mention our views on this, but local policies also depend on central policies. We are supportive and want to see what measures the government will take in this area to enable the industry to develop, as after all, people are buying fewer cars, right? Energy conservation and emission reduction is a future development trend."*

Clinton (NEV Association)

Moreover, by facilitating open channels of communication and fostering partnerships between the government, EVSS providers, and other stakeholders, the NEV and EVSS Business Association seeks to create a unified vision for the future of the industry. This shared vision is perceived as important for promoting long-term viability, sustainability, and success in the SEV.

6.4.2.2 Collaboration with place of interest and high mobility demand areas

The cooperation between shared vehicle platforms and places of interest, as well as high mobility demand areas, has been an integral aspect of their development. Early involvement in the industry has enabled certain shared vehicle platforms to establish exclusive partnerships with popular tourist destinations, thus providing a unique advantage over competitors.

Jimmy (Baishi EVSS) stated that customers choose their shared vehicle platform due to the availability of parking spaces in specific locations, particularly at popular tourist attractions. Since their involvement in the industry began in 2015, they have managed to build relationships with these attractions, which have not partnered with other shared vehicle platforms.

> *"These scenic areas only cooperate with us and not with other car-sharing platforms. This is because I got involved quite early, starting to work with scenic areas in 2015, and when I entered the industry in 2017, I was mainly involved with these areas."*

Jimmy (Baishi EVSS)

In cities such as Suzhou and Hangzhou, many shared vehicle parking spots are located at tourist attractions, shopping malls, and transportation hubs, such as subway stations. In this way, the shared vehicle platform has strategically positioned itself in areas with high mobility demand, making it more accessible to potential users.

The use of QR codes for shared vehicles in large tourist attractions in Suzhou and Hangzhou further streamlines the process for users, making it more convenient for them to access shared vehicles during their visits to these areas. By scattering the shared vehicle stations throughout various commercial complexes, tourist attractions, and transportation hubs, the platform effectively caters to the diverse mobility needs of its users.

Through these strategic collaborations with places of interest and high mobility demand areas, shared vehicle platforms can leverage the exclusive nature of their partnerships to attract and retain customers while fostering sustainable development in the industry.

6.4.2.3 Collaboration with electricity providers and charging facility platforms

Collaboration with the electricity providers and charging facility companies is an important aspect of the shared electric vehicle industry. These partnerships can help overcome the challenges of charging infrastructure, drive down costs, and provide attractive incentives for users.

One factor contributing to the reduction of electricity costs is the outlet charging providers which have lowered costs, in some cases by more than half (Charging station companies provide subsidies to electric vehicles in order to gain market share). This reduction in cost can make SEVs a more affordable and attractive option for users (e.g., SuPai).

Additionally, John mentioned that platform operators and charging facility companies also provide substantial subsidies to attract users and increase market share. This competition-driven pricing strategy can lead to significantly reduced charging costs for users, making the adoption of shared electric vehicles more appealing.

> *"Because of the competition among platform apps for user traffic, they are offering a large amount of subsidies. Within this context, there might be other companies aiming to monopolise the market."*

John (Universal Motor)

Some companies may even engage in price undercutting strategies, such as offering charging services at an extremely low cost, to gain market share and drive out others. Although this strategy can be beneficial for users in the short term, it may impact the long-term health and sustainability of the industry.

The development of charging infrastructure for EVs can be influenced by policy initiatives rather than market forces. This is due to the fact that the infrastructure and electricity provision originate from state-owned enterprises or entities with government involvement. Policy directives play a more important role in shaping the growth and direction of charging infrastructure compared to purely business-driven factors.

6.4.3 Involvement of additional stakeholders in EVSS ecosystem

Effective collaboration with additional stakeholders such as innovative technology companies, urban planners, transportation experts, and environmental organisations can enhance the sustainability of electric vehicle sharing systems.

6.4.3.1 The role of repair garages in maintaining EVSS fleet operations

The efficacy and dependability of EVSS fleets are contingent upon meticulous maintenance and repair. Consequently, the role of repair garages can be examined from three distinct dimensions: in-house repair services, collaboration with external repair garages, and utilisation of SEVs as substitute vehicles.

1. Efficacy of in-house repair services:

Operating in-house repair services affords EVSS providers greater autonomy over the maintenance process, ensuring that the fleet adheres to their precise standards. This approach can lead to heightened efficiency and diminished downtime, as there is a comprehensive understanding of the operational requirements and the capacity to address issues more expeditiously. Furthermore, in-house repair services can circumvent the risk of theft or unauthorised component replacement, resulting in overall cost savings.

2. Misconduct by collaborating repair garages:

When partnering with external repair garages, EVSS providers may encounter challenges in cultivating a productive working relationship. Misconduct, such as deliberate damage to vehicles or theft of components, can transpire, potentially compromising the fleet's performance and escalating costs. To manage these risks, EVSS providers can exercise diligence in selecting and monitoring their partners, and establish unambiguous guidelines and agreements to ensure compliance with their standards and expectations.

3. Cooperation with repair garages for substitute SEVs:

An additional facet of the relationship between EVSS providers and repair garages is the potential utilisation of SEVs as replacement vehicles for customers whose cars are undergoing repairs. By offering this service, EVSS providers can enhance customer satisfaction during the repair process and further promote the adoption of shared electric vehicles. However, the implementation of this practice can be arduous due to the supplementary costs and potential reluctance of repair garages to assume the responsibility of providing rental vehicles. Fostering a mutually advantageous partnership and a transparent understanding of roles and responsibilities can help surmount these challenges and enable a fruitful collaboration.

6.4.3.2 Collaboration with innovative technology companies

The collaboration with innovative technology companies in the development of autonomous vehicles and EVSS demonstrates the potential for significant transformations in the transportation sector. These collaborations involve a diverse range of stakeholders, including OEM, ICT, self-driving technology and 5G technology, each contributing unique expertise.

Technological advancements in areas such as 5G connectivity and battery technology play a key role in the success of autonomous driving and EVSS. For instance, 5G connectivity enables real-time communication and data processing, enhancing the reliability and safety of autonomous vehicles. AI contributes to the development of advanced driver assistance systems (ADAS), which are essential for autonomous driving, while battery technology improvements facilitate increased range and efficiency in EVs:

> *"One opportunity is when the 5G network is fully promoted and all vehicles become autonomous, this can be realised because our current model is people looking for cars. However, once autonomous driving is achieved, cars will look for people instead. Customers only need to request a vehicle, as vehicles are centrally located or placed at designated stations. The vehicle will come directly, and we can send clean vehicles to customers through the system."*

Jack (Car Inc)

Collaborations with technology companies also lead to the development of sophisticated platforms for managing EVSS. These platforms enable efficient fleet management, smart charging, and user experiences, further promoting the adoption of SEVs. Moreover, these partnerships can foster innovation by facilitating the exchange of knowledge, resources, and technology. This collaborative approach accelerates the pace of development and enhances the potential for breakthroughs in autonomous driving and EVSS, ultimately transforming the transportation landscape.

6.4.3.3 Collaboration with urban planners, transportation experts, and environmental organisations to enhance EVSS sustainability

To achieve greater sustainability for EVSS schemes, it is essential to engage in collaborative efforts with urban planners, transportation experts, and environmental organisations. This cooperation can ensure that EVSS are developed and implemented in a way that maximises their potential for reducing emissions, easing traffic congestion, and improving the overall quality of urban life.

Urban planners play a critical role in designing cities and transportation infrastructure that support the widespread adoption of EVSS. This may involve creating designated parking zones for shared electric vehicles, incorporating charging infrastructure into public spaces, and integrating EVSS into existing public transportation networks. Additionally, urban planners can work to develop land-use policies and zoning regulations that encourage the use of EVSS by promoting compact, mixed-use developments:

> *"Shared cars are an integral part of urban public transportation and require a certain level of regulation. Similar to the supervision by transportation departments over vehicle violations, road safety, and proper usage by users, urban planning departments also play a crucial role in determining the locations of parking lots for shared vehicles. Nowadays, many cities have designated locations for shared bicycles. Shared car distribution should likewise be integrated into urban development plans, as this falls under the category of urban public transportation infrastructure."*

Cal (Public Transport Department)

Additionally, with the development of EVSS, autonomous driving technologies, emerging new business models, and other innovative ICT government are being prompted to reconsider existing plans and to launch new policies:

> *"This will then force us to change our thinking, which in turn will drive the planning of our roads, including the planning of some parking lots, as well as the follow-up of our management policies."*

Charles (Deputy Mayor)

Transportation experts can contribute valuable insights into the most effective strategies for integrating EVSS into existing transportation systems. They can help EVSS providers to design incentive programs and pricing structures that encourage the use of EVSS, as well as develop innovative solutions for managing EV fleets and optimizing their utilisation. Transportation experts can also analyse data generated by EVSS to identify patterns and trends, leading to more informed decision-making and continuous improvements in the system. By collaborating with local government department can not only benefit local mobility systems and city development but also benefit the development of EVSS:

> *"Then, the city of Shanghai was specifically opened for us, although we initially hadn't entered that city. Under the guidance of the local traffic bureau, a dedicated area was designated near Shanghai's high-speed train station for attracting investment. The primary goal was to attract more people to visit Jiangxi for tourism, so a special location was opened just for us."*

Jack (Car Inc)

Collaboration with environmental organisations is important for ensuring that the environmental benefits of EVSS are maximised. These organisations can provide guidance on useful practices for reducing emissions, minimising waste, and conserving resources in the operation and maintenance of EV fleets. They can also help to evaluate the environmental impact of EVSS by providing valuable feedback for development.

Furthermore, interview data from government department also reflected positive attitudes towards the impact of EVSS on traffic and the environment:

> *"Right now, we're just at the beginning of seeing EVSS and other new mobility options making their way into our streets and environment. Sure, they haven't magically fixed the congestion problems and reduced environment impact overnight, but that's to be expected – it's still early days. What I'm thinking is, give it some time. With the right kind of planning and policies in place, these sustainable transport options, like EVSS, combined with the upcoming autonomous vehicle tech, they could really change the game. But let's be real, it's not going to be all smooth sailing. We've got to think about potential issues, like, more cars on the road without passengers, just driving around waiting for pick-ups. That could actually make the traffic situation worse if we're not careful. So, yeah, I'm hopeful, but also keeping my eyes open to the challenges we might face."*

Chris (Traffic Police)

6.4.4 Vignette: (In Shanghai city) EVCARD's success through strategic collaboration with government policies

EVCARD (Shanghai) belongs to local OEM called SAIC Motor group, which focuses on the research, development, production, and sales of complete vehicles, including passenger and commercial vehicles (See appendix A). The company is actively promoting NEVs with ongoing research into intelligent driving technologies. In addition, SAIC Motor Group is involved in various related sectors, such as automotive components, logistics, e-commerce, mobility services, finance, insurance, investments, overseas operations, international trade, and advancements in big data and artificial intelligence.

Findings shows that EVCARD's success and expansion partly belongs to its strategic alignment with government policies, active involvement of the government in fostering partnerships, and the support from local communities. This example highlights the importance of understanding and responding to government policies and market conditions, as well as the important role governments and communities can play in pushing the growth of innovative companies in competitive businesses environments.

1. Government-driven Support

The Shanghai government played an important role in EVCARD's development by fostering strategic partnerships with major companies like China Mobile and Shanghai International Automobile City. These government-driven collaborations aimed to integrate advanced technologies, such as 5G and autonomous driving technology, into EVCARD's services. By involving these stakeholders, the Shanghai government demonstrated its commitment towards developing innovation and supporting the growth of EVSS schemes.

2. Expansion Supported by Government and Stakeholders

EVCARD's successful pilot case was placed at the Fudan University campus in Shanghai through the support of the local government. After achieving initial success, the government suggested using this as a foundation for the company's expansion throughout the city. After that, EVCARD's growth to over sixty cities can be attributed to its ability to adapt its business model to different market conditions, facilitated by the strategic support provided by the government and other relevant stakeholders.

3. Support from local community

EVCARD's success in Shanghai also gets support from local communities. The grassroots community organisations played an important role in promoting the adoption and utilisation of EVCARD services. This top-down approach, in which government's support and direction are integrated with local communities, can improve its acceptance within the city.

4. Government's role in encouraging autonomous driving adoption

EVCARD adoption of emerging technologies, such as autonomous driving, was supported by the government's interest in fostering future innovative technologies. By investing in self-driving technology, EVCARD aimed to reduce future labour costs (such as operational fees) and enhance the user experience.

5. Addressing urban mobility challenges through government support

The government's role in supporting EVCARD's efforts to address urban mobility challenges, such as high parking fees and limited parking spaces, can be another evident in the company's success. By providing fixed parking spaces for EVCARD vehicles, the government helped to solve these issues for users, making the service more attractive and convenient. Additionally, the use of local Shanghai license plates (which can avoid being restricted access to central areas) on EVCARD vehicles ensured that users did not face restrictions or penalties when driving within the city.

6.5 Addressing research question E: What factors affect eMaaS (taking EVSS as an example) businesses and in what ways?

Six potential factors may play an important role in shaping the development and success of eMaaS businesses. They highlight the importance of collaborations across different sectors, involvement of diverse stakeholders, strategic location choices, and the important role of government and associations in the industry's growth and success.

1. **Role of associations**: Associations such as the New Energy Vehicle (NEV) and EV Business Association play an important role in bridging the gap between government and EVSS providers. They ensure an exchange of information, resource sharing, and sup-

port that helps address industry challenges and opportunities. The presence of such organisations promotes well-informed policymaking and decisions conducive to EVSS development.

2. **Strategic collaborations with high mobility areas**: Partnerships with high mobility demand areas and tourist destinations offer a competitive edge to shared vehicle platforms. Strategic placement of SEV stations in these areas increases their accessibility, which can drive customer attraction and retention.

3. **Collaboration with electricity providers and charging facility platforms**: Cooperation with electricity providers and charging facility companies helps to tackle charging infrastructure challenges. This approach also aids in reducing costs and providing incentives for users through subsidies and competition-driven pricing strategies. Such collaborations make shared electric vehicles more affordable and attractive to potential users.

4. **Involvement of additional stakeholders**: The EVSS ecosystem benefits from the involvement of diverse stakeholders such as technology companies, urban planners, transportation experts, and environmental organisations. These collaborations drive advancements in autonomous driving technology, sophisticated management platform development, and the integration of EVSS into urban infrastructure, thereby possibly enhancing the sustainability of EVSS.

5. **Role of repair garages**: In-house repair services ensure precise standards of fleet maintenance, reducing downtime and costs. Collaborations with external repair garages need careful selection and monitoring to prevent misconduct. Offering shared electric vehicles as substitute vehicles during repairs can improve customer satisfaction and promote EVSS adoption.

6. **Strategic collaboration with government policies**: A case in point is EVCARD's success in Shanghai, which can be attributed to strategic partnerships with major companies, local government support, and collaboration with local communities. Government's role in fostering innovation, addressing urban mobility challenges, and encouraging autonomous driving adoption plays a key role in eMaaS businesses' expansion and acceptance.

6.6 Chapter Summary

This chapter examines business models within EVSS schemes by employing the McKinsey 7S framework and empirical research methodologies (Vignette) to discuss the current state of these models, while also tracing their evolution over time. “Marketing”, as a functional role within EVSS schemes, is analysed, illuminating its influence on the uptake and perception of EVSS. Moreover, the chapter acknowledges the importance of stakeholder integration within the EVSS business’s ecosystem, highlighting its impact on these business models. The next chapter intends to explore the future of EVSS in the context of urban mobility.

Chapter 7. Implication orientated findings

7.1 Chapter introduction

The previous chapter analysed EVSS in the YEDZ through a business model-oriented approach, delving into the intricacies of the evolving business model, sophisticated marketing strategies, user synergy, and complex stakeholders' interactions. This chapter considers the implications of the EVSS framework, by examining the integration of sustainability across three critical dimensions: mobility, society, and the environment. Subsequently, a vision for the future of smart urban mobility will be presented, taking into consideration the potential impact of these interconnected dimensions on the overall mobility paradigm.

7.2 Tri-factor synergistic nexus: Impact on mobility, society and environment

7.2.1 Tri-factor synergistic nexus: Impact on mobility

The emergence of EVSS has impacted urban mobility in multiple ways (as set out in **Table 7.1**) including changes to the mobility options for individuals, the competitive situation amongst mobility providers, and physical aspects of the city linked to mobility (from congestion to infrastructure).

Table 7.1 Tri-factor synergistic nexus: Impact on mobility.

Aspect: Mobility paradigm	**Transition towards sustainable mobility**	**Sources**
Mobility option	Diversified modes of transportation; mobility equity; Convenient and accessible SMS	(e.g., Public transport department)
Supplement of public mobility system	Enhances public transportation infrastructure by filling service gaps, offering last-ten-mile connectivity, and serving low-demand areas cost-effectively.	(e.g., Charles)
EVSS forces the government to recon-sider urban infrastructure planning	Reduces necessary infrastructure by promoting sustainable solutions.	(e.g., Public transport department)
Car ownership	Reduce car ownership by providing access to transportation without the costs and responsibilities of owning a car. This can result in reduced traffic congestion and improved air quality.	(e.g., Traffic and roads department and Traffic police)
Replace traditional taxi	Transition towards EVSS type of "timely travel" mobility tool.	(e.g., Public transport department)
Combine with current hailing-service	Integrate existing travel resources and optimise them into shared mobility.	(e.g., Public transport department and DIDI)
Implication of non-driver mobility	Non-driver mobility solutions, create mobility and social fairness.	(e.g., Jidu automotive)
Fulfil mobility needs: multiple options	Multiple mobility options to meet the diverse needs of urban citizens, including short-distance travel, commuting, and leisure activities. This can enhance the overall mobility experience and improve quality of life in urban areas.	(e.g., Traffic and roads department)
Change urban citizens' mobility style	Providing new and innovative solution that is both sustainable and convenient to reduced environmental impacts, and improved urban planning.	(e.g., Public transport department and EVCARD)
Parking system	Intelligent parking system	(e.g., Jidu automotive)

One of the benefits of EVSS is that they meet the needs of diverse travel, thereby providing urban residents with an additional transportation option. Public mobility systems such as buses and trains do not always offer direct routes to desired destinations, and this is where EVSS come in handy. EVSS can access areas that are not accessible to buses and trains, giving users more flexibility in their mobility choices. EVSS offers the same advantages of private car ownership and taxi/ride hail services of flexibility in time and space compared to bus and train services with their fixed networks and timetables (e.g., EVCARD). EVSS can then offer specific time and place advantages over taxis (wider time/multi-point journey options) and private car ownership (parking options) as highlighted by Daniel below. This is particularly advantageous in urban areas where traffic congestion and limited parking options are prevalent, as users can avoid traffic and park at designated charging points.

"If parking becomes troublesome as well as drink and drive is forbidden, like if I have to go somewhere today and plan to drink tonight, then I would use a SEV to go there and leave the SEV at the destination."

Daniel (Group A: Users)

Although EVSS has been considered a new competitor to taxis and ride hailing services as highlighted by Bennett: *"Ride-hailing services, taxis, and shared cars will become one product, integrating into a major category of diversified urban travel tools."* The findings suggest integration as the next development:

The EVSS also reshapes relevant governmental department urban infrastructure priorities (e.g., Deputy mayor: Charles), partially reducing the need for investment in motorways, bridges, petrol stations and parking facilities, and by reducing the number of cars on the road, EVSS can lower infrastructure maintenance costs (**Table 7.1**). This could free funds for more investment in EV charging and smarter systems:

"Future cities will cater to the evolution and transformation of intelligent transportation. For example, smart parking lots can save time compared to traditional parking methods, such as searching for parking spaces and leaving the parking lot."

Brian *(Che Xiaodong hailing service)*

Another benefit of EVSS can be the reduction in car ownership. According to respondents like Dylan (Group A: Users), owning a car in urban areas can be expensive, with high costs associated with parking (at the average of 25 CNY/3 £ per hour), insurance (4,500 CNY/500 £ annually), and maintenance (2,000 CNY/250 £ annually). With EVSS, individuals can have access to electric vehicles on an as-needed basis, which can be much more cost-effective than car ownership (with 25 CNY/3 £ per trip, e.g., EVCARD). This is especially true for individuals who only require transportation occasionally, such as those who live in cities with good public transport links but occasionally need a car for a longer trip.

Respondents like Bennett (Baishi Shunxin) foresaw the potential replacement of traditional taxis by EVSS and merger with current ride hailing services: *"Ride-hailing vehicles with drivers will be replaced or merged with EVs."*, which has implications for autonomous technology. People who may not be able to drive or have access to a vehicle, making it difficult for them to get around. By using EVSS, customers can book EVs through a mobile app, providing an accessible mobility option for individuals who cannot drive or do not have access to a vehicle.

Respondents like Jason (EVCARD, Shanghai) and Mike (LD go) stated that:

> *"As an OEM-orientated company in EVSS schemes, our mandate extends beyond merely providing shared services. We embrace the responsibility of influencing the urban mobility system and nurturing eco-conscious mobility behaviours among urban citizens."*

This implies that EVSS companies view themselves, not just as individual companies providing a specific mobility service, but as part of an evolving and disruptive mobility system that is offering more and more sustainable options and more innovation while reducing the number of cars on the road.

These benefits have implications for automated mobility service (See section 6.2.2.4), potentially reconfiguring on mobility infrastructure, and providing a more sustainable urban environment. As such, EVSS has the potential to revolutionise urban mobility and improve transportation options for urban residents (Nazari et al. 2018).

7.2.2 Tri-factor synergistic nexus: Impact on society

The emergence of EVSS is potentially transformative in relation to societal norms and values concerning transportation and car ownership. As the awareness of the environmental impact of private car use grows, attitudes towards car ownership could evolve, improving individuals' willingness to adopt sharing-EV services. The successful implementation of EVSS can foster greater social equity by offering affordable and accessible mobility options to a wider demographic. **Table 7.2** shows the overview of social dimension that can be potentially impacted by emergence of EVSS.

Although EVSS are usually considered in relation to the environmental quality side of the sustainability agenda, this could make a contribution in terms of social justice in making mobility more accessible and affordable to a wider range of people. This perhaps extends further if autonomous vehicles will be involved which could extend the benefits of EVSS (such as cost effectiveness, flexibility, and a degree of convenience to those unable to drive due to impairment issues etc).

Furthermore, a question about children's safety is posed by such developments. Currently children are only able to traverse cities (beyond cycling distances) via public transport or a taxi, where adults control the means of transport. Issues may be raised by allowing children to roam free in a city via an autonomous EVSS as long as they can afford it, which future business practices and research will need to address.

Table 7.2 Tri-factor synergistic nexus: Impact on society.

Social Dimension	Impact of EVSS	Sources
Improve social benefits	Offering affordable and accessible transportation options, promoting social equity.	(e.g., Auto travel)
Raise citizens' environmental awareness	Driving demand for clean transportation technologies, fostering a greener mindset among the population.	(e.g., EVCARD and EV association)
Provide a green, convenient, and efficient mobility environment	Contributing to a cleaner and environmentally friendly transportation ecosystem, promoting sustainable urban development.	(e.g., ShouQi hailing service)
CSR: Reduce criminal activities, illegal driving, and accidents	Implementing advanced technologies for real-time monitoring, GPS tracking, and driver identification systems to enforce safety regulations and responsible driving behaviours.	(e.g., EVCARD and Traffic police)
Foster citizens' sustainable mobility behaviours	Encouraging the adoption of eco-friendly transportation alternatives, reducing the collective impact on the environment and urban infrastructure.	(e.g., Charles and Public transport department)

Although EVSS can be better understood through a business model lens or a transitions theory perspective - there is more to them than a product and consumption system to fulfil mobility needs. The assumption of private car ownership and use as central to peoples' reality of, or aspirations about, personal mobility, has shaped not just people's values and lifestyles but also the structural fabric and design of cities and their infrastructure and peoples' homes.

EVSS has begun to have a transformative effect through the combination of a 'hard' technology (EV) and an innovative service business model (EVSS). Add to this an innovative 'soft/information' technology (autonomous driving), and the pace of this transformative impact could potentially accelerate, further reshaping our understanding and expectations of personal mobility.

The expansion of EVSS schemes and their parking and supercharging infrastructure can contribute to reductions in car ownership and a more convenient and efficient mobility and traffic environment that changes citizens' lifestyles and experience of a city. EVSS marketing and use also has the potential to shift societal values if they can promote long-term pro-sustainability mobility attitudes, and the promotion of climate change mitigation and carbon-neutral goals.

Although the technologies and business models of EVSS will contribute to more environmentally sustainable mobility, there are still societal risks posed by driver behaviours including illegal driving and accidents. This poses a corporate social responsibility challenge for EVSS providers to promote responsible, as well as more sustainable, mobility behaviours amongst citizens.

7.2.3 Tri-factor synergistic nexus: Impact on environment

In terms of environmental sustainability, numerous respondents, such as the Traffic police, confirmed Liao and Corrreia's (2022) view that the widespread adoption of SEVs can decrease reliance on private car ownership, reducing traffic congestion and the associated negative impacts such as air pollution.

Furthermore, the integration of EVSS into the urban transportation landscape encourages a shift in public perception towards environmentally conscious travel choices (e.g., EVCARD).

Additionally, EVSS schemes may support efficient use of resources, as SEVs can be utilised by multiple users throughout the day. This increased efficiency may reduce the overall demand for vehicle production, further decreasing the carbon footprint associated with manufacturing processes as highlighted by T3 mobility.

EVSS use can replace conventional vehicle-based journeys and avoid the 'passenger free' miles involved in delivering taxi or ride hailing services. This can help to reduce carbon emissions and urban air pollution from urban mobility. The resulting replacement of private car ownership (of both conventional and EVs) will require fewer vehicles, reducing the CO2 and other environmental impacts linked to production. This will also potentially improve the visual quality of urban environments requiring fewer resources dedicated to things like parking spaces. There may also be spill-over environmental benefits if the use and marketing of EVSS raises consumers' awareness of sustainability issues and prompts other lifestyle and consumption changes (Whitmarsh and O'Neill 2010).

7.3 Entwined realities: Future EVSS and urban mobility paradigm

As EVSS continue to evolve in response to advancements in autonomous driving technologies, 5G connectivity (e.g., Jidu automotive), and the development of various travel modes, they are poised to play an important role in shaping the future of urban transportation. Policymakers and other stakeholders may consider the complex interplay of policy push and market pull dynamics when devising strategies to respond to EVSS schemes, ensuring that these services are integrated into future urban planning and transportation development initiatives. In doing so, they can facilitate the transformation of transportation systems, moving towards more sustainable, efficient, and accessible mobility solutions for urban citizens.

Although the obvious impact of EVSS is on journeys themselves, their integration with information technologies can allow a reorganised and more efficient relationship between vehicle locations, parking and key points of likely demand:

> *"By tracking the vehicle's location through its movements, we can identify areas with a high concentration of parked vehicles. For example, if a large number of vehicles are parked in a particular location, we will redistribute them to other areas such as airports, high-speed railway stations, and schools to ensure a more balanced distribution."*
>
> Tom (SuPai)

This would enable EVSS to complement existing long-distance travel options, resolving citizens' "last-ten-mile" mobility needs.

In the transitional phase EVs (both for private ownership and EVSS use) will act to increase the stock of (mostly conventionally powered) vehicles in a city before EVSS has the opportunity to fulfil its potential of reducing traffic congestion and associated environmental problems. To fulfil that potential the disincentives of buying a non-EV may need to be increased (via costs or access restrictions) which may be easier to implement within China than in countries and cities with more openly democratic systems. The Public transport department highlighted the government's role in improving convenience for the public, such as by setting up super-charging stations, dedicated parking outlets, and providing convenient access to SEVs. As the public's awareness and acceptance of new energy vehicles increases, so will their usage and popularity, potentially altering urban mobility system (Schlüter and Weyer 2019).

7.3.1 The transformative potential of autonomous driving technologies

Autonomous driving technologies have the potential to reduce reliance on traditional transportation modes and revolutionise urban mobility. With advancements reaching Level 4 autonomy[1] and efforts towards Level 5[2], these technologies will disrupt traditional urban planning and necessitate infrastructural adaptations as highlighted by Jidu automotives (See section 6.2.3.1). Integrating autonomous driving with eMaaS may also contribute to business models evolution, such as autonomous EVSS, further altering urban mobility paradigm. As technology advances, innovative (and previously fantastical) solutions like intra and intercity flying cars will emerge and require advanced urban planning and infrastructure support. In summary, autonomous driving technologies have far-reaching implications for urban mobility, EVSS, and urban infrastructure, necessitating adaptation by cities and urban planners to accommodate these transformative changes.

Emerging from the interviews was the central role in these developments of Baidu, a Chinese multinational technology company, that has been focusing on the integration of autonomous driving technology with EVs. This includes enhancing the company's Baidu Maps product, which has been adapted for use in new energy vehicles. This adds value to the driving experience, providing real-time navigation and location-based services, thereby fostering more seam-

[1] **Level 4:** The car drives itself in specific areas or conditions without driver input.

[2] **Level 5:** Full automation. The car drives itself everywhere under all conditions.

less urban mobility. As cities transform their infrastructure to accommodate smart transportation, Baidu Maps' integration will play an important role in enhancing the capabilities of EVs and contribute to the development of efficient urban transport systems.

This is also being supported with new hardware development:

> *"Our Baidu company is also manufacturing the "Kunlun Chip" (Shanghai) and "Honghu Chip" to address the autonomous development of ECU (Electronic Control Unit) for achieving self-driving capabilities."*

Bill (Baidu, Jidu automotive)

These chips are allowing Baidu to develop ECUs with Level4 autonomous driving capabilities by overcoming the challenges related to existing self-developed[1] ECUs. The confluence of these new ECUs with emerging automotive technologies (such as sixth-generation vehicles) aligns with the broader trends in the automotive industry towards automation and connectivity.

Baidu Maps navigation and the "Xiao Du Xiao Du" interaction system (a similar AI voice system to "Siri") will create vehicles with advanced features that facilitate unmanned commercial operations, such as autonomous EVSS. This will both disrupt traditional urban planning and transportation infrastructure, and hand a central role to a company rooted in the internet economy in shaping intelligent transport systems and future urban mobility.

7.3.2 Future EVSS in eMaaS context

> *"In the future, EVs will play a crucial role in urban transportation and long-distance travel, as they can not only meet individual travel needs but also partially replace traditional transportation methods such as taxis, buses, and rental cars. As a car manufacturer with expertise in human-machine interaction technology and ride-hailing services, I believe EVs will become a single category that combines our own products and ride-hailing services."*

Bill (Baidu, Jidu automotive)

[1] Previously reliant on imports for Electronic Control Units (ECUs), Baidu have now broken through technical barriers to achieve domestic independent research and development.

The future of autonomous EVSS, like JiDu cars, aligns closely with the concepts of eMaaS. New technologies in autonomous driving and interpersonal interaction are not only changing the way in which transportation is perceived but also shaping the evolution and transformation of smart urban mobility. This is evident in the development of intelligent systems, which save time by automatically finding available parking spaces, users, destinations and routes:

> *"In the future, there will certainly be a trend towards autonomous driving. Autonomous driving can be considered as part of ride-hailing services, and from my personal perspective, it can also be understood as car sharing, because it can drive right to your doorstep."*

Bella (Xiaopeng Car)

The integration of new EVs into ride-hailing services will likely preface the widespread adoption of L5 autonomous driving and the disruption of traditional urban planning and mobility systems:

> *"I believe that the future of transportation will force cities to make adjustments."*

Bennett (Baishi Shunxin)

> *"Electric vehicles are definitely a direction for future development, as they integrate aspects of vehicle networking, intelligence, and connected intelligence, including subsequent autonomous driving. All of these are integrated as part of a terminal direction for smart transportation."*

Elias (Group B2)

Baidu Maps, an intelligent navigation platform, provides users with precise navigation data and real-time traffic updates, optimizing routes and minimizing delays, thus increasing mobility efficiency (e.g., Jiudu automotive and Xiaopeng car). Its integration with voice and video interface systems, as being implemented in JiDu cars, offers a driving experience that can be more intuitive, personalised, and intelligent, hence enhancing user pleasure and well-being (e.g., Jidu automotive).

In turn, this may lead to an understanding of the possible societal ramifications of AVs and their role in altering urban transportation networks (Wang 2010). For instance, the evolution from smart EVSS to autonomous EVSS, is predicted to bring efficiency benefits, but the nature of the experiential benefits could change as well. This change hinges on how consumers react - for example, the enjoyment derived from driving in the context of smart mobility could transform into a more passive journey experience with AVs. Whether this transition enhances or diminishes the journey experience may depend heavily on consumer psychology, particularly attitudes towards elements like control (Wells and Xenias 2015).

Various respondents emphasised the role of Baidu Maps and voice and video interaction systems in advancing the human-machine interaction involved in driving and autonomous mobility (Shen et al. 2020). For instance, JiDu cars are emblematic of this trend, demonstrating a more intuitive, hands-free mode of communication which mitigates the cognitive load on the user and promotes road safety. Moving beyond traditional driving system, the evolution in human-machine interaction is increasingly oriented towards intelligent interfaces. The advent of biometric technologies such as facial and voice recognition in vehicles promises an era of more personalised and adaptive user experiences and preference. With the integration of AI and machine learning into vehicles, such as JiDu automotive, Xiaopeng car, and T3 mobility, vehicles are now capable of learning from users' behaviours, preferences, and habits. This predictive and adaptive mechanism facilitates a more enjoyable driving experience that can cater to individual needs.

Finally, the multimodal interaction has become visible in AV development (Dey et al. 2020). This combines various channels of communication including voice, touch, and gesture-based controls, thereby offering users a range of interaction methods with their vehicles. As evident in JiDu automotive, this shift is leading towards an interaction experience that is efficient, natural, and, most importantly, user-orientated.

7.3.3 Addressing the research questions E: What factors affect eMaaS (taking EVSS as an example) businesses and in what ways?

The emergence and evolution of EVSS can be influenced by various factors, which span across innovative technologies, human, structural, and experiential domains.

In terms of innovative technologies, advances in autonomous driving technologies and 5G connectivity, exemplified by companies like Jidu Automotive, are beginning to disrupt traditional urban planning paradigms and necessitate infrastructural adaptation. Coupled with the evolving business models in the eMaaS schemes, these technologies are shifting the transition towards autonomous EVSS, which represents a significant potential change to urban mobility.

In contrast, the human domain brings to light the important role of stakeholders, particularly policymakers. Their decisions can wield influence over the integration of EVSS into future urban planning and transportation initiatives, thus fostering or hindering a shift towards these more sustainable, efficient, and accessible mobility solutions. According to the interviews, financial considerations and technological readiness inhibit policymakers from supporting EVSS. Regarding financial concerns, Universal Motor said that OEMs and EVSS providers earn profits by 'utilising' financial policies such as 'subsidies and exemptions'. Such behaviour leads local governments to take only cautious actions to support EVs' development. In terms of technological practicalities, SEVs are physical products running on the road, which may cause incidents by users misusing, as highlighted by Go Fun; based on this potential danger, some local governments require EVSS providers to share access to track their SEVs by using big-data system. Such data can also be used for analysing the role of eMaaS within the urban mobility paradigm (Bokolo et al. 2020). As another practical issue, T3-mobility highlights that *"the issue of recycling the EVs' battery has not been solved."* Finally, if overproduction of EVs continues this will not only result in supply exceeding demand, but will also create pressure on the manufacturers relating to stock levels and environmental impacts.

However, environmental and human concerns prompt policy makers to support EVSS, as a part of eMaaS, to achieve benefits such as lower-carbon emissions and reduced traffic congestion (Wells et al. 2020b; Bokolo et al. 2021a). While in terms of consumer responsiveness and uptake towards EVSS, although the interviewees from Group B and EVCARD implied that some urban citizens prefer to drive the car themselves. However, based on the normalisation of ICT technologies and circular-orientated service, such as using smart payment by using scannable QR codes, sharing bikes and power banks, sharing is becoming increasingly prevalent and popular within urban life as customers become familiar with these shared products.

Moving to the structural aspect, the infusion of novel technologies such as high-speed internet connectivity, new energy sources, and autonomous driving into the eMaaS regime underscores the need for cities to adapt to intelligent transportation. As traditional urban mobility systems might struggle to cater to these emerging modes of transport, making the necessary structural transformation challenging.

In terms of experiential considerations, large tech companies like Baidu are becoming instrumental in revolutionising urban mobility. Their innovative solutions, spanning autonomous driving technology, mapping capabilities, and advanced human-machine interaction systems, will be important for enhancing user experiences and promoting the popularity of EVSS.

In conclusion, these diverse factors intertwine to determine the course of EVSS. Their collective influence sets the stage for a transformative era of urban mobility that is poised to redefine our understanding of transportation systems.

7.3.4 The future of urban infrastructure and transportation

EVSS connects to several government department, such as transportation department, which may determine the direction of public or private transportation in urban areas. City planning departments play an important role in allocating land use for shared EV parking facilities, as well as integrating charging and battery replacement stations (e.g., Traffic & Roads Department and Public transport department). Additionally, legal and regulatory frameworks can be established to address potential risks and disputes that may arise from EVSS.

Policy stakeholders' attitudes towards EVSS were generally cautious and inclusive and open to new technologies and management models as long as they complied with existing laws and regulations. The focus is on ensuring safety, environmental sustainability, and fairness in transactions, which includes addressing concerns such as contract transparency and fair billing practices. In this transitional period, the government may work to achieve a balance between public and private transportation options, adjusting production quotas for conventionally powered and NEVs, and focusing on collaboration with law enforcement and public transportation departments to effectively manage and support the growth of shared EV services within cities in ways that also reflect the national policy landscape:

> *"Future city planning and transportation planning should respond to the national strategy for a shared economy, carbon neutrality, and peaking carbon emissions. Moreover, it should aim to transform from a major transportation country into a powerful transportation nation."*

Carter (Traffic and Roads Department)

From the policy perspective, policymakers are theoretically promoting EVSS to achieve circular economy-linked targets (e.g., Charles, Vice Mayor). However, at the same time, they worry about what might go wrong (e.g., indiscriminate parking based on shared bicycle experience), making sure that EVSS schemes obey current laws (e.g., Universal motor). Therefore, although policymakers intend to support EVSS, they also act to restrict and inhibit them (See also section 6.2.4.1).

Xpeng Inc. highlights their commitment to Urban Air Mobility (UAM) solutions by providing air-bus services. These services aim to transport people and goods efficiently within urban environments. The overarching objective of UAM is to significantly reduce congestion on urban roadways, introduce innovative forms of mobility, and enhance the quality of life in densely populated urban areas (Palaia et al. 2021).

In terms of future developments, one surprising finding when exploring the role of EVSS and the strategies of the providers behind them, is that it was not necessarily the final mobility solution they were seeking to provide. Some EVSS providers had strategies to develop new Urban Air Mobility (UAM) solutions, such as Xiaopeng's flying car based air-bus service. Flying cars are viewed as having the potential to improve the effectiveness of urban transportation networks by lowering congestion and journey times (Rothfeld et al. 2021), and they may provide new opportunities for interstate travel for customers (Al Haddad et al. 2020; Çetin et al. 2022).

Although such flying cars have reached the stage of practical concept testing in some locations (perhaps add example), there are many aspects of their future that remain uncertain including issues around regulation and safety, infrastructure development, consumer acceptance, economic viability and how to resolve related energy issues to make them relatively sustainable and carbon neutral (Al Haddad et al. 2020; Bennaceur et al. 2022; Çetin et al. 2022; Choi et al. 2023; Mazur et al. 2022; Palaia et al. 2021; Ranasinghe et al. 2022). The extent to which these issues are successfully resolved will determine the extent to which UAMs become a meaningful extension of, competitor to, and/or complement to the business models of EVSS providers in China. Each of these issues, and the implications of UAMs for EVSS providers, represent important areas for future research.

7.4 The evolution of transportation modes and travel habits

In the context of contemporary urban and interurban transportation in YRDEZ, a reliance on private vehicles and conventional public mobility systems has been the norm. EVSS has a key role to play in the processes through which YRDEZ's transportation landscape may transform into a more sustainable model.

7.4.1 The shift towards energy-saving, low-carbon, and sustainable travel methods

EVSS, as an increasingly popular low-carbon travel option, offer the benefits of reduced energy consumption and efficient resource utilisation (Hu and Creutzig 2022). Despite their current small share in urban transportation systems, they complement public transportation, taxis, ride-hailing services, and public bicycles (Hu and Creutzig 2022). Public transportation may remain an important mode of travel for daily commutes, while EVSS offer an energy-efficient alternative for personal travel.

Although EVSS face challenges such as limited vehicle options and location distribution, with adequate investment, infrastructure, and policy support (e.g., SuPai), they can potentially supplant private cars and contribute to lower greenhouse gas emissions (e.g., Public transport department). Public bicycles have already demonstrated their capacity to replace private vehicles for short trips, suggesting a similar potential for shared cars if they provide comparable convenience and accessibility (Hu and Creutzig 2022).

7.4.2 The role of EVs in promoting new energy vehicles (NEVs) and domestically produced electric vehicle brands

Building upon the insights from Chapter 6, the future of EVSS will be shaped by multiple influences, including the commitment of stakeholders, technological advancements, and government policy frameworks. The interplay between traditional OEMs and new IT stakeholders like Baidu introduces an interesting dynamic to this equation.

From a traditional standpoint and based on Go fun’s view towards OEMs: *“The vehicle manufacturer is a core element, as it determines the cost.”*, which implies that OEMs, given their solid financial resources and long-standing industry experience, hold a notable advantage. Benefitting from policy support geared towards EVs, such as the initiatives pursued by Universal Motor, OEMs have the capacity to lead the design and development of intelligent NEVs. They can manage the entire process, from concept through to execution, bolstering the advancement of EVSS.

In the words of Jimmy: “Shared cars are created by OEMs on a shared platform.”. The inherent capacities and extensive resources of OEMs position them as natural leaders in the promotion and deployment of EVSS. However, the growing understanding of EVSS as not just a mobility market, but also an information technology market, raises intriguing questions about future power dynamics. The next segment of this discussion explores the potential impact of IT stakeholders, such as Baidu, on the trajectory of EVSS.

In the Chinese automobile market, a portion is dominated by non-local OEMs such as Volkswagen, BMW, Mercedes, Audi, Lexus, and Land Rover, among others (e.g., Group A: Dylan). Local Chinese OEMs which produce EVs, on the other hand, may suffer from a less favourable brand image among consumers (e.g., ShouQi hailing service). The emergence of EVSS with UAM solutions, which utilise NEVs, presents a valuable opportunity for local OEMs to build reputation and regain market share. Concurrently, these systems offer an effective platform for local OEMs to enhance their brand recognition and reputation.

7.4.3 The transition from traditional private car travel and fuel-powered vehicles

The transition from traditional private car travel and fuel-powered vehicles is driven by a complex interplay of environmental and traffic concerns, technological advancements, government policy and changing consumer preferences. The rise of EVSS, supported by advancements in autonomous driving technology and a growing focus on sustainable transportation, can be poised to reshape the transportation sector in the future.

Environmental and traffic efficiency concerns have become a central driving force behind the push for cleaner and more sustainable travel options. As cities struggle with escalating levels of pollution and traffic congestion (stated by Case and Charles below, the adverse impacts of fuel-powered vehicles on air quality, public health, and the global climate have become increasingly apparent). Consequently, there is a mounting demand for alternative modes of transportation that mitigate these negative effects.

> *“In China, medium-sized and larger cities are facing traffic congestion, or an excessive number of private cars.”*

Case (EV Association)

"Moreover, many vehicles still use fuel emissions, which can be said to have an impact on air pollution. Shared vehicles using new energy sources are beneficial for our environment and health."

Charles (Deputy-Mayor)

Government policy push the transition towards sustainable mobility directly and indirectly such as encourage OEMs to produce EVs by launching policies promoting circular economy and carbon-neutrality:

"From the government's perspective, it is certain that the government supports green and low-carbon emissions. However, when it comes to allocating resources between electric vehicle sharing and free bicycle parking in Suzhou, I believe that the higher carbon emission value is in providing bicycle parking spots. This is because bicycles can better achieve carbon emission reduction and solve the last-ten-mile of transportation issues. Additionally, they can improve individuals' health levels."

Edward (Gofun EVSS)

"Environmental protection is highly valued and demands that our entire party, nation, and governments at all levels strengthen their efforts towards environmental protection. The fifth issue is the transportation environment in various cities, which also needs to address the energy and carbon emission problems. In this context, our country has proposed to tackle environmental pollution and carbon emission issues."

Chris (Traffic Police)

Changing consumer preferences also contribute to the ongoing transition from traditional private car travel and fuel-powered vehicles. The increasing cost of private car ownership, coupled with limited parking availability and rising fuel prices, has prompted many consumers to explore alternative transportation options (e.g., Gofun). The growing interest of mobility companies in SEVs reflects a broader shift in promoting consumer values towards sustainability and environmental responsibility.

OEMs have recognised the potential of EVs to promote NEVs and domestically produced EV brands (e.g., NEV Association and EVCARD). By offering a combination of travel convenience and low usage costs, OEMs encourage users to experience SEVs by creating mobility needs (e.g., using EVSS at the first time), fostering a shift in attitudes and behaviour towards more energy-saving, low-carbon, and environmental beneficial transportation methods:

> *"We use EVSS to create (sustainable) mobility demand."*
>
> Edward (Gofun EVSS)

> *"During use, guide some customers and cultivate their vehicle usage habits."*
>
> Mike (LD Go)

> *"The enterprise has a certain domesticating effect, guiding the travel methods of consumers, the shared travel industry, or new travel methods, which definitely play a promotional role."*
>
> Lee (Evcard Suzhou)

7.4.4 Addressing the research questions D: What are the factors that affect SEV program participants' car ownership changes in terms of mobility behaviours and attitudes towards car ownership?

Table 7.4 below provides an overview of the factors that affect SEV program participants' car ownership changes in terms of mobility behaviours and attitudes towards car ownership according to section 7.3.3. The interview data identified these factors. The factors range from technological advancements and policy interventions to environmental concerns and consumer preferences, demonstrating the multifaceted nature of the transition from private car ownership to shared mobility systems. These factors interact to change mobility patterns and attitudes toward car ownership. OEMs may play an important role in this transition, by taking responsibilities to shift consumer behaviour and inform the market evolving. However, their success also depends on other factors such policy support, technological advancements, and the shifting consumer preferences. Understanding these factors and their interactions can provide potential for the future EVSS's development and vehicle ownership transitions.

Table 7.3 Factors affecting SEV participants' car ownership changes.

Factor	Description	Sources
Technological advancements	Progress in EV technology, autonomous driving, and charging infrastructure have made SEVs more viable and attractive.	(e.g., Group B2: Eve)
Policy interventions	Government policies aimed at reducing carbon emissions and promoting a circular economy have encouraged OEMs to manufacture EVs, promoting SEVs.	(e.g., Edward and Chris)
Environmental and traffic efficiency concerns	Awareness of environmental and public health issues associated with low emissions facilitates the interest in low-carbon mobility tools, such as SEVs.	(e.g., Case and Charles)
Shifting consumer preferences	Consumers' attitudes shifting towards sustainability, rising expenses associated with private car ownership, and convenience provided by SEVs drive the transition from private car ownership.	(e.g., Gofun)
Role of OEMs in promoting SEVs	OEMs can encourage the SEVs' utilisation by creating demand and shaping consumer habits, potentially reducing car ownership.	(e.g., Edward, Mike, and Lee)
Brand image and market dynamics	The emergence of SEVs presents an opportunity for local OEMs to enhance their brand recognition and regain market share, potentially influencing consumer attitudes.	(e.g., ShouQi hailing service)

7.4.5 The potential impact of Autonomous driving and UAM on existing Ride-hailing services

The integration of AVs and UAM into ride-hailing services may have the potential to transit the industry by reducing costs, enhancing service efficiency, and improving user experience (e.g., Jidu automotive and Xiaopeng car). However, this transition may also present challenges, such as navigating complex regulatory environments, addressing data privacy concerns, and managing competition from emerging UAM providers. To capitalise on the opportunities and mitigate the challenges, ride-hailing companies need to adopt strategic approaches, such as forming partnerships with AV manufacturers and UAM providers, investing in AI-driven dispatch systems, and engaging with regulators and policymakers (See **Table 7.4**). Companies' transition towards AVs and UAMs - a shift that is currently more driven by 'technology push' than 'market pull' - creates a focus on user education and transparency. These efforts can be important to facilitate public acceptance and trust in these emerging technologies, thereby addressing the communication and education demand required to improve acceptance and adoption. By proactively addressing these factors, ride-hailing services may better integrate AVs and UAM into their operations and maintain their competitive edge in the evolving transportation paradigm.

Table 7.4 Analysing the benefits, challenges, and strategic opportunities of integrating AVs into shared mobility services.

Factors	**Benefits of AVs in shared mobility service (SMS)**	**Challenges of Integrating AVs into SMS**	**Opportunities & Strategies for SMS**	**References and Sources**
Cost reduction	Reduced labour costs, lower maintenance expenses, and improved fuel efficiency	Initial high costs of AV technology, infrastructure investment, and insurance considerations	Form strategic partnerships with AV manufacturers, leverage economies of scale	(Haboucha et al. 2017)
Service efficiency	Improved dispatching algorithms, shorter wait times, and increased vehicle utilisation	Managing the transition from human-driven to autonomous fleets	Invest in AI-driven dispatch systems, gradual integration of AVs into existing fleets	(e.g., EVCARD and Go fun)
User experience	Enhanced safety, reduced human error, and customisable in-vehicle experiences	Public acceptance and trust, ensuring passenger safety and comfort	Conduct pilot programs, focus on user education and transparency	(e.g., Jidu automotive) (Ranasinghe et al. 2022)
Regulatory environment	Potential for streamlined regulations supporting AV adoption	Navigating complex and evolving regulatory landscapes, addressing liability concerns	Engage with regulators and policymakers, contribute to standards development	(e.g., Jidu automotive)
Data privacy	Opportunities for personalised services and targeted marketing through data collection	Addressing data privacy concerns and regulatory compliance	Implement robust data privacy policies and practices, invest in cybersecurity measures	(Shen et al. 2020)

7.5 Chapter summary

Chapter 7 firstly reflects on sustainability literature by presenting findings on three interdependencies. Secondly, it examines the transformation of transportation in the YRDEZ, focusing on the rising prominence of EVSS. Finally, it discusses the potential of EVSS to supplement public transport and reduce greenhouse gas emissions, the role of OEMs in promoting new energy vehicles, and the transition from traditional cars to shared mobility due to environmental concerns, policy support, and changing consumer preferences. It also explores factors affecting car ownership changes among EVSS participants and anticipates the impact of Autonomous driving on ride-hailing services.

Chapter 8. Discussion

8.1 Chapter introduction

This chapter is divided into five sections. Initially, the author will provide a summary of each research question to set the stage for further examination. Secondly, the author will explore the theoretical framework, based on Figure 3.5 (See section 3.7.2), to redevelop it by integrating it with the findings. The third part presents a new model demonstrating the stakeholder interdependencies and interactions that impact the prospects of success for EVSS firms' business models. In the fourth section, the author will detail the integration of this model with an advanced theoretical framework, extending our understanding of the role niche level dynamics play in determining the prospects for sustainable transitions. Lastly, a section with a discussion of the contributions the research makes to the existing literature.

8.2 Summary of addressing research questions

The findings chapter details the insights gained from interviewing the key stakeholders in new EVSS schemes in the Yangtze River Delta Economic Zone in China. This section addresses the implications or the 'so what?' questions. While research questions A, B, D and E have been addressed in Chapters Six and Seven, research question C requires further exploration which is presented in a separate section (8.5). This discussion will summarise the addressed research questions and reflect on the literature review, providing an in-depth understanding of the research context.

8.2.1 Addressing research question A: To what extent, and how, are new sustainable business models providing successful EVSS businesses in China?

Section 6.2.1 shows that the current five business models adopted by EVSSs are already succeeding. Elements of their success is connected to conditions within YRDEZ, which may not be equally applicable in other Chinese cities. For example, as section 6.4.4 shows, EVCARD's success relies strongly on the local government's support. No single "perfect" business model for EVSSs emerged from the research, as success depends on the service provider's characteristics, allowing SUPAI and EVCARD to both succeed, but by using very different business models (See sections 6.3.4 and 6.4.4). Since the majority of EVSSs studied were 'heavy asset' businesses, the findings suggest that OEM-led EVSS providers are likely to be successful as future urban mobility providers by adopting manufacturer-driven ecosystem business models

(See section 6.2.1.6). By contrast section 6.2.1.6 also implies that the user-focused vehicle resource allocation business models have yet to fully demonstrate their potential.

Regarding "how" they succeeded, the success depended on elements of the business models themselves (convenience and cost-effectiveness) and the policy and physical environment in which they operated. Furthermore, the interview with Group A shows the appeal to customers being more linked to practicality and technophilia than to overt sustainability concerns - but that may change as sustainability problems intensify, and with a younger generation emerging with stronger environmental concerns (Zhu et al. 2007; Matowicki et al. 2021). The findings also imply that the relative influence of those different factors (e.g., urban citizens' environmental awareness, innovative technology, policy push, and interaction with other stakeholders) will increase in future.

8.2.2 Addressing the research question B: What is the potential of EVSS to reduce individual car travel and minimise vehicle ownership, and how is this affected by its attributes?

EVSS have a potential to reduce private car trips and car ownership (Curtale et al. 2021; Liao and Correia 2022), driven by attributes such as environmental sustainability, cost-effectiveness, convenience and technological integration. The benefits of EVSS can be low carbon emissions, cost savings compared to car ownership, parking and charging outlets, flexible rental options, and the utilisation of digital platforms for real-time information.

Furthermore, the findings also imply that EVSS will encourage those individuals less likely to use their private vehicle to decide against buying new or extra personal vehicles. Although current EVSS may not yet result in people selling their individual cars (interviews state that EVSS have yet to be widely spread and are limited by factors such as insufficient parking outlets), as EVSS capacity expands, and use becomes normalised, this will become more likely. Currently the findings indicate that using EVSS depends on the nature of the journey and the person making it. For example, Dalia (Group A: Users) indicates *“I would like to use it for one way trip, like I need to attend a dinner with drinking alcohol.”* While Ellen (Group B2: Late majority) states: *“I will use EVSS if my private car is unavailable”.*

From an innovation diffusion perspective, EVSSs’ ability to impact vehicle ownership levels will depend on reaching a scale of provision (so that urban citizens can easily find shared EVs) and a scale of adoption that makes using EVSS a social norm. According to the interviews with the traffic departments, EVSS is currently in Phase One, where it is treated as an additional option which limits its use. Usage will extend with the envisaged second phase of increased integration of EVSS with taxis and ride-hailing services. Although this appears to emphasise EVSSs' attributes as the key to success, the findings suggest it is equally about the attributes of the policy and physical environments in which schemes operates and their "fit" with that, and with other complementary service provision systems (this will be further discussed in section 8.5).

The realisation of this potential relies not only on these service attributes, but also on external factors and the service's positioning within the broader urban mobility paradigm. Factors such as innovative business models, regulatory policies, and collaborations with other stakeholders come into play. For example, addressing functional concerns like regular vehicle maintenance, safety inspections, and robust charging infrastructure development. Mitigating issues like user misbehaviour through clear guidelines, penalties, and educational campaigns is another important aspect. Particularly in the context of China, the influence of the national/social credit system on user behaviour cannot be overlooked.

Moreover, the future potential and evolution of EVSS will depend on whether it is viewed as a definitive solution or a transitional phase towards a more informational based PSS involving automated products and services (Ma et al. 2018; Nazari et al. 2018). This perspective influences how EVSS will be positioned and adopted within the mobility transition narrative, affecting both service use and vehicle ownership patterns. It also positions driving as a potentially transitional consumer behaviour. EVSS in which consumers drive EV cars as a journey-specific option to driving their own car emphasises the substituting of a shared for a private vehicle. EVSS in which consumers electronically hail an AV into which they step to be taken to a destination is less like the direct replacement of private car journeys and more like extending a public transport network to becoming infinitely flexible. The potential implications for the shift from self-drive EVSS to automated EVSS will be an interesting subject for future research.

Therefore, the potential of EVSS is not static, but evolves with changing technological innovation and societal norms. The interplay between these internal and external factors shapes the potential of EVSS to transform mobility patterns, replace private car trips and reduce car ownership. The importance of such evolution is underlined by the failure of the French vehicle sharing scheme Autolib in which a failure to evolve was viewed as a key reason behind its failure. According to Gregory Ducongé, CEO of Vulog quoted in (Brown 2018) "*The offer didn't stay in touch with changing expectations, like the user experience: there were issues* *over the state of the cars, they weren't always clean or in good working order, plus there wasn't always a vehicle available when you wanted one*."

8.2.3 Addressing research question D: What are the factors that affect EVSS program participants' car ownership changes in terms mobility behaviours and attitudes towards car ownership?

This research contributes to the broader field on the factors influencing the transition from private car ownership to shared mobility services by shedding light on the Chinese context. It further highlights the need for ongoing research in this area, as factors influencing this transition are dynamic and complex, requiring an understanding of the interplay among these factors within specific cultural and geographic contexts.

While technological innovations, policy interventions, and changing consumer preferences have been widely discussed in the context of Western societies (Wells et al. 2020b), this research uncovers some prominent implications within Chinese cities. For example, rapid urbanisation and the role of digital technology in daily life for urban citizens might shape the adoption of EVSS differently.

This research also explores the role of OEMs in China's EVSS schemes. They have the potential to influence on urban citizens' behaviours, influence market trends, and drive the transition from private car ownership towards shared mobility. In contrast to Western markets where shared mobility services are primarily driven by tech firms (Bergek et al. 2013; Wells et al. 2020b), in China, OEMs and other stakeholders are emerging as important roles in the shared mobility ecosystem.

Additionally, this research highlights the importance of the brand image of local OEMs and market dynamics in the Chinese context. The rise of local OEMs, such as BYD, Xpeng Inc and Geely, provides an opportunity to reshape the EVSS market. As they strive to enhance their brand recognition and increase market share, these local OEMs may influence consumer attitudes and preferences, encouraging a shift towards shared mobility and a sustainable future (Wells 2013a).

8.2.4 Addressing research question E: What factors affect eMaaS (taking EVSS as an example) businesses and in what ways?

In the eMaaS sector, using EVSS as an example, technological information innovation is evolving rapidly, with physical infrastructural development tending to lag behind and with consumer preferences being mixed. Policy factors are not operating as strongly at a local or city level as might be expected given the overall national policy context. The future of this sector, however, promises an era of transformation underpinned by these factors.

In this transformation, technological advances, particularly in autonomous driving and 5G connectivity, will play an important role. They will challenge and reshape conventional business models, pushing for an accelerated shift towards autonomous EVSS and redefining the urban mobility paradigm. This redefinition has changed how EVSSs can be understood. EVSSs began with an emphasis on changes to ownership of, and access to, a particular mobility technology (the car). It has then evolved to be more a part of a wider mobility 'ecology' in which information technology is used to access mobility solutions (and which might integrate multiple mobility technologies to meet consumers' needs). Therefore, the nature of eMaaS is shifting further from an emphasis on conventional mobility products, and further towards the 'service' element and informational based technologies representing the core of the offering instead of an augmentation (For example, citizens can arrange a hailing car via an App).

Simultaneously, the future will demand a responsive policy framework that fosters the growth of eMaaS businesses. As sustainability becomes an increasing matter of importance, governments will likely seek to strengthen their support for NEVs by creating a positive regulatory environment that can facilitate the expansion of eMaaS businesses.

Urban infrastructure development will also play an important role. As eMaaS businesses grow they require robust charging and parking facilities provision. Successful expansion is likely to rely on strategic alliances with electricity providers and charging facility companies, with the aim of integrating infrastructure into urban planning.

In terms of market pull and consumer behaviour, the challenge lies in meeting evolving consumer preferences for sustainable and efficient mobility solutions. Strategic collaborations with diverse stakeholders, underpinned by a deep understanding of changing consumer demands, will be vital to navigate this changing landscape.

Lastly, efficient operation and strategic collaborations with governments and major companies could provide a competitive advantage. For instance, the success story of EVCARD in Shanghai presents an implication for eMaaS businesses looking to address these opportunities.

8.3 From niche experimentation to mainstream adaptation: The role of business model innovation in sustainable eMaaS transitions

In the literature review chapter, the author developed a theoretical model (see section 3.7.2 based on transition theory. The literature highlights how BMI influences user practices, by fostering new meanings and competences like digital skills required for car sharing (Sarasini and Langeland 2021). BMI, as a subject of innovation, thus mediates between niche-level activities and broader systemic transformations (Wells 2013a; Wells 2018). Experimental niche initiatives like car-sharing continue to be clearly marginal to the mainstream industry of producing vehicles with internal-combustion engines (Wells 2013a). Wells (2013a, p.239) raises an urgent call *"to understand more clearly the scope and barriers to growth afforded by business model innovation in the automotive industry."* Bidmon and Knab (2018, p.905) argue that "in a phase of experimentation, various forms of technological innovation emerge in local projects at niche level." By integrating insights from the findings, an updated theoretical framework (**Figure 8.1**) can be developed to demonstrate what happens at the niche level as an experimentation contributing towards more sustainable eMaaS elements of city-based mobility paradigms based on the findings.

As business models scale up, new users are drawn in, which promotes further adoption and creates ties between multiple regimes and geographical scales. This scaling up and the recruitment of new users reflects the diffusion of innovations (Sarasini and Langeland 2021).

Within the framework of transition theory, the operation of businesses is often perceived through a simplistic lens. Nonetheless, the research findings from this thesis demonstrate a complexity of interactions among various stakeholders within the business models of EVSSs (See section 6.4). Given this intersection of relationships, the role of businesses within niches and regimes is often oversimplified, reducing the representation of business models to a relatively straightforward entity. Transition theory emphasises the importance of landscape level factors such as policies which can influence an industry, within which individual companies are also exerting their own influence and making changes, each contributing to the transition process. However, it traditionally takes a 'vertical' and hierarchical perspective that may not fully capture the reality for EVSS schemes. The findings show the reality is more complex, partly because of the different range of stakeholders and the role of intersecting business models, as well as intersections operating across regimes (Costa et al. 2022). For instance, within the mobility regime, an online technology company like Baidu has become a key player. The findings show that mobility initiatives with ICT capabilities are important in reshaping urban mobility which will provide opportunities for transformation while highlighting the complex and interconnected reality of contemporary business models.

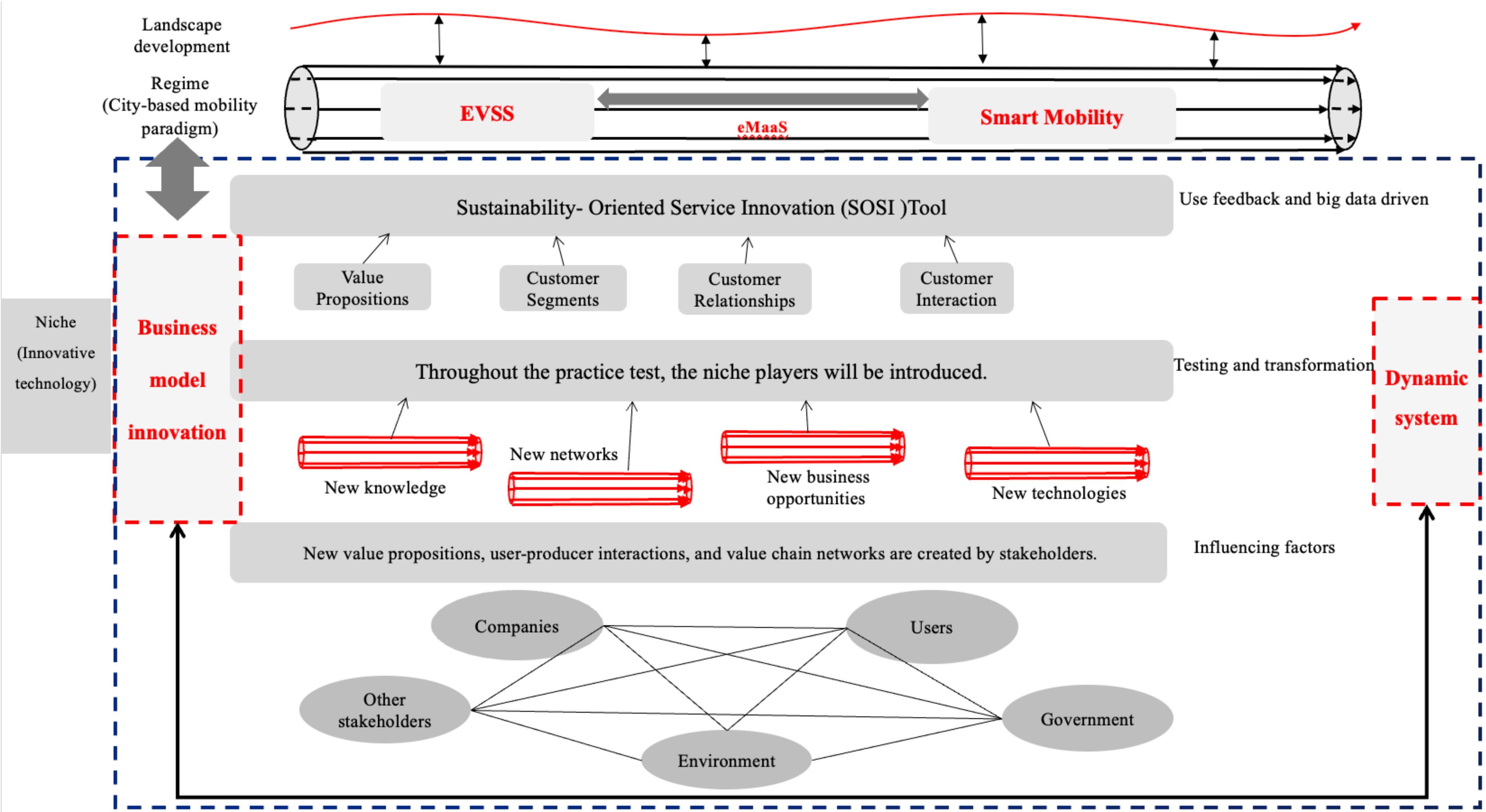

Figure 8.1 Theoretical framework (Developed by the author).

8.4 Reframing transition theory and bridging the gap: The role of individual firms, business model innovation, and collaborative stakeholder engagement.

Transition theory tends to underplay the role of the individual firm, as it lacks firm level analysis and a focus on business model innovation (Ruhrort 2020; Sarasini and Langeland 2021). Sarasini and Langeland (2021) highlight the transition theory to business model gap in the context of theory about urban vehicle sharing schemes which this thesis has explored further through empirical research. What the findings of this thesis suggest is that the business model to transition theory gap can only be understood and bridged via a thorough understanding of the localised relationships between EVSS providers and other stakeholders.

The city-based schemes highlight how the city's environment intertwines with the business models of EVSS providers and their success is dependent on things like local urban infrastructure and traffic policy, to an extent that they are not simply acting as environmental limitations on the businesses. This can require the businesses to engage in dialogue with government officials to negotiate and collaborate to solve some of the challenges regarding various scheme aspects like parking and insurance.

While transition theory is valuable for understanding how both landscape level influences and the actions of individual firms within niches may help to reshape particular regimes, it likely underestimates the role of localised environmental influences. and the extent to which interactions across different regimes (and/or production and consumption systems) may impact both individual firm behaviour and the prospects for sustainability transitions (Aagaard et al. 2021).

8.4.1 The ‘six petals’ business model ecosystem

By reflecting on the findings and implications, EVSS business models cannot be fully understood by envisaging them in terms of individual business operating PSSs within a specific market for urban mobility. Instead, a complex interconnected network of business models that jointly form a 'business model ecosystem' (See **Figure 8.2** and **Figure 8.3**) determines the prospects of success for EVSS providers, the behaviour of their customers, and their ability to contribute to a transition towards more sustainable urban mobility. EVSS providers plays as a core firm within the business ecosystem may have an impact on niche markets as well as other stakeholders (Pierce 2009). By integrating Pierce (2009)’s approach, findings also indicate that EVSS providers may work with each stakeholders as paring groups (six different petals).

Understanding such a business model ecosystem-based approach is potentially important because the different components of that business model ecosystem will exist within different policy landscapes and may be subject to differing, inconsistent or opposing influences from the landscape and regime levels. This perspective can be linked to the concepts of industrial ecology, emphasising the understanding of production and consumption systems, viewing them as holistic entities with both a physical and strategic existence (Erkman 1997; Klöpffer 2003; Lebel and Lorek 2008). Given the interconnectedness of these systems, alterations in one subsystem (for instance, insurance or energy) can potentially result in unintended consequences due to these interdependencies. Further, there exists a risk of system failure if modifications to one subsystem are not reciprocated by concurrent changes in the other interconnected systems.

Visualising this complex interaction, this model is shaped with six symmetrical petals. Each petal represents a part of the ecosystem: OEM business models, energy firm business models, charging provider business models, car insurance firm business models, ICT technologies and internet company business models. Although the issue of technology has been discussed heavily in the previous chapters, it is regarded here as a separate entity, not confined within the boundaries of tech firm business models, as these tech firms are not necessarily adapting their operations to accommodate EVSS. Conversely, EVSS providers increasingly develop their strategies around ICT, and internet companies' business models may provide insights for EVSS providers, particularly because some EVSS providers' management had internet company backgrounds.

This model encapsulates the blend of physical (energy and charging), financial (insurance), and informational (ICT and internet) aspects of the business model ecosystem approach. Developments in policy and infrastructure directly impact EVSS firms, for example through parking regulations, and through energy and charging firms' provision via infrastructure evolution.

The finding chapters demonstrate the intersection of stakeholders of EVSS schemes, and it can be helpful to consider the nature of each of the six petals. In terms of the OEM business models' petal, findings suggests that OEMs have capabilities relating to finance, resources, technologies and social relationships to push forward business model innovation. For example, the EVCARD (Shanghai) scheme, which is operated by the SAIC OEM, benefits from the resources and relationships of the OEM including finance, using its relationship with a key technology company (China telecom) to support EVCARD, and leveraging local social relationships including galvanizing local community support and local government support for EVCARD as SAIC is a locally based OEM.

In the context of energy s and charging providers' business models, the rapid growth of EV and EVSS markets, stimulated by governmental incentives, has opened new avenues for specialisation. As highlighted by interviewees, firms aiming to dominate the EV charging market are adopting strategies like offering subsidies to users who select their services. This approach could lead to a competitive landscape where multiple charging providers, distinct from government-affiliated energy firms, vie for market share by offering uniquely priced EV charging solutions.

Regarding the business models of car insurance firms, a distinction exists between regulation for social use and commercial use. However, research findings indicate a conflict between car insurance companies and EVSS providers. This conflict arises as insurance firms often refuse to cover claims, citing that EVSS providers opt for social use insurance rather than the more appropriate commercial use category. Nevertheless, a collaborative resolution to the current business model mismatch may be feasible. Particularly with government intervention to provide a more encouraging policy landscape, there is the potential to align their interests by redefining and clarifying regulatory frameworks specifically tailored for EVSS schemes.

Regarding ICT technology and EVSS business models, the findings demonstrate that EVSS providers adopt the innovations led by technology companies to expand their businesses through big data services and analysis, online promotion, and (in future) autonomous driving. Furthermore, ICT companies can also potentially extend their own businesses into this market by leveraging their capabilities and advantages (particularly relating to data), as interviewees from Baidu indicated in their strategic plan for the urban mobility market.

In terms of internet companies, the research findings highlight that EVSS providers use social media platforms such as TikTok, WeChat, Weibo, Kuaishou, and others to promote their services. These internet companies benefit by earning commissions from EVSS providers. An interviewee from DIDI noted the emerging strategy of initiating operations via a purely online platform. This approach involves collaborating with vehicle owners, utilizing their cars and drivers to fulfil the basic mobility needs of passengers. Internet companies are also important for the business models of EVSS in generating public attention and interest in the services being promoted, and providing access to those services.

Industrial ecology traditionally emphasises the co-location of production and consumption resources or systems, forming an interlinked network often observed in industrial symbiosis and eco-industrial parks. This focus has mainly created an understanding of more sustainable production ecologies while the EVSS business model ecology approach presents an alternative concept of a consumption-oriented ecosystem involving interlocking consumption-based activities and systems.

The consumption ecosystem represented by EVSS schemes represents the strategic symbiosis and co-location of various interdependent consumption systems. Instead of concentrating on how products are manufactured, and the by-products reused (as seen in section 2.3), EVSS highlights the importance of the efficient and effective use of resources post-production. It emphasises the strategic alignment and interdependence among multiple actors, including users, service providers, infrastructure providers, and policymakers, to optimise consumption. The co-location in this context is less a direct physical view, as with industrial symbiosis, and more about the strategic coordination of services that maximise the overall system's efficiency and sustainability. In essence, it represents a shift towards understanding and managing complex networks of interdependent services as a business ecosystem oriented towards sustainable consumption. Thus, EVSS can be seen as an innovative extension of the principles of industrial ecology, adjusted to meet the complexities of future urban mobility paradigm.

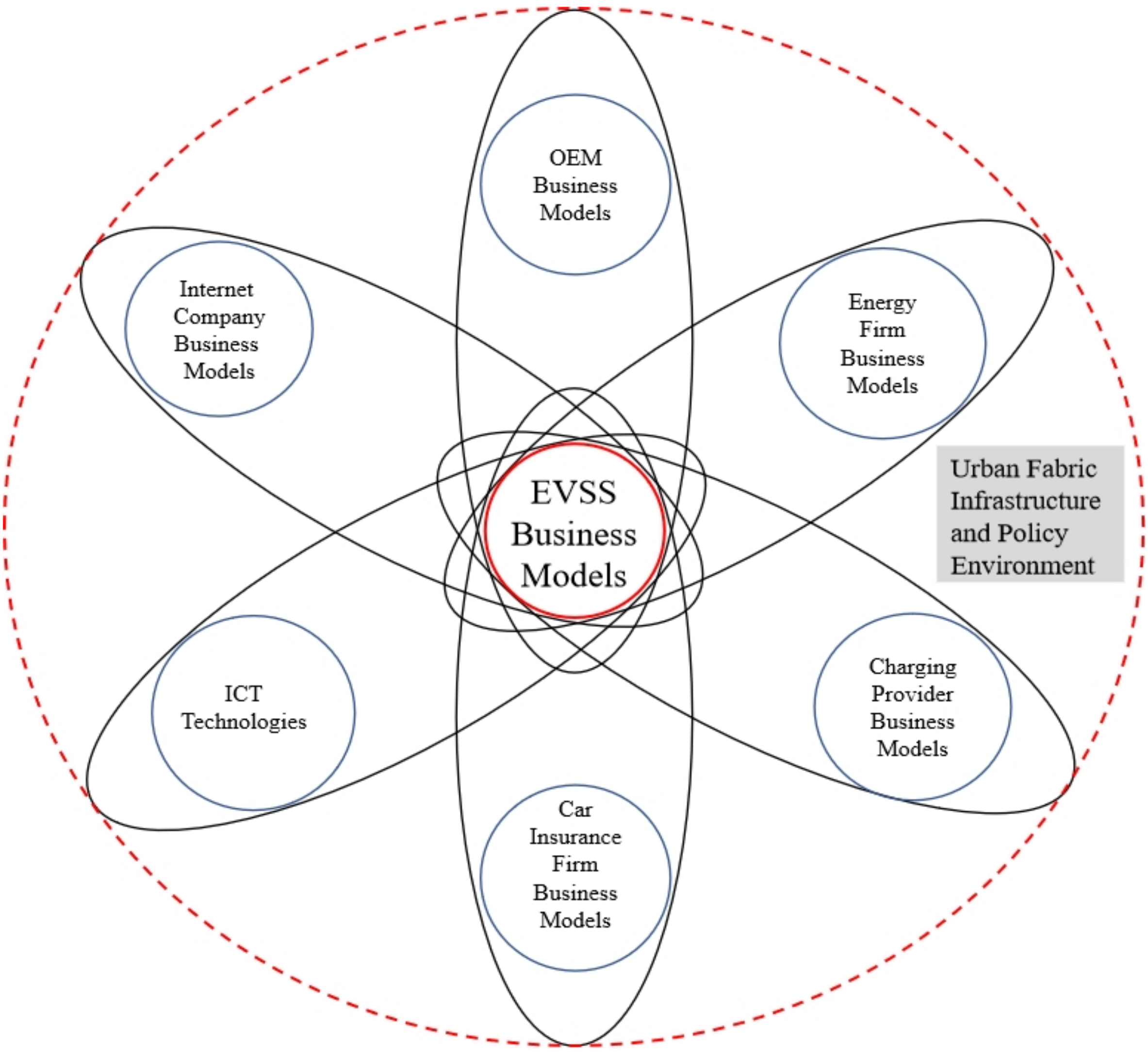

Figure 8.2 Six 'petals' business model ecosystem (Made by the author).

8.4.2 Operational challenges and practical considerations

The findings suggest that the EVSS business ecosystem does have the potential to contribute to a transition towards more sustainable urban mobility within Chinese cities, although the speed and extent of that contribution will depend upon a range of factors including local and national governmental support, rates of consumer acceptance, technological evolution and the success and effectiveness of the business models of the providers within the market.

The experience of the case EVSS companies demonstrates that they all faced a range of operational challenges linked to both internal and external factors, including challenges accessing sufficient capital and other resources, relatively high business overheads, problems in the practical deployment and maintenance of the vehicle fleet, coping with consumer misbehaviour and the mismatch between the market sector and their insurance providers.

The ultimate success of the providers of EVSS, in terms of both profitability and contribution to sustainability, will depend on meeting operational challenges linked to managing EVs as a technology and business asset, and other operational challenges linked to establishing an effective marketing mix in terms of the product range of available vehicles and the nature of the service provided, pricing, vehicle distribution and availability, and effective communication with consumers.

In managing the vehicles as business assets, the respondents were mostly concerned with short-term issues around maintenance, but the EVSS providers also face longer-term issues relating to vehicle end-of-life, particularly in relation to battery recycling since the technology is not yet mature. However, as mentioned earlier, there are ways to extend battery life by reconditioning and redesigning the batteries from relatively high-speed cars to relatively low-speed vehicles, such as for agricultural use.

In developing an effective marketing mix, providers are caught between the potential consumer satisfaction benefits of being able to provide a range of different types of vehicles with the operational benefits that would come from providing standardised vehicles for issues like insurance, maintenance and minimising the distance between a consumer and an available vehicle to deliver a quick and convenient service. That last dilemma is central to the practical success of vehicle sharing business models since profitability requires high vehicle usage rates, but high vehicle usage rates make widespread vehicle availability at any given time and place hard to achieve. Therefore, balancing SEV availability and utilisation can also be a major challenge for business model success, but the success of the EVSS business model of Mobility Carsharing in Switzerland suggests that such a balance between availability and utilisation can be achieved (Bocken et al. 2022).

The pursuit of high vehicle utilisation rates tends to push providers to locate their vehicles near points of likely high demand such as tourist attractions, stations or shopping malls. This so-called ‘honeypot’ effect can lead to multiple operators overloading particular locations with vehicles while other parts of the city remain underserved. Another practical issue potentially restricting the location and availability of SEVs relates to parking. The theoretical advantage of shared vehicle use allowing for a reduction in the number of vehicles on the road and related demand for parking space doesn’t account for the location of those parking spaces (Ness 2010). Chinese urban living is currently dominated by residential apartment living in which private car use is effectively supported by underground parking for residents. Whether and how such parking infrastructure could be repurposed to support SEVs, should sharing ultimately become the norm, remains unclear at this time.

8.4.3 The relationships between mobility demand and EVSS

Returning to the issue of the relationship between EVSS availability and mobility demand highlighted in Section 4.8.2, the potential of EVSS to increase demand and congestion in the short term, while yet able to benefit the city in the long term, was mentioned by Chris (full quote in section 6.4.3.3):

> *"…more cars on the road without passengers, just driving around waiting for pick-ups. That could actually make the traffic situation worse if we're not careful".*

Chris (Traffic Police)

Furthermore, from a marketing perspective, the EVSS schemes may not literally create demand, but they provide another option for users to complete their journey. The challenge may come in developing a business model and operational systems capable of effectively matching supply with demand, particularly when demand fluctuations may go beyond what the services can cope with, introducing a risk of generating consumer dissatisfaction and a loss of consumer confidence in the service, as mentioned by Jason:

> *"While big data tech is a game changer in how we allocate shared electric vehicles, it does have its limits. For instance, when there's a sudden spike in mobility needs – like, say, a big concert happening in an area – our current system struggles to cope."*

Jason (EVCARD Shanghai)

8.5 Understanding the dynamics of EVSS market: An integration of transition theory and business model ecosystems

Based on the above discussion, if the relationship between the levels in transition theory can be demonstrated 'vertically', this six-petal model can be conceptualised 'horizontally', forming a foundational layer to the transition theory structure. This dynamic model (See **Figure 8.3**) offers an in-depth understanding of the EVSS market's business model ecosystem, providing valuable insights to inform strategic planning for the transition towards sustainable urban mobility.

Transition theory, is visualised two-dimensionally with three layers: *“In multi-level perspective there is a nested hierarchy of causal relations in which the field is the top level.”* (Wells and Nieuwenhuis 2012, p.1684). However, if viewed from a top-down perspective, this model gains a new dimension. This shift in perspective introduces a new construct, by integrating with the 'six petals' business model ecology approach. Each 'petal' is not representative of a singular business but a distinct business model. These petals appear to push upwards towards the regime layer, indicating an active, complex relationship between the business models and a number of intersecting regimes.

Therefore, mobility can be visualised vertically in terms of a mobility landscape, regime, and niches. These elements, however, are interconnected with another set of layers representing the ICT landscape, ICT regimes, and ICT niches. When viewed collectively, they form an interconnected whole, more easily envisaged as a three-dimensional model than a ‘flat’ one.

From a vertical perspective, the model takes on a new form; the niches are not isolated points but interconnecting links across a spectrum of intersecting landscapes and regimes. This implies a series of landscapes and regimes linked by the petals, each representing different business models.

The essence of this model is its transformation from a two-dimensional landscape to a more nuanced three-dimensional system. Elements initially thought unrelated to the regime find their place in the model as they are connected through different niches. For instance, ICT business models, though not immediately apparent, play an important role as they link mobility providers, energy companies, and infrastructure providers.

This shift in perspective gives depth to the understanding of the model, emphasising that what initially seemed like a discrete mobility regime is actually part of a complex more interconnected system. Understanding this interconnectedness also indicates that landscape pressures from varying fields are relevant, thus highlighting the impact of different sectors on one another and the importance for developing more sustainable mobility of ‘joined up’ policymaking (Aguiléra and Pigalle 2021). This is something that may be more feasible in a country like China with relatively heavily centralised government influence compared to some other countries.

Just as in ecology, where multiple species and their habitats are interconnected and interdependent, the understanding of EVSS services may also need to consider the complexity of multiple interconnected business models and niches. A narrow perspective might overlook this complexity and either underestimate the potential for EVSS services to contribute to sustainability or fail to appreciate key supporting initiatives required for success. Behind apparently distinct niches based around business models for EVSS, there is a more complex picture of interconnected business models and niches. The model is no longer a mere horizontal entity; it has gained a vertical depth, indicating a transition towards a more interconnected business ecosystem approach.

Looking at EVSS from a business ecosystem perspective helps to understand the roles that the intersecting business models and technologies within the Six Petals model play, alongside the influence of government policy, competitors, consumer demand and other stakeholders. Understanding the complexities of such a business ecosystem does not guarantee success for the business model innovation of EVSS providers in China, and the acknowledged challenges and the risks of failure in providing vehicle sharing services (Lagadic et al. 2019) remain significant. However, the case of EVCARD (Shanghai) demonstrates the potential for effectiveness in business model innovation with EVSS.

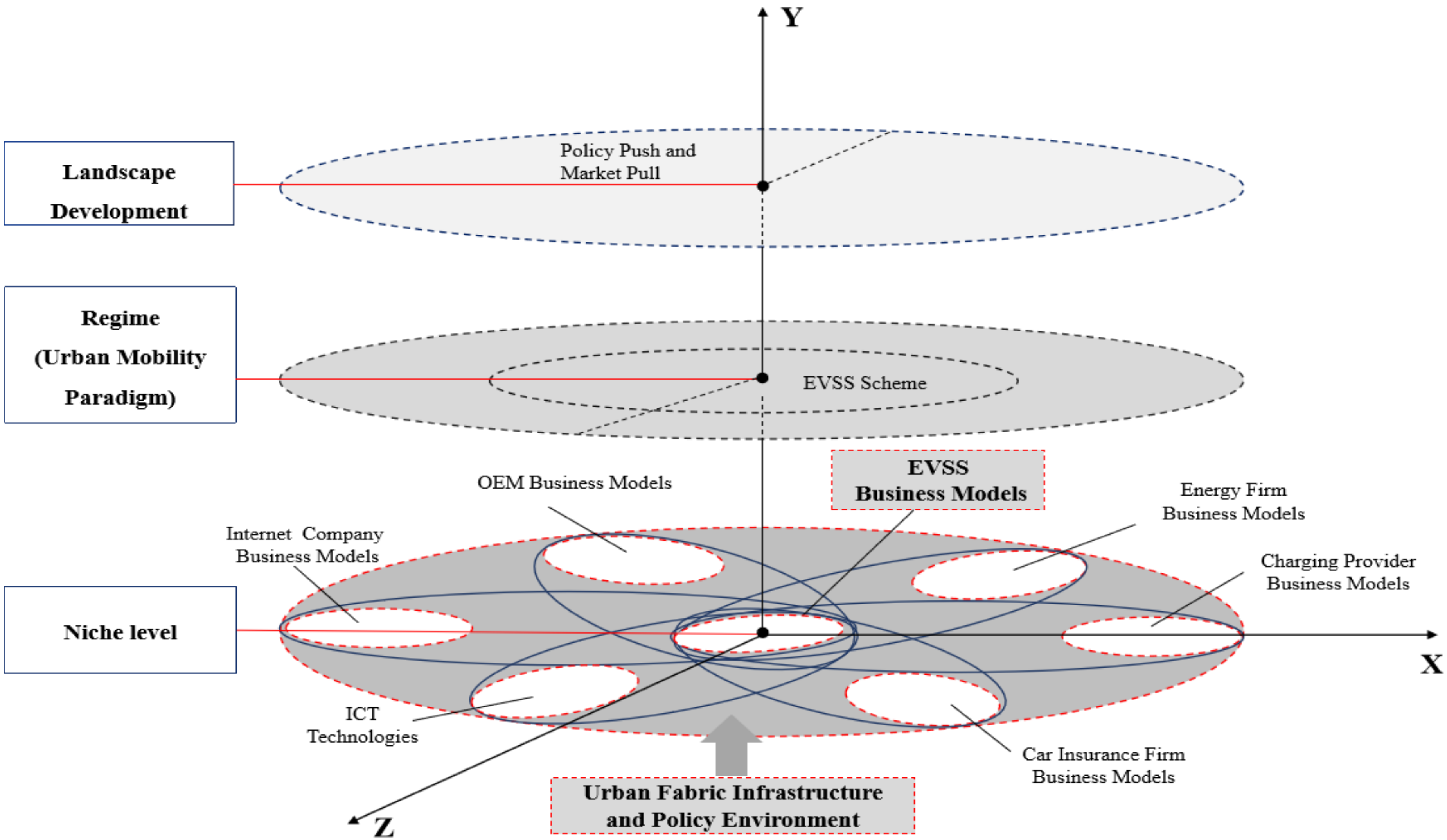

Figure 8.3 A three-dimensional model of interconnected business ecosystems within multi-level perspectives (Made by the author).

8.6 Addressing research question C: Using transition theory, how can existing shared mobility business models develop an effective relationship between service providers and the local stakeholders to promote sustainable mobility?

Figure 8.3 implies the importance of developing an effective relationship between service providers and local stakeholders. Achieving this for a shared mobility business model ecosystem will involve mutual interdependence, co-learning, co-creation, embracing an information-oriented service approach, and alignment with local policies and infrastructure. A business model ecology approach can help to identify whereby EVSS business models interact with other business models within the ecosystem, both impacting and being influenced by them.

The concept of interdependence and strategic significance amongst stakeholders within such an ecosystem is important to foster cooperative growth. For example, OEMs are integral to this ecosystem, perceiving EVSS as a potential market, while EVSS providers are reliant on ICT, with ICT companies beginning to perceive EVSS as a new business opportunity. Such interactions underscore the more symbiotic relationships within this ecosystem, rather than framing them as one-directional dependencies (Wang and Wells 2021). Hence, a shift in one element of this system can impact the others, underscoring the necessity for collaborative strategies and concerted efforts to effect sustainable change. The dynamics of this ecosystem need to be understood to design effective policies and strategies.

One possible approach to build the relationships needed to contribute to a substantial transition towards more sustainable urban mobility can be through co-creation (Fernandes et al. 2020; Sharma 2021). Shared mobility service providers cannot only rely on a narrow perception of market needs but also need to engage with local stakeholders, such as city planners, infrastructure providers, policymakers, and complementary markets (like insurance) to understand and discuss their perspectives and requirements. Co-creation can then create opportunities to learn from other stakeholders within the business model ecosystem. For instance, car companies could learn from ICT companies about innovation, market responsiveness, and user engagement strategies. This learning process, if fostered correctly, could lead to the creation of innovative solutions promoting more sustainable mobility.

Furthermore, to achieve the viability and sustainability of EVSS, it is important to recognise that the future of urban mobility is leaning towards an informational-based service rather than a traditional mobility service. This trend is evident with the advent of App-based ride-hailing services and the eventual transition to AVs (e.g., Jidu automotive and Xpeng Inc). Embracing this shift requires a reconceptualisation of service provision, focusing on ICT, user experience, and service accessibility rather than just the physical aspect of mobility.

8.7 Contribution towards IE (Industrial ecology) and CE (Circular economy): Shifting focus from production to consumption patterns

This study makes a contribution towards IE and the CE by extending their foundational perspectives. This research focuses on the traditional elements of IE and CE, such as the constraints of growth, resource efficiency, and waste management, but this thesis also explores the important role PSS can play in achieving resource efficiency through consumption and service changes rather than through more efficient manufacture and disposal of products.

In an innovative turn, this thesis introduces the concept of an integrated ecology of consumption approach, offering a parallel to the spatial interplay for resource efficiency observed in eco-industrial parks. The findings suggests that the consumption dynamics within an urban environment can be bridging the gap between the production-focused view of IE and towards a more consumption-oriented perspective.

Furthermore, this study helps to address the existing imbalance within the CE literature, which is primarily centred on material efficiency and waste (Erkman 1997). A closer examination of PSSs from a perspective of consumption practices, particularly in high-impact areas such as urban mobility, would help to provide a counterbalance.

In sum, this research contributes a step forward in the discourse surrounding urban mobility related sustainability, IE, and the CE by expanding the boundaries of IE by reemphasising the role of consumption patterns, and by advocating for a more balanced exploration within the CE, one that extends beyond just resource use and waste. This paves the way for an more in-depth understanding of these domains and their roles in building sustainable futures.

8.8 Evaluating co-evolution and its impacts

This section will discuss how co-evolution played out within the EVSS schemes. The aim of government incentives is to reduce private vehicle ownership and potentially reduce the number of vehicles on the road, as well as ultimately reducing emissions to achieve more sustainable mobility solutions. Furthermore, another goal of government incentives towards EVSS is to promote the development of this business ecosystem to the point that it can run without government incentives. However, the interviewees from the ten EVSS providers, particularly those smaller scale companies, expressed their reliance on government support. This reflects the type of challenge in creating a fully profitable vehicle sharing service outlined by Lagadic et al. (2019). Instead, the Chinese government tried to adjust their policy incentives to encourage EVSS providers' innovation as a response.

The innovation in EVSS business models aims to generate a shift from private vehicle ownership towards a shared-use business model, thereby catalysing a transition towards reduced car ownership. This transition not only aims at decreasing emissions, but also could significantly contribute to enhanced overall sustainability. In this dynamic, the interaction between the system (encompassing policy frameworks and societal norms) and the individual firms is dialectical, characterized by a reciprocal relationship where causality flows in both directions. This symbiosis reflects the nuanced interplay where business model innovations (BMI) in shared mobility influence, and are influenced by, broader systemic transitions towards reduced car ownership and lower emissions.

The findings chapters also demonstrate that EVSS providers are affected by the systems because of incentives. Based on the interviews, current policymakers hold a positive attitude towards EVSS schemes and EVCARD (Shanghai) potentially represents a successful case demonstrating the potential to reduce private vehicle ownerships, congestions and emissions in Chinese cities. However, this case in Shanghai currently relies heavily on government incentives and support.

The emergence of shared mobility models, as showed by the strategies of companies like SuPai and Universal Motor, was a direct response to government incentives aimed at reducing private car ownership and emissions. These policies may not only encouraged the growth of EVSS but also necessitated regulatory measures to manage this sector. Interviews with key players in firms such as Gofun EVSS and Car Inc shows a strategic shifts towards shared mobility that aligns with policy developments. However, as government support fluctuated, these firms faced the challenge of sustaining their operations independently, highlighting the direct impact of policy on business practices. This interplay illustrates a broader societal shift towards sustainability, a transition within the EVSS business models aligning with environmental objectives. Evaluating the outcomes of this co-evolution raises critical questions about the long-term impact of these business models on sustainability goals, the effectiveness of governmental strategies, and the mutual benefits comes from this relationship. The complex dynamics between the EVSS companies and policy frameworks indicate a complex narrative of adaptation and influence, emphasising the need for ongoing dialogue and strategic flexibility to ensure that shared mobility effectively contributes to more sustainable urban transportation.

Chapter 9. Conclusion

9.1 Chapter introduction

This final chapter concludes the thesis by identifying the key research contributions and highlighting both practical and policy implications drawn from chapters 6, 7 and 8. Lastly, it presents the limitations to this research, before proceeding to highlight potential avenues for future research.

9.2 Academic contributions

This section will summarise both theory and literature contributions.

In the context of mobility services Sarasini and Linder (2018) point out that the lack of a theory of the individual firm within the application of transition theory results in an under-appreciation of the role of business model innovation within the broad scope of transformative processes. Bidmon and Knab (2018) established the linkage between transition theory and sustainable business models by addressing the business models' three roles in transition research. This research bridges the research gap by providing insights into an innovative business model through interviewing electric vehicle sharing service (EVSS) providers and other stakeholders.

Although it is acknowledged that transition theory tends to underplay the role of individual firms and business model innovation, this thesis further argues that it also underplays the linkages between different types of firms operating within and between production and consumption systems. Chapter 6 illustrated the extent to which EVSS schemes work collaboratively with different types of stakeholders. Transitions cannot be fully understood without understanding the roles played by individual firms, and the operation of those individual firms cannot be understood without understanding how they interact within a 'consumption ecology'. While Sarasini and Linder's paper outlines the transition theory to business model gap, this thesis both addresses it and extends it by highlighting the significance of the localised relationships between the service providers and other stakeholders. Chapter 8 introduces the six 'petal' model (**Figure 8.2**) that illustrates these complexes, intertwined relationships between the business models of EVSS and other stakeholders. This conceptual model is then integrated into the framework of transition theory, offering a 'horizontally' oriented perspective of micro-level interactions to complement transition theory's conventionally 'vertical' presentation of macro-to-micro level interactions. This innovative approach demonstrates how the interdependencies between various business models can potentially give rise to distinct transition patterns. This contribution enriches the current understanding of transition theory by examining the role of business model interrelations in shaping the dynamics of transformative processes.

In terms of contributions towards business model theory, the thesis demonstrates the importance of extending considerations of relationships beyond the conventional (and relatively abstract) financial and strategic connections that characterise business models to include more interactions within the local market setting and environment that can help shape niches and regimes and can represent key factors for success. The success of an EVSS scheme is very dependent on things like local infrastructure planning and local traffic policy, but those are not simply environmental limitations on the businesses to be accommodated by strategies and business models. The businesses actively talk to governmental officials and seek to develop their business through negotiation and working together to solve problems (See section 6.4). Businesses can therefore sway local policies and regulations, but the success of private vehicle reduction services also depends on EVSS companies; reciprocally, these policies influence the operational strategies and success of the enterprises too. Such city-based interactions are important, but they are not the only influence on the business model. The intertwining of ICT within the business model adds another layer of complexity as does the novel challenge that EVSS can pose for companies operating in insurance markets.

Considering the complex nature of EVSS business models and the interdependencies with other types of business and market, the idea of a 'business model ecology' operating at the niche level is potentially helpful for both socio-technical transition theory and business model theory. Also, in terms of the current product service system theory, understanding how product service systems operate and interact can be helped by incorporating this idea of business model ecology.

A better understanding of EVSS businesses within Chinese cities can contribute to several different literatures. The most obvious and direct contribution is to the literature on eMaaS but it can also contribute to wider literatures concerning circular economy, industrial ecology and sustainable management.

In terms of eMaaS literature, the findings highlight the important role of parking provision, charging provision and policy, something not widely reflected in the eMaaS literature (Zarazua de Rubens et al. 2020). Future research can address this gap to consider the role of parking and charging provision and policy for eMaaS schemes (See section 9.4).

For the circular economy literature, Chinese cities have been identified as an important context in which to understand and implement more circular strategies and production and consumption systems, with mobility one of the important sectors (Ellen MacArthur Foundation 2018). While the potential of such circularity is reflected in government policy and academic discourse, this thesis provides establishing and operating new sharing-based mobility businesses. This also helps to rebalance the wider CE literature, which has tended to emphasise physical efficiencies achieved through product reuse, remanufacture or recycling rather than from shared use t al. 2016; McDowall et al. 2017; Junnila et al. 2018). The Ellen MacArthur Foundation (2018, p.10) states that the importance of: *"applying circular economy principles across five high-impact areas comprised of three urban systems: the built environment, mobility, and nutrition – and two industrial systems: textiles and electronics."* This thesis contributes towards two principal systems: the built environment, which provides low-carbon products for building a sustainable urban environment. While in terms of mobility, this thesis contributes towards building up a multi-modal sharing system by exploring EVSS's role in eMaaS provision. This thesis scales up a zero-emission form of travel by promoting EVSS as one part of urban transportation systems.

Similarly in the industrial ecology literature, the emphasis in understanding how to improve the material efficiency of production and consumption systems has been towards the production elements of these systems through strategies to reclaim and reuse raw materials or to co-locate complementary production facilities in eco-industrial parks. This thesis complements this through further exploration of the consumption elements of mobility systems and how material efficiency can be achieved, not just via the operational and physical elements of production and consumptions systems, but by their more strategic informational or relational elements. Sustainable mobility via EVSS provides a service and informational-based contribution to the circular economy via the sharing economy. Also, industrial ecology elements have conventionally focussed on production ecologies with the colocation of vertically linked production and consumption resources and systems via industrial symbiosis and eco-industrial parks. However, EVSSs represent a consumption ecology based more on strategic symbiosis and colocation of different elements of a consumption system. This thesis shows how it also complements classical industrial ecology's emphasis on physical colocation of production systems and industrial symbiosis between them within eco-industrial parks with an idea of co-location for consumption systems based on strategic symbiosis to create a form of consumption ecology.

In terms of the wider management and sustainable management literatures, these have both shifted away from a product and towards a service orientation to improve both sustainability and consumer relationships by emphasizing interaction and communication with consumers. The turn towards a 'service-dominant logic' in marketing and strategy highlights the importance of building relationships with consumers, of the information needed to accomplish this, and of involving consumers in the co-creation of value (Lusch et al. 2007). Such servitisation of markets might be assumed to shift the emphasis away from technologies in the form of products and towards human resources, emphasising the importance of employees (Vargo et al. 2007). However, in the case of the EVSS schemes studied here, servitisation counterintuitively went hand-in-hand with technological intensification, with increasingly advanced technology vehicles, and a seamless service experience delivered via mobile phones, being used to entice consumers to adopt and use EVSS.

In terms of a contribution towards the business ecosystems literature, this thesis has provided an exploration of Chinese EVSS as a form of business ecosystem and an examination of business model innovation within it. This thesis explores a view of the entire EVSS ecosystem which contains regulation, technology, markets, public goods, a range of stakeholders, and also a set of interactions between the business models of EVSS providers and players in other industries as explained in the Six Petals model. Arguably what is demonstrated is that EVSS represents both a form of business ecosystem, and an intersection between other forms of business ecosystem such as for mobile phones or the internet. The scale and power of those ecosystems is such that it raises the question of whether in future EVSS providers will become the mobility-providing element of the business models of powerful players from those other business ecosystems.

9.3 Practical implications

For both practising companies, and government policymakers, the findings have implications. At an individual level EVSSs address urban citizens' daily mobility needs, but at a societal level they have the potential to weaken the symbolic value users associate with vehicles, the internal combustion engine, brand images, and the conventional mobility model centred around the benefits of individual car ownership.

Although EVSS can be better understood via a business model lens or a transitions theory perspective - there is more to them than a product and consumption system to meet a core need for mobility. The assumption of private car ownership and use as central to peoples' reality of, or aspirations about, personal mobility has shaped, not just peoples’ values and lifestyles, but also the structural fabric and design of cities, their infrastructure, and peoples' homes. EVSSs have begun to have a transformative effect by combining shared access to a more sustainable 'hard' technology (electric vehicles) and an innovative service business model (EVSS). Adding in the innovative 'soft/info' technology represented by autonomous driving, could significantly accelerate this transformation process.

This thesis began with an assumption of EVSS representing a new sharing economy-based business model to provide more sustainable mobility that would exist alongside existing travel modes including ride hailing services and traditional taxis. One surprising result from the findings was the extent to which the current EVSSs are perceived as a ‘stepping stone’ towards new autonomous vehicle-based services which are likely to involve the integration of those currently separate types of service provider. This, and the extent to which information technology and software companies are likely to challenge vehicle manufacturing companies for control of this emerging market, will be important in understanding how mobility systems and businesses within Chinese cities are going to evolve, and be impacted, in the future.

In terms of the implications for vehicle stocks and manufacturing volumes, from a CE perspective, EVSS is intended to have sustainability benefits by requiring fewer cars to be manufactured, but the policy push behind EVSS in Chinese cities was partly driven by a need to get the market to ‘absorb’ built-up stocks of EVs. SEVs are therefore promoted by OMEs to release the stock caused by hyper-production. Although this provides a medium-term solution. the normalisation of widespread EVSS use will require OMEs to produce fewer EVs in the long-term, and policymakers will need to reconsider their EV policies to avoid worsening overproduction and associated environmental problems.

Another potential implication of a future shift away from urban driving as a component of urban mobility provision is the loss of driving as an element of consumer behaviour and a life skill. If autonomous technology becomes commonplace, stakeholders such as driving test centres and driving schools will also be impacted.

Ideally EVSS business models and design will provide a more circular mobility system that facilitates multi-modal shared urban mobility. This can then be complemented by vehicle design that emphasises zero-emissions, longevity and avoiding waste, and OEM production strategies that shift towards complete EVs and emphasise using more recycled materials. As EVSS markets mature they can impact the transport system more widely by integrating current online-hailing service, taxi services and other renting models into one system, which will become a main part of city-based mobility paradigms.

9.4 Policy implications

The findings show that EVSSs are operating in a dynamic environment (See figure 8.3) with technological information innovation evolving rapidly, with physical infrastructural development lagging behind (e.g., Traffic police department) and a diversity in users' preferences. There are obvious policy implications in that, if policymakers want to achieve more sustainable and 'liveable' cities with lower levels of private car ownership, air pollution and traffic congestion, they need to support EVSS providers through policies and practical measures to deter private car use and encourage EVSS use (e.g. parking provision or access restrictions) and working together with providers to solve problems through negotiation and interaction (See section 8.4). Policy involvement plays an important role in shaping EVSS schemes, at local/city, national and regional levels, and the policy agenda can make a significant difference. Furthermore, the unique 'sharing' nature of EVSS, which involves sharing the entire system rather than just a specific product, underscores the importance of understanding policy impact dynamics at various levels for the promotion and support of EVSS. For example, if the city of Shanghai passed a regulation for a vehicle that was difficult for OEMs to meet, they could not afford to ignore it and be unable to sell in Shanghai.

Policymakers can play an important role locally by integrating EVSS into future urban infrastructure and planning for parking and charging outlets suited to Shared Electric Vehicles (SEVs). In the urban transportation systems, the integration of autonomous driving within ground transportation design merits consideration and will potentially have impacts on taxi and ride hailing providers in terms of employment which may trigger resistance (something which may have a limited impact on Chinese cities but could be significant if the technology then spreads to other countries).

The findings also indicates the policy and regulation beyond those directly governing mobility markets including insurance provision and the application of the social credit policy. In term of insurance concerns, there is a need for policy makers and insurance companies to work to redefine the concept of 'commercial vehicle use' to accommodate SEVs. Policymakers might also explore options for financial support to EVSS providers to cover part of the insurance purchases. This could help service providers to overcome the barriers related to road accidents involving EVSS and prevent instances of insurance claim refusals (See section 6.4.1.5).

In terms of the implications linked to the evolution of mobility markets away from simply mobility technologies and towards information technologies, the finding indicate that different types of companies (See section 8.5) will have increasing power in the EVSS market in future. For example, a company like Baidu, which has not been a traditional player in mobility markets but is a powerful player elsewhere, is entering the market, and it may have the critical mass and power to dictate the terms of the market in future. Therefore, it is becoming less of a market driven by vehicles and individual consumers, to a market driven by information technology and data. Given the increasing reliance on complex technologies like 5G and cloud services for transportation accessibility, the question arises: What are the implications for the accessibility and reliability of transportation services in the event of system vulnerabilities or disruptions, such as power outages? This has direct implications for the design, operation, and regulatory oversight of future mobility services, which implies that OEMs and urban planners need to consider robustness and resilience in addition to efficiency and convenience.

9.5 Research limitations

This thesis, like any other, is subject to potential limitations linked to data collection methods, research context, sample size, and analytical approach. It was also conducted during a time in which many forms of social science research were impacted by the global pandemic. This introduced some limitations, for example requiring much of the primary data gathering to take place from the UK and precluding opportunities to observe the EVSS schemes operating in practice.

Chapter five explains that the thesis uses Zoom as the primary data collection method. Although this proved to be efficient (See section 5.4.5) and ‘agile’ in terms of being able to take advantage of interviewees’ availability due to the lock-down policy in China, the opportunity was lost to conduct face-to-face in-situ interviews that may have generated further and§ more insightful ideas (Bryman 2012).

The second limitation was imposed by this thesis using one area of one country, which may hinder the researcher from understanding more comprehensively how EVSS operate across China and beyond.

The samples used created the third limitation. The sample of EVSS operators and related stakeholders was sufficient for the researcher to investigate the EVSS schemes within the Chinese urban mobility context and gain some rich insights for this thesis. However, a larger sample size to make this 'world' more perfect (Bryman 2012) would have been beneficial, particularly in terms of a wider range of policy-based stakeholders across the geographic region. This research also did not attempt to conduct in-depth research with a wide range of consumers, as the researcher was not attempting to pursue a consumer behaviour thesis, but instead sought to understand urban citizen's perceptions towards EVSS and autonomous vehicles (e.g., why they do or do not use EVSS and autonomous vehicles) sufficiently to understand their impact on EVSS' business models and the potential evolution of eMaaS schemes.

The fourth limitation is generalisability, as this thesis did not use a quantitative approach. Chapter five indicates that EVSS is a new embryonic field, and quantitative studies would face significant limitations. Therefore, a qualitative approach was judged as most valuable, even if using a quantitative approach would have provided greater generalisability for the thesis.

9.6 Future research and opportunities

This thesis addressed the perceived lack of individual firm focussed research in the transition theory field as a core research gap in relation to sustainable mobility. The findings generated demonstrate that successful EVSS schemes rely on a successful business model (with five key forms in operation), appropriate policy support and urban infrastructure, and symbiotic interactions with other firms' business models (as represented by the six 'petals' model). It also indicates that EVSS development to be just one point in a wider evolution of urban mobility within Chinese cities and its sustainability.

Therefore, the following research opportunities are suggested by the work conducted here and its findings:

Firstly, this thesis addresses the research gap concerning the role and behaviour of individual firms within transition theory (Sarasini and Linder 2018; Ruhrort 2020; Sarasini and Langeland

2021). The six ‘petals’ model demonstrates the importance of interactions with other stakeholders’ business models for EVSS’ business model, at the niche level. Thus, future opportunities can focus on how these stakeholders’ business models interact and connect in ways that may also indicate intersections between regimes and landscapes that may be important to understand how sustainability transitions operate in practice.

Secondly, in terms of product-service systems, future research can investigate other products or services (e.g., informational-based products) role at the niche level as well as its business model innovation (Wells and Nieuwenhuis 2018). The evolution of EVSS within Chinese cities suggests that the balance of importance between information technologies and mobility technologies is shifting, with likely implications for the balance of power between information technology and vehicle providers, which will be an interesting topic for future research.

Thirdly, the findings highlighted the prosaic but important role of parking and charging infrastructure provision and policy, which is a practical constraint and influence on eMaaS. However, it is not widely reflected in the eMaaS literature and therefore provide future research opportunities to take into account their practical importance.

Fourthly, in terms of future urban mobility to address parking availability and congestion of road transportation (See section 7.3.4), the opportunities can be explored for urban air mobility solutions within eMaaS schemes (Choi et al. 2023) and the extent to which they could genuinely represent affordable and sustainable solutions in future.

Fifthly, although the SD logic is not featured in the literature review of this thesis, its relevance was appreciated during the conclusion stage of writing (see section 9.2). It was not developed further to avoid a new key concept being introduced relatively late in the development process of a thesis which already contains numerous themes. SD logic may provide directions for future research, especially as mobility moves towards mobility-as-a-service schemes. This thesis indicates a progression towards technology which might initially seem counterintuitive. It might seem paradoxical that as this market moves further into service-based systems and apparently away from product-based systems, it is also becoming increasingly reliant on technology. This notion mainly seems counterintuitive in the context of mobility, though it becomes less so considering the proliferation in urban citizens’ lives of online services, which are inherently both service-based and technology-driven.

The thesis began with EVSS as a visible phenomenon in the region that the author comes from, which is impacting daily life there, and that also represented a market opportunity for the vehicle industry that the author had experienced. The author also appreciates EVSS business models as an important part of the story and that the part they could play in sustainability transitions was not fully understood, because of the gap that existed between the transition theory and business models literature. Exploring it further led the author to grapple with the complexities involved in trying to apply production and consumption systems perspectives and appreciate the interconnectedness between systems that makes sustainability ultimately so challenging to measure and manage. The resulting picture, combining EVSS provision with new information technologies, means that, although some elements of the findings are context-specific, the research as a whole may provide an important view of the future urban mobility systems and their sustainability which will have profound implications for the lifestyles (and associated impacts) of urban dwellers globally.

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11. Appendix

Appendix A: EVSS

1. Supai (since 2009) EVSS（since 2017

Supai, established in 2009 and with more than 300 employees, operates in a range of businesses including car rentals, car sales, and used car dealership. In 2017, Supai applied the car-sharing model to its car rental services, a response to the government's call for "low carbon and environmental protection". This significantly expanded the company's market share in car rentals and provided important support for the company's transformation and development. As a pioneer in the field of car sharing, it is representative of private enterprises.

2.Universal Motor (since 2012)

In response to the national electric vehicle subsidy policy, Universal Motor launched an electric vehicle sharing service. Established in 2012, the company primarily caters to C-side customers and a small number of B-side customers. Due to the low threshold (free for initial users and the App will offer promotional codes frequently) of using the EVSS, it is quite popular among customers, leading to a positive market response on the company's platform and high brand recognition. This enhancement in customer usage frequency gives car sharing a competitive edge over long-term rentals. In Suzhou, Universal Motor was the earliest car-sharing service platform to collaborate with the tourism industry.

3.BaiShi EVSS (since 2015)

Since its establishment in 2015, the company has been involved in car rental services. In 2017, based on its understanding of brand image in terms of EVSS, it launched an electric vehicle rental service. The company primarily uses big data for location-based rentals and conducts market promotions through e-commerce platforms such as Ctrip and 58.com. It uses multiple channels to acquire customer information and expand its customer base. In 2023, the company collaborated with Gofun and opened up its backend services. BaiShi EVs' car-sharing service is a representative private enterprise.

4. Gofun EVSS (since 2018)

The company is one of the earliest domestic firms to provide professional car rental services. The wholly-owned parent company is Beijing Shouqi (Group) Co., Ltd., founded in 1951.

Shouqi Leasing summarised and organised its five main businesses in 2014: short-term self-driving, business vehicles, targeted long-term leasing, hailing-service with drivers, and finance leasing. The company faces its customers with a modern, networked boutique operating style, equipped with experienced, road-savvy, highly skilled, and law-abiding drivers. All vehicles are equipped with GPS satellite positioning navigation, making all services safer, faster, and more efficient.

Gofun's national branches and partners cover all first-tier cities in the country. Nanjing Shouqi Car Rental Co., Ltd Gofun initially conducted online car-hailing and vehicle rental services. With the emergence of diversified rental services in the market, it launched car-sharing services and is one of the few large service providers in the country, providing significant research value.

5. LD EVSS

LD EVSS is a a large-scale online mobility operator in the country, strategically prioritising car rental, and is committed to creating an industrial structure of "closed-loop operation of the car value chain" and "multi-platform cross-border win-win". Their online rental platform (Cloud renting) actively explores new value chains and launches "Changyou Rent", "Leading Energy", "Landa Car Service", and "Enjoy the Start" services. In December 2018, LD EVSS shared cars were introduced in 100 cities. Currently, its rental has entered more than 360 cities nationwide, with over 40,000 car use sites, and has put into operation over 100,000 high-quality sedans and SUVs. By continuously optimising and upgrading the all-round experience of their APP, it gradually realises the intelligence and efficiency of daily operations, providing a convenient, safe, and high-quality car rental service experience for over 40 million users, ensuring that users can use cars easily anytime, anywhere, and solidly implement the corporate mission of "making car use simpler".

6. LD Go EVSS (since 2018, Suzhou)

The Suzhou branch is one of the earliest branches established by the LD GO Group, primarily engaged in car rental services. Since the introduction of the sharing concept in the industry in 2018, it has started to carry out car rental business using a sharing mode. The company primarily relies on customer resources accumulated from the traditional rental model and has derived its own EVs from this, which serves to attract customers. As one of the earliest enterprises engaged in car rental services, its early practice of car-sharing services can provide reference value for researching car sharing services.

7. Car Inc (since 2011)

Car Inc is a well-known brand and travel service provider in China, offering car rental and fleet rental services for individual and corporate users. The company is committed to promoting green travel and a new car consumption culture, leading the development of China's car travel service industry. With its service network spread across major cities and tourist areas on the Chinese mainland, professional 24-hour car pick-up and return services, customer service, and additional services such as free GPS navigation and roadside assistance, it meets customers' car rental needs anytime, anywhere, ensuring their journey is safe and smooth.

8. EVCARD (Suzhou)

EVCARD is an online, full-time, all-scenario car rental platform under the Global Car Sharing division of SAIC Group's mobility and service business module. It mainly relies on the industrial and industry resource advantages of SAIC Group and Shanghai International Automobile City Group. Starting with "time-sharing", it adopts new energy vehicles and is a leading brand in China's electric vehicle time-sharing rental market. SAIC Group's EVCARD (Suzhou) primarily targets the "time-sharing" rental service business in the Suzhou, Changshu, and Zhangjiagang markets. Currently, in the shared vehicle market it has deployed 5,000 vehicles, and since its registration in 2016, it has enjoyed a large user base.

9. EVCARD (since 2016) Shanghai

"EVCARD" is the world's largest electric vehicle time-sharing rental brand under SAIC Group, a leading company in China's car-sharing industry, and a "Shanghai Traffic Safety Public Welfare Partner". It focuses on new energy vehicle time-sharing rental as its core business, and is an innovative company committed to developing car sharing as a strategic goal. EVCARD Global Sharing advocates electrified, intelligent, and networked shared travel solutions, adheres to the concept of "sharing, environmental protection, efficiency, and innovation", and follows the development path of "based in Shanghai, layout across the country, and moving towards the global market". It aims to break down the barriers in the car-sharing industry and has reached cooperation agreements with major retail platforms such as Fliggy, Ctrip, and Hema through platform interconnection to jointly enhance the ability to connect the world, layout the new EVCARD business model, and strive to build a globally leading car-sharing platform and service ecosystem.

SAIC Group's EVCARD has expanded its coverage in 65 cities across 22 provinces in the country, deployed more than 50,000 vehicles, and accumulated more than 8.5 million registered users. It provides people with convenient, economical, and green shared travel services. It actively develops urban joint transportation and multi-city interaction, implements strategic and demographic layout in various regions and cities such as the Yangtze River Delta, Pearl River Delta, Chengdu-Chongqing, and Beijing-Tianjin-Hebei, fills the gap in medium and long-distance mobility in cities, and builds brand advantages.

Based on EVCARD (since 2016) Shanghai's industry-leading position and brand advantages in the shared car industry, choosing it as a case study for the research of electric vehicle sharing services has important value.

10. AUTO Travel (since 2013) Nanjing

AUTO Travel is a new car rental platform launched by Shanghai Xinyu Information Technology Co., Ltd. Founded in 2013, it was one of the first to introduce the "car sharing concept". Through providing a richer selection of vehicles, its services include time-sharing rental, short-term rental, long-term rental, various luxury car rentals, personal car rentals and more. The brand evaluation index is 71.5, ranking third in the 2023 shared car platform list of power rankings (Professionally evaluated by CN10/CNPP brand researchers)[1].

[1] The 2023 ranking rules are as follows: The data for the top six shared car brands is collected and organised by the CNPP Brand Ranking Big Data 'Research Institute' and the CN10 Ranking Technology 'Research Institute'. Based on big data statistics and professional evaluations derived from analyses of market and parameter changes, the results are a true and objective representation of big data, cloud computing and data statistics. CN10/CNPP is a long-standing, objective and impartial evaluation research institution/big data cloud computing company in China. Through the extensive collection, organisation, and compilation of a large amount of global data, combined with professional independent research evaluations, they regularly publish and update objective and fair rankings.

Appendix B: Hailing and other services

1.Public transport department (Suzhou)

Founded in 1959, Suzhou Bus operates primarily in public transportation and is a key service provider in Suzhou's urban public transportation system, playing a proactive role in improving passenger service quality and establishing a diverse and comprehensive urban public transportation system.

In 2021, under the decision and deployment of the municipal government, Suzhou initiated a deep reform of the urban bus system, integrating the original city bus, park, new district, Xiangcheng, Wuzhong, Wujiang bus, and Xin Hui bus, seven bus companies in total, to form a nationally funded bus group, which is listed as a first-level state-owned enterprise of the city, realizing the overall coordination and integrated management of bus resources. The integrated bus group has total assets of about 5.5 billion yuan, operates 640 regular bus routes in the city, involving 268 bus terminuses, and covers the Suzhou urban area including Wujiang district. The group owns 6,362 vehicles, of which more than 87.8% are new energy vehicles, covering the entire main urban area; it has a total of 11,571 employees, including 9,091 drivers. Since 2022, the average daily operating mileage is about 700,000 kilometres, and the average daily passenger flow is about 500,000 people.

Suzhou Bus plays a significant role in the field of shared public transportation in Suzhou and is an important case study for shared public transportation research.

2.Baishi Shunxin (Suzhou)

Baishi Shunxin Car Rental Co., Ltd, established in 2015, is a car rental company. In an era when car rental methods are gradually diversifying, in order to meet the diverse travel needs and different individual choices for mobile transportation, the company established a department (see Baishi EVSS) to provide sharing services in 2017.

3.Baidu (Jidu automotive) Shanghai

Since its launch in 2005, Baidu Maps has adhered to the brand mission of "technology makes travel simpler" and has continuously explored innovation with "technology" as a means. It has developed into a leading internet map service provider in China. Baidu Maps has global geographic information service capabilities, including intelligent positioning, POI retrieval, route planning, navigation, road conditions, real-time buses, and more. Baidu (Jidu automotive)

Shanghai is a mobile travel service module launched by the Baidu Maps APP. Based on Baidu Maps' powerful positioning function and rich customer resources, Baidu's ride-hailing service has become a popular online ride-hailing brand.

4. Xiaopeng Car (Suzhou)

Xiaopeng car is part of Xpeng Motors which is a leading Chinese electric vehicle brand with a global reach. The company pursues intelligent and beautiful designs in its comprehensive and diversified development process. As a leader in smart cars, it continues to lead in fields such as intelligent driving, interactive experience, and the Internet of Things, with cumulative R&D investment exceeding 12.5 billion yuan. Its core vehicle systems are independently designed, developed, and manufactured, including key technologies related to powertrain and electronic electrical architecture, and it provides excellent and reliable vehicle performance. Based on the self-developed full-stack second-generation voice architecture, it is the first in the industry to introduce full-vehicle, full-time voice interaction features, achieving innovative functions such as multi-person without wake-up, multi-person simultaneous car-voice dialogue. The company puts customers at the centre, using technology to create a more convenient and pleasant travel life for humans. Its user size has experienced rapid growth, and by the end of 2022, the cumulative delivery volume had exceeded 250,000 units.

As a leading brand of electric vehicles, it holds an important position in the field of shared public transportation, especially green shared transportation, and it has significant practical significance for this study.

5. ShouQi hailing service Suzhou

Shouqi Car Hire is an online ride-hailing platform created by the Shouqi Group in response to the call from the Ministry of Transport. It aims to actively embrace the internet, drive the transformation and upgrade of the traditional taxi industry, and strengthen the construction of a strong transportation nation. Since its launch in September 2015, Shouqi Car Hire has focused on creating quality travel services around the core brand value of "high quality". Insisting on state guest-level service and a compliant, trustworthy brand image, it has become the preferred brand for business travel users. Additionally, Shouqi Car Hire actively complies with local online car-hailing policies, becoming the currently preferred platform on the market for compliance and safety guarantees. Furthermore, it has become the vehicle support for important national conferences such as the 2016 Hangzhou G20 Summit, the 2017 BRICS Summit, the

2018 SCO Qingdao Summit, and the 2019 "Belt and Road" International Cooperation Summit Forum.

In terms of car-hire services, Shouqi Car Hire platform offers instant car use, scheduled car use, multi-day transfers, charter services, airport transfers, international car use, inter-city carpooling, Shenzhen-Hong Kong commuting, and other car service scenarios. It provides a range of vehicle types including taxis, buses and different vehicles emphasising enjoyment, comfort, business and luxury. Shouqi Car Hire has also launched products such as "Mum's Car", "Student Car", and "Conference Treasure" through data integration and smart technology to meet the business and personal travel needs of different groups and scenarios. With the arrival of the 5G era, Shouqi Car Hire has also started a pilot project for online car-hailing mobile business based on 5G edge computing, exploring the application and expansion of edge computing in the travel sector in the 5G era, driving the development and upgrade of the travel industry, and leading the era of smart transportation.

6. Xiao Che dong hailing service (Suzhou)

Suzhou Xiaochedong Automobile Service Co., Ltd. is a company engaged in the business of car transfer, insurance services, annual inspections and more, established on December 9, 2016, located in the city of Chinese gardens - Suzhou. In the 7 years of the company's growth and expansion, it has always provided customers with good products and technical support, and comprehensive after-sales service. The company's business covers car business agency, car designated driver services, car rental, car sales, etc.

The company is mainly engaged in traditional car rental and taxi services. Under the continuous impact of diversified rental methods in the market, it can more acutely feel the ever-changing market environment and competitive pressure, as well as the challenges brought to the traditional industry. Based on this, it is an important case study for this research.

7. Tubu hailing service

Tubu is a brand under Suzhou Tubu Car Rental Co., Ltd. Suzhou Tubu Automobile Company was established in August 2016. At present, Tubu Car Rental Company manages 3 city branches in the Suzhou area.

In January 2018, the Xiaoma Ant Automobile Service Co., Ltd. was established. In order to rectify and standardise the Suzhou ride-hailing market and improve the investment environment, with the support of relevant departments, an investment of 30 million yuan was made to purchase 100 brand new Leiling Dual Engine and 200 brand new BAIC EU5 new energy vehicles to the market, actively responding to the national call for "green travel, low-carbon life", setting a benchmark for the ride-hailing industry. In 2020, the company expanded its scale, invested millions, and launched green freight in line with market demand, providing convenient and secure car usage experiences for city commuting and delivery. It aims to bring more high-quality and comprehensive services to customers, making the ride-hailing market more standardised and perfect.

As a well-known enterprise brand, Tubu has promoted the development of the local ride-hailing market. It is a model of a well-known enterprise in promoting the transformation of the company's business model and is a good research case.

8. DIDI hailing service (Suzhou, Wuxi and Lianyun gang)

DiDi Global Inc. is an exceptional global mobile transportation technology platform, providing diversified travel services such as ride-hailing, taxi hailing, chauffeuring, and carpooling in markets such as Asia Pacific, Latin America, and Africa, and operating vehicle services, take-away, freight, and financial businesses. DiDi Travel is a one-stop travel platform covering taxis, private cars, DiDi Express, carpooling, chauffeuring, and buses, freight, and other businesses. The business covers more than 400 cities in China, with total revenue in 2021 of 173.83 billion yuan.

The "DiDi Travel" App has changed the traditional way of hailing a taxi, establishing and cultivating modern travel methods for users in the era of the large mobile Internet. Compared with traditional telephone hailing and roadside hailing, the birth of DiDi Taxi has changed the traditional taxi market pattern, subverted the concept of roadside flagging down, and used the characteristics of the mobile Internet to integrate online and offline. From the initial stage of hailing a taxi to getting off and using online payment for the fare, it draws a tightly connected O2O closed loop between the passenger and the driver, optimising the passenger's taxi experience to the maximum, changing the traditional way for taxi drivers to wait for customers, and allowing the driver to "accept orders" according to the passenger's destination at will, saving the communication cost between the driver and the passenger, reducing the empty ride rate, and saving the resources and time of both the driver and the passenger to the maximum.

DiDi Travel is a very influential ride-hailing service platform in China. Data before DiDi's rectification shows that it holds more than 87% of China's private car market share and more than 90% of the ride-hailing market share. In September 2022, DiDi Travel's market share was 77%. DiDi Travel's market volume is large in the Jiangsu, Zhejiang and Shanghai areas, and is particularly large in Suzhou and Lianyungang, therefore it has significant reference value for the research topic.

9. T3 mobility (Supplier)Hangzhou

T3 mobility is a smart travel ecosystem platform created by Nanjing Ling xing Technology Co., Ltd. The company, with the brand vision of "becoming the most trustworthy travel service enterprise" and the mission of "technology leads to enjoyable travel", advocates a "trustworthy, freer" travel concept. It is committed to providing "trustworthy, safe, quality" travel services to allow 120 million users to experience a freer travel experience. T3 mobility is the first travel platform in China to deeply apply the vehicle-networking architecture, using centrally purchased customised and intelligent new energy vehicle models, with drivers who have undergone strict review. The V.D.R safety protection system is created to comprehensively ensure passenger travel safety and ride experience.

T3 mobility, with the brand vision of "becoming the most trustworthy travel service enterprise", is committed to becoming a technology-innovative enterprise providing "safe, convenient, and quality" travel services for users through a powerful travel platform, cooperation with local transportation enterprises, integration of service resources, and customised products. T3 mobility Hangzhou has a large-scale automobile repair factory, specifically for the inspection and repair of T3 mobility vehicles. They are familiar with the operation of the T3 mobility market and can provide relevant information for this study from the perspective of vehicle damage, making it a good case study.

Appendix C: The business model canvas (developed by the author)

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
The EVSS collaborates with Original Equipment Manufacturers (OEMs), policy departments, repair services, and possibly insurance companies. They also see competitors as potential partners, indicating a cooperative mindset in the industry.	The EVSS engages in managing its online platform, improving and maintaining vehicle fleet, implementing AI and autonomous driving tech, ensuring vehicle availability and utilisation, cooperating with policy departments and stakeholders, and maintaining a good reputation. **Key Resources** Key resources for EVSS include the vehicle fleet, the online platform (ICT), AI and big data capabilities, charging infrastructure, and human resources.	EVSS presents itself as the future of urban mobility with its low-carbon footprint, technology-driven service, and affordability. The convenience of an online platform and access to a range of vehicles and services (such as autonomous driving) serve as key selling points. Additionally, EVSS can alleviate urban problems like expensive parking and heavy traffic congestion.	Customer relationships are managed through an online platform and customer service channels. The EVSS aims for high customer retention and satisfaction, often offering coupons and vouchers to incentivise repeated use. The company also maintains a relationship through a national credit system. **Channels** Customers are accessed through online platforms, using ICT and big data to connect with and understand their needs. These platforms can be promoted through digital marketing, including on social media platforms such as WeChat and TikTok. Physical outlets are also considered an important channel.	The EVSS in China seems to be targeting both B-side (business) and C-side (consumer) segments. B-side customers may use EVSS for logistical support or company use while C-side customers could represent the general public who might use the service for convenience, cost-effectiveness, and as an environmental beneficial option. The customers prefer services that are low-cost, convenient, and that offer a good driving experience.

Cost Structure	Revenue Streams
Major costs include those related to vehicle procurement, maintenance, and replacement, operating costs (such as parking and charging), ICT development and management, marketing, and customer service. It's mentioned that financial support may be needed to cover some of these fixed costs.	The EVSS earns profits from the commission on each ride, penalty charges from users for infractions, and possibly from maintenance services. Partnerships with OEMs might also offer financial benefits.

Appendix D: Ethical approval

Monday, May 29, 2023 at 14:23:40 British Summer Time

Subject: Your ethics application has been APPROVED: ID 784; Service or own a car, a sustainable transition view
Date: Monday, 29 May 2023 at 14:22:54 British Summer Time
From: Tiansheng Yang
To: Tiansheng Yang

Dear Tiansheng Yang,

Research project title: Understanding the transition towards sustainable product-service systems as providers of personal mobility in China. A consumer orientated case study of electric car sharing schemes in Yangtze River Delta Economic Circle.
SREC reference: 784

The School Research Ethics Committee (SREC) reviewed the above application via its proportionate review process.

Ethical Opinion
The Committee gave a favourable ethical opinion of the above application on the basis described in the application form, protocol and supporting documentation.

Additional approvals
This letter provides an ethical opinion only. You must not start your research project until all any other approvals required for your research project (where relevant) are in place.

Amendments
Any substantial amendments to documents previously reviewed by the Committee must be submitted to the Committee via CARBS-ResearchEthics@cardiff.ac.uk for consideration and cannot be implemented until the Committee has confirmed it is satisfied with the proposed amendments.

You are permitted to implement non-substantial amendments to the documents previously reviewed by the Committee but you must provide a copy of any updated documents to the Committee via CARBS-ResearchEthics@cardiff.ac.uk for its records.

Monitoring requirements
The Committee must be informed of any unexpected ethical issues or unexpected adverse events that arise during the research project.

The programme director would include your research in end of project report. The Committee must be informed when your research project has ended. This notification should be made to CARBS-researchethics@cardiff.ac.uk within three months of research project completion.

Documents reviewed by the Committee
The documents reviewed by the Committee were:
Application ID: 784
Link to applications list, where you can access the reviewed version.
CARBS RESEARCH ETHICS COMMITTEE(V05).docx
Consent Form （V02).docx
Ethical trainning.png
Interview Guideline.docx
Participant Information Sheet (V02).docx
SREC- feedback form - July 2021 version(01).docx

Complaints/Appeals
If you are dissatisfied with the decision made by the Committee, please contact Dr Carmela Bosangit (BosangitC@cardiff.ac.uk) in the first instance to discuss your complaint. If this discussion does not resolve the issue, you are entitled to refer the matter to the Head of School for further consideration. The Head of School

may refer the matter to the University Research Integrity and Ethics Committee (URIEC), where this is appropriate. Please be advised that URIEC will not normally interfere with a decision of the Committee and is concerned only with the general principles of natural justice, reasonableness and fairness of the decision.

Please use the Committee reference number on all future correspondence.

The Committee reminds you that it is your responsibility to conduct your research project to the highest ethical standards and to keep all ethical issues arising from your research project under regular review.

You are expected to comply with Cardiff University's policies, procedures and guidance at all times, including, but not limited to, its Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and our Research Integrity and Governance Code of Practice .

Yours sincerely,

Dr Carmela Bosangit
Chair of School Research Ethics Committee

Participant ID no:
Do not include box for

Appendix E: Consent form

CONSENT FORM

Title of research project: **Understanding the transition towards sustainable product-service systems for personal mobility. A study of electric vehicle sharing schemes in China's Yangtze River Delta Economic Zone.**

SREC reference and committee: 784 CARBS SREC

Name of Chief/Principal Investigator: Tiansheng Yang

	Please initial box
I confirm that I have read the information sheet dated 27/04/2022 version 02 for the above research project.	
I confirm that I have understood the information sheet dated 27/04/2022 version 02 for the above research project and that I have had the opportunity to ask questions and that these have been answered satisfactorily.	
I understand that my participation is voluntary, and I am free to withdraw at any time without giving a reason and without any adverse consequences (e.g. to medical care or legal rights, if relevant). I understand that if I withdraw, information about me that has already been obtained may be kept by Cardiff University.	
I understand that data collected during the research project may be looked at by individuals from Cardiff University or from regulatory authorities, where it is relevant to my taking part in the research project. I give permission for these individuals to have access to my data.	
I consent to the processing of my personal information like name, age, educational qualifications and gender for the purposes explained to me. I understand that such information will be held in accordance with all applicable data protection legislation and in strict confidence, unless disclosure is required by law or professional obligation.	
I understand who will have access to personal information provided, how the data will be stored and what will happen to the data at the end of the research project.	

Participant ID no:
Do not include box for

I understand that after the research project, anonymised data may be made publicly available via a data repository and may be used for purposes not related to this research project. I understand that it will not be possible to identify me from this data that is seen and used by other researchers, for ethically approved research projects, on the understanding that confidentiality will be maintained.	
I consent to being video recorded for the purposes of the research project and I understand how it will be used in the research.	
I understand that anonymised excerpts and/or verbatim quotes from my INTERVIEW may be used as part of the research publication.	
I understand how the findings and results of the research project will be written up and published.	
I agree to take part in this research project.	

____________________________ ____________________ ____________________
____

Name of participant (print) Date Signature

Tiansheng Yang____________ 27/04/2022_____ ______________________________
____

Name of person taking consent (print) Date Signature

Principal Investigator_______
Role of person taking consent (print)

THANK YOU FOR PARTICIPATING IN OUR RESEARCH

YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP

Appendix F: Interview Guideline

Aim of the Research

The purpose of this research is to understand the transition towards sustainable product-service systems (i.e. car sharing services) by service providers of personal mobility in China through exploring how business models influence stakeholders' acceptance of Electric Vehicle-based sharing services (thereby exploring how sustainable business models can evolve beyond a niche market).

Research questions

- A: To what extent, and how, are new sustainable business models providing successful sharing-EV service businesses in China?
- B: What is the potential of EVSS to reduce individual car travel and minimise vehicle ownership, and how is this affected by its attributes?
- C: Using transition theory, how can existing shared mobility business models develop an effective relationship between service providers and the local stakeholders to promote sustainable mobility?
- D: What are the factors that affect sharing-EV program participants' car ownership changes in terms mobility behaviours and attitudes towards car ownership?
- E: What factors affect eMaaS (taking sharing-EV service as an example) businesses and in what ways?

Semi-Structured Interview Guidelines

Part A: For Service Providers

Initial Background/General Topics

- **Overview of the organisation** (i.e. name of the company, main service/product, ownership, number of employees, operating years, average annual sales, type of business alliance (i.e. suppliers/manufactures/retailer/others), major customers [1], current business models.
- **Overview of the interviewee** (i.e. department, job responsibility, length of time in current role, level of education, gender).

The knowledge and perception of sustainable business model (SBM)

[1] The major customer those accounts for the largest percentage of your sales.

1. How was the business started? (Was it by an entrepreneur, as a new venture for an existing business, a collaboration between existing businesses? (A)
2. How does your business generate much of its revenue? (A)
3. How has the business/organisation evolved since it was established or while you've been working for it? (A) (Open-ended question: Capture the components like "business model", "cars and energy", locations for cars and links to ICT for the system to operate).
4. Do people within the company/organisation ever use the phrase 'business model' when describing how it operates? (A) If yes, What do you understand by the term 'Business Model' and how would you describe it? If no, go to next question.
5. How did your company come to enter the EV-sharing service market? (Seek to establish whether it was opportunity driven (a new market exploit) or threat driven (e.g., Keeping up with competitors or old markets declining)).
6. Who are your customer types? What motivates them to use your service? What are customers looking for from your service? What are their priorities? How do you get information about what your customers want? (D)
7. How do you see this market evolving? (In respond to company's future business/from a competitive perspective). (A)
8. How did you expect the move into EVS to impact your relationship with customers and their satisfaction levels? How do you think it impacted customers and their satisfaction in practice? (E&D) (open-ended)
9. How does your customer find out about your sharing-service and engage with it – how do you reach them? (B&D)
10. In what ways do you think government policies impact your business? In what ways do policies and planning at the city level impact your business? (D)
11. Are you familiar with the government's policy regarding to EV sharing-service? What's your opinion about it? (E)
12. How important will EV-sharing services be to the business in terms of its future? (A)

<u>Motivation to participate in EVSS</u>

13. What stakeholders have affected your company's participation in EV-sharing service? (For external stakeholders, such as the government, industry associations, public media, and even consumers; For internal stakeholders, such as shareholders, upstream

and downstream partners, how did they view your company's attempt to implement EV-sharing service? Does government policies help? Do they create barriers? Do they need to do more? (E)

14. More specifically, what factors determine your company's motivation to participate in EV-sharing service? (A&E)
15. How long has it been between you/your company first learning about eMaaS (explain if necessary) and becoming involved in the EV-sharing service? (If the interval is long, what factors delayed your involvement?) (A&E)
16. Are there any challenges/difficulties constraining your company's involvement in EV-sharing services? Please give an example. (D&E) Will those factors will constrain your ability to expand and develop the service?
17. How do you see your company' relationships with other EVS providers? Is it very competitive? Is there collaboration? Do these providers share information? Do you ever come together to take action (e.g. to lobby government for action)?

<u>Part B: For Service Users</u>

<u>Customers' attitude towards EV-sharing services (Car owners/ non-car owners; genders; Ages)</u>

Are you aware of EV-sharing service? If No – end interview.
If 'Yes' - **<u>Open discussion:</u>**

a) **What is your opinion about electric vehicles? (B)**
b) **What is your opinion about the principles of sharing access to products, and whether there are other types of products that you access in terms of paying to use them rather than buying and possessing them? (D&E)**

Have you ever used an EVSS? If 'Yes' – Go to "Group A: Users";
If 'No', Would you be interested in using an EVS in future?
If 'yes' go to "Group b: Potential Users".
If 'No', go to "Group C: Refusers."

- **Group A: Users**

When did you first start using EVSS?

What encouraged you to start using EVS?

Which service do you use – and why?

Which types of journeys do you use EVSS for?

When don't you use EVSS? Why?

What are the pros and cons? What company do you use, do you use the same one or different one?

Do you think you're likely to use EVSS more/less frequently in future?

- **Group B: Potential Users**

Why haven't you used EVSS yet?

What is putting you off using them?

What would encourage you to start using them?

What do you imagine using an EVSS is like?

- **Group C: Refusers (May use):**

Why don't you think you'd use an EVSS?
What do you think using an EVSS involves?
Where have you got your understanding about EVSS from?
Has anyone you know had a bad experience about EVSS?

- **Group D: Refusers (will not use in the future):**

Why don't you think you'd use an EVSS?
What do you think using an EVSS involves?
Where have you got your understanding about EVSS from?
Has anyone you know had a bad experience about EVSS?

- **Group E: For all respondents:**

What are the main ways you take journeys within the city in a typical week?
Do you ever use (any missing ones – taxi, bus, train, underground, Didi etc)?

What determines the type of transport you use to get somewhere?
Do you have private car? (Except for C -Refusers: If yes. When would you use Sharing-EV than your own car?)

Part C: Call-hailing service providers; Taxi, bus, tram and subway (Public mobility service providers) attitudes towards EV-sharing services

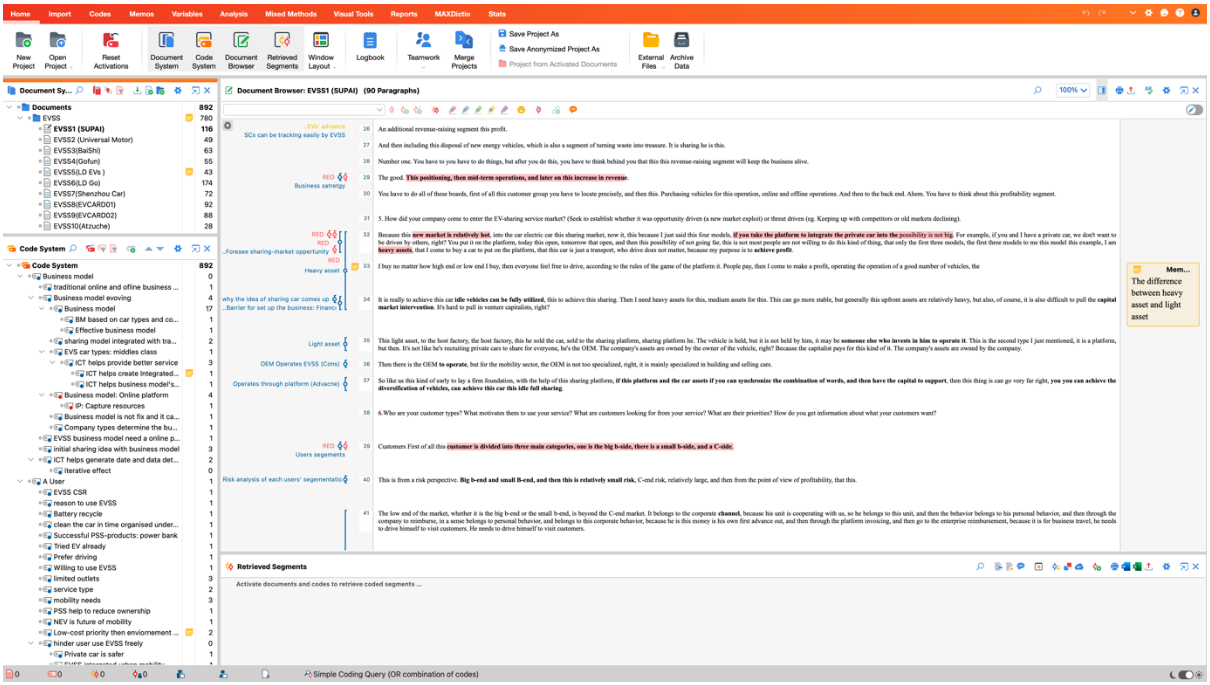
1. What do you think about this service? (E)
2. Have you tried this service? If yes, how do you find about it? If not, do you think you will you use it in future and why? (B&D&E)
3. Does this service affect your current business? If yes, how does it affect your business. If not, why? (D&E)
4. How do you think transport is going to change within the city in future? (D&E)
5. What do you think the future role of EVS is likely to be, and how might it affect your business in future? (D&E)

Part D: Government' (Public traffic department: Urban planning department, city officers, traffic police officers) attitudes towards EV-sharing services (Open-ended questions)

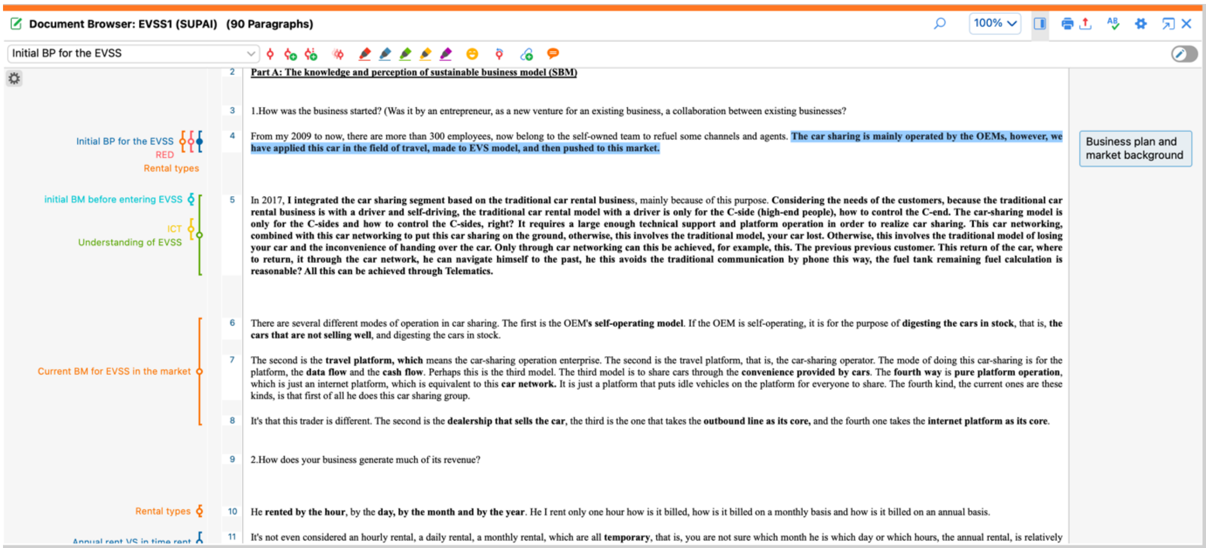
1. EVS is a relatively new part of the transport provision within the city – when did you first become aware of it, and how has it developed over time?
2. What do you think has driven the introduction and growth of EVS?
3. How do you see EV-sharing service connecting to other areas of government policy? (If CE is not mentioned prompt for their opinion) (C&D)
4. What are the implications of these services? (C&D&E)
5. Can you tell me whether there have been unexpected impacts from EVS introduction and growth? (Checking for unintended consequences)
6. How do you see the provision of EV-sharing service (eMaaS) in relation to city planning/traffic management? (D)
7. How do you think about this service? (A&C&D&E)
8. What is your department's attitudes about these services? (A&E)
9. How would you expect EVS in the city to develop in future, and what do you think the implications of that development might be? (A&E)

Appendix G: MAXQDA examples

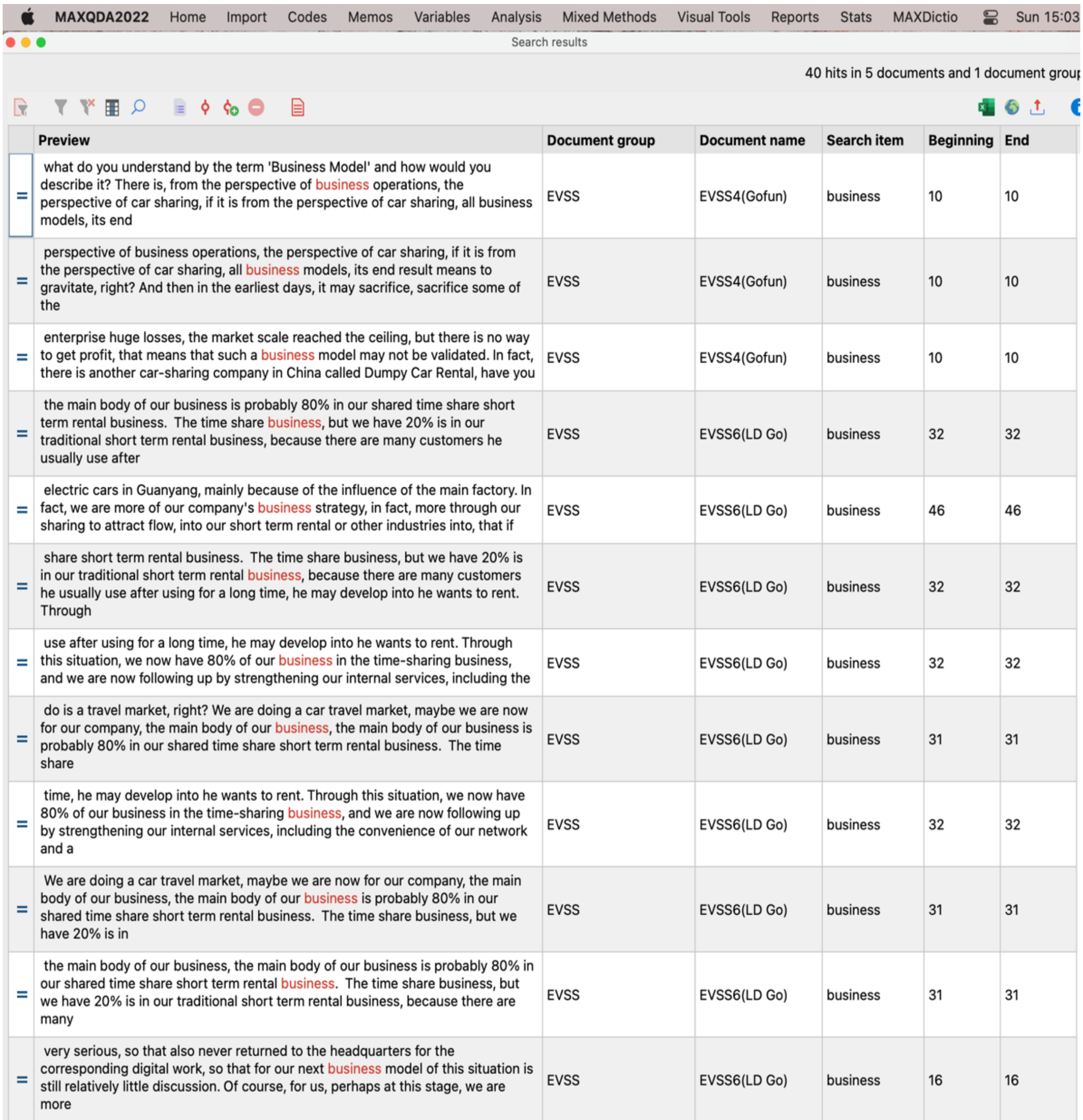
1. Example of a document in MAXQDA (Made by the author).



2. Example of a document in MAXQDA: Line-by-line coding process (Step 1).



3. Example of a document in MAXQDA: Line-by-line coding process (Step 1.1).



	Preview	Document group	Document name	Search item	Beginning	End
=	what do you understand by the term 'Business Model' and how would you describe it? There is, from the perspective of business operations, the perspective of car sharing, if it is from the perspective of car sharing, all business models, its end	EVSS	EVSS4(Gofun)	business	10	10
=	perspective of business operations, the perspective of car sharing, if it is from the perspective of car sharing, all business models, its end result means to gravitate, right? And then in the earliest days, it may sacrifice, sacrifice some of the	EVSS	EVSS4(Gofun)	business	10	10
=	enterprise huge losses, the market scale reached the ceiling, but there is no way to get profit, that means that such a business model may not be validated. In fact, there is another car-sharing company in China called Dumpy Car Rental, have you	EVSS	EVSS4(Gofun)	business	10	10
=	the main body of our business is probably 80% in our shared time share short term rental business. The time share business, but we have 20% is in our traditional short term rental business, because there are many customers he usually use after	EVSS	EVSS6(LD Go)	business	32	32
=	electric cars in Guanyang, mainly because of the influence of the main factory. In fact, we are more of our company's business strategy, in fact, more through our sharing to attract flow, into our short term rental or other industries into, that if	EVSS	EVSS6(LD Go)	business	46	46
=	share short term rental business. The time share business, but we have 20% is in our traditional short term rental business, because there are many customers he usually use after using for a long time, he may develop into he wants to rent. Through	EVSS	EVSS6(LD Go)	business	32	32
=	use after using for a long time, he may develop into he wants to rent. Through this situation, we now have 80% of our business in the time-sharing business, and we are now following up by strengthening our internal services, including the	EVSS	EVSS6(LD Go)	business	32	32
=	do is a travel market, right? We are doing a car travel market, maybe we are now for our company, the main body of our business, the main body of our business is probably 80% in our shared time share short term rental business. The time share	EVSS	EVSS6(LD Go)	business	31	31
=	time, he may develop into he wants to rent. Through this situation, we now have 80% of our business in the time-sharing business, and we are now following up by strengthening our internal services, including the convenience of our network and a	EVSS	EVSS6(LD Go)	business	32	32
=	We are doing a car travel market, maybe we are now for our company, the main body of our business, the main body of our business is probably 80% in our shared time share short term rental business. The time share business, but we have 20% is in	EVSS	EVSS6(LD Go)	business	31	31
=	the main body of our business, the main body of our business is probably 80% in our shared time share short term rental business. The time share business, but we have 20% is in our traditional short term rental business, because there are many	EVSS	EVSS6(LD Go)	business	31	31
=	very serious, so that also never returned to the headquarters for the corresponding digital work, so that for our next business model of this situation is still relatively little discussion. Of course, for us, perhaps at this stage, we are more	EVSS	EVSS6(LD Go)	business	16	16

4. Example of a document in MAXQDA: Line-by-line coding process (Step1.2).

=	little discussion. Of course, for us, perhaps at this stage, we are more through our development of this kind of shared business model, we have enough of this kind of customer flow of this kind of prerequisites, we gradually change to our	EVSS	EVSS6(LD Go)	business	16	16
=	through this kind of slow incubation bar, slowly this kind of incubation, and then to improve the viability of our own business. So through this kind of slow incubation, we can improve the viability of our business. 5. How did your company come to	EVSS	EVSS6(LD Go)	business	16	16
=	improve the viability of our own business. So through this kind of slow incubation, we can improve the viability of our business. 5. How did your company come to enter the EV-sharing service market? (Seek to establish whether it was opportunity	EVSS	EVSS6(LD Go)	business	16	16
=	and energy", locations for cars and links to ICT for the system to operate). It is to do car sharing, at that time his business model is is it, is it purely that is to take out the old car to sit, time share, this is one of his most classic	EVSS	EVSS7(Shenzho...	business	13	13
=	model is is it, is it purely that is to take out the old car to sit, time share, this is one of his most classic business model. For him actually for travel, because overall it is travel industry well, travel industry his business model must be, by	EVSS	EVSS7(Shenzho...	business	13	13
=	classic business model. For him actually for travel, because overall it is travel industry well, travel industry his business model must be, by reducing my vehicle procurement costs, reduce my operating costs, to achieve my positive capital flow,	EVSS	EVSS7(Shenzho...	business	13	13
=	it, it has the host factory, maintenance is certainly not a problem. Right, so how do you guys you understand the word business model, business model is to make this industry sustainable, sustainable and profitable. Only from the profit point of	EVSS	EVSS7(Shenzho...	business	18	18
=	host factory, maintenance is certainly not a problem. Right, so how do you guys you understand the word business model, business model is to make this industry sustainable, sustainable and profitable. Only from the profit point of view, is there	EVSS	EVSS7(Shenzho...	business	18	18
=	or is that is is to improve the way of life of human travel, do sustainable way of travel this piece do you think the business model is pure profit or. How can I put it, I think it's all of these things, maybe in. I think all of these, maybe in the	EVSS	EVSS7(Shenzho...	business	18	18
=	of sex, then I would like to ask Shenzhou company, like you guys in Shenzhou when you have not mentioned the word business model, and then how to describe it, or how to understand, Shenzhou actually mentioned more, including I just said travel this	EVSS	EVSS7(Shenzho...	business	15	15
=	pure profit or. How can I put it, I think it's all of these things, maybe in. I think all of these, maybe in the daily business, we may consider the outside world may be relatively less, more from the perspective of their own business, but we have	EVSS	EVSS7(Shenzho...	business	18	18
=	in the daily business, we may consider the outside world may be relatively less, more from the perspective of their own business, but we have always had a slogan in Shenzhou. Or the company's core values have always been, because after all, leaving	EVSS	EVSS7(Shenzho...	business	18	18
=	Do that do what? This kind of person is let use the car in advance also have it. Definitely can't recall, Shenzhou business model in fact emphasizes or quite a lot, linking to welcome this piece, because maybe I joined for a longer time, more	EVSS	EVSS7(Shenzho...	business	19	19

5. Example of a document in MAXQDA: Generate the conceptual category (Step 2).

Code: Business model > Business model evoving > Business model

	Docu...	Document n...	Code	Beginning	End		Preview	Modified by		Area	Coverage %
O	EVSS	EVSS2 (Univ...	Business model ...	10	10	)	Let's say I download an app and you charge this charg...	Tiansheng Yang		173	0.71
O	EVSS	EVSS4(Gofun)	Business model ...	10	10	)	There is, from the perspective of business operations, t...	Tiansheng Yang		702	2.70
O	EVSS	EVSS6(LD G...	Business model ...	16	16	)	In fact, I've heard of it before, I've heard of it before, be...	Tiansheng Yang		1392	2.54
O	EVSS	EVSS6(LD G...	Business model ...	31	31	)	In fact, I think the discussion of this, in fact, can not be li	Tiansheng Yang		380	0.69
O	EVSS	EVSS6(LD G...	Business model ...	32	32	)	The time share business, but we have 20% is in our tra...	Tiansheng Yang		638	1.17
O	EVSS	EVSS6(LD G...	Business model ...	46	46	)	we are more of our company's business strategy, in fac...	Tiansheng Yang		475	0.87
O	EVSS	EVSS7(Shen...	Business model ...	8	10	)	Because of the high frequency of time-sharing, the cle...	Tiansheng Yang		2070	5.42
O	EVSS	EVSS7(Shen...	Business model ...	13	15	)	It is to do car sharing, at that time his business model i...	Tiansheng Yang		1219	3.19
O	EVSS	EVSS7(Shen...	Business model ...	17	19	)	By reducing our own procurement costs, to achieve ou...	Tiansheng Yang		1901	4.98
O	EVSS	EVSS7(Shen...	Business model ...	59	59	)	At that time, it should be considered a competitive rela...	Tiansheng Yang		1816	4.76
O	EVSS	EVSS8(EVC...	Business model ...	11	13	)	The first part is purely on our roadside parking spaces,...	Tiansheng Yang		1356	2.79
O	EVSS	EVSS8(EVC...	Business model ...	15	17	)	This is because since the beginning of his establishme...	Tiansheng Yang		3147	6.46
O	EVSS	EVSS8(EVC...	Business model ...	19	21	)	The business model is discussed by our grassroots sta...	Tiansheng Yang		2198	4.51
O	EVSS	EVSS8(EVC...	Business model ...	64	64	)	The two words "sharing" were used by our senior man...	Tiansheng Yang		1028	2.11
O	EVSS	EVSS9(EVC...	Business model ...	7	7	)	Well, Shanghai is also almost 100 people in this scale, ...	Tiansheng Yang		596	1.22
O	EVSS	EVSS9(EVC...	Business model ...	12	12	)	This model I can do 260 a day, so a few years down it, t...	Tiansheng Yang		1156	2.37
O	EVSS	EVSS9(EVC...	Business model ...	15	16	)	The business model is discussed by our grassroots sta...	Tiansheng Yang		1145	2.35

Appendix H: McKinsey's 7S Framework - Factor Interactions

1. Critical pairings and well-aligned in the analysis of McKinsey's 7S Framework

In the analysis of EVSS providers using McKinsey's 7S Framework, several pairings emerge where two elements are well-aligned:

a. Collaboration between Strategy and Systems: The efficacy of an EVSS provider is contingent upon harmonizing strategic objectives with the implementation of systems. This may include using the latest technologies, such as Information and Communication Technology (ICT), big data analytics, Artificial Intelligence (AI), and autonomous driving to augment operational efficiency, enrich customer experiences, and maintain a competitive edge. Ensuring the company's strategy is congruent with its technological infrastructure and systems is paramount for thriving in the dynamic EVSS market.

b. Interdependence of Structure and Skills: An organisation's structure can be devised to support the cultivation and execution of innovative business models, while simultaneously enabling cross-functional collaboration and resource allocation for research and development. This can be a competent workforce with proficiencies in service maintenance, operational efficiency, marketing, and service reliability. Nurturing the appropriate fusion of structure and skills can propel innovation, adaptability, and overall success within EVSS schemes.

c. Nexus of Staff and Style: The staff's expertise in diverse domains, such as eMaaS schemes, service sector, marketing promotion, and driving technology, can be complemented by a leadership style that cultivates innovation, customer-centricity, collaboration, and sustainability. An encouraging management style will enhance employee engagement and motivation, culminating in superior service quality and innovation.

d. Cohesion between Shared Values and Strategy: Aligning the organisation's shared values with its business strategy can be important for obtaining the endorsement of customers, government agencies, and other key stakeholders. Emphasizing sustainability and BMI in the company's core values and integrating them into the business model will not only forge a robust brand identity but also distinguish the organisation from competitors.

2. Conflict that occurs in the analysis of McKinsey's 7S Framework

Within some of the sample providers conflicts between certain elements in the 7S framework could also be observed:

1. Strategy vs. Style (e.g., EVCARD): The strategic objective of devising an EVSS service that combines convenience and sustainability may be hampered by the organisation's management style and culture. For instance, a top-down approach characterised by minimal interdepartmental collaboration could obstruct the generation of innovative solutions, which are necessary to tackle the myriad challenges inherent to the EVSS sector.

2. The interplay of strategy, structure, and staff (e.g., LD EVSS): This issue may revolve around the strategic-structural-staff triad within the organisation - the issue of abundant outlets can be a structural dilemma just as much as it's a strategic one, which may result in a thinly dispersed workforce. Based on the interview with LD EVSS, the organisation's strategy seems to prioritise customer service and gathering user feedback, as illustrated by its abundant outlets. However, this expansive network created operational pressures and complications, considering the limited number of outlets a single employee can efficiently oversee. For example, the return of a vehicle at a specific outlet may require staff members to travel to that location for the vehicle's maintenance. This dichotomy between the strategic emphasis on customer service and the operational requirement for efficiency calls for a critical assessment of the relationship between the organisation's goals and its workforce's capabilities (France24 2018).

"Then, with our outlets being widespread and abundant, under this precondition, it will bring operational pressure and some difficulties. This is because the number of outlets an individual can shoulder or manage is limited. When a customer returns a vehicle at a particular outlet, the staff member may need to go to that outlet to clean up the vehicle."

Richard *(LD EVSS)*

3. Skills vs. Staff (LD go): The accelerated pace of technological advancements within the EVSS landscape requires an expert workforce to proficiently manage complex systems and deliver outstanding customer service. Nevertheless, a potential deficit of adequately trained professionals or an incongruity between the staff's skill set and the job requirements may give rise to inefficiencies and ensuing conflicts within the organisation.

3.Potential weaknesses that may emerge in EVSS schemes

a. Dissonance between strategy and systems: EVSS providers that fail to synchronise their strategic objectives with their systems may grapple with optimizing their operations and effectively competing in the rapidly evolving EVSS market (e.g., EVCARD).

b. Negligence related to customer-centricity: EVSS providers may not prioritise customer satisfaction and experiences and may by confronted by challenges in attracting and retaining users, impacting the overall success of their EVSS schemes.

c. Deficient collaboration with stakeholders: Inability to effectively engage with stakeholders, such as government agencies and other partners, may impede a company's capacity to adapt its strategy and operations, ultimately affecting its growth and competitiveness in EVSS schemes (Baishi EVSS).

"In the industry, communication with peers is common, but there is almost no specific progress in collaboration."

Jimmy (Baishi EVSS)

4. A comparison between EVSS and Didi style hailing services by using 7s framework

Earlier sections employed the McKinsey 7S framework to examine EVSS schemes. It could be helpful to continue utilizing this framework to delineate the similarities, such as style and skills, and differences, like structure and staff, between EVSS and Didi's ride-hailing service. Although both of them aim to deliver mobility solutions, Didi incorporates drivers as an integral part of their service, a feature absent from the EVSS model. This differential, among others, will be further detailed in the ensuing discussion.

Similarities:

Style: Both types of business emphasise collaboration and openness, acknowledging their important role within the urban mobility ecosystem.

Strategy: Their operations are likely capture attentions from governmental institutions concerning road safety, crime prevention, and future urban infrastructure planning giving both an incentive to influence institutional developments in their favour. Additionally, other stakeholders, such as insurance companies, other mobility service providers (e.g., taxis, subways, buses), charging station providers, vehicle repair garages, and internet companies were potentially important stakeholders for collaborative strategies or to address conflicts.

Skills: Both companies may focus on operational efficiency and marketing. On one hand, they both deliver services using vehicles as a physical product, making vehicle utilisation an important factor. On the other hand, they continuously engage in marketing promotions to capture and retain users.

Differences:

Structure: There can be a difference in the organisational structures of EVSS and Didi. The majority of EVSS operations feature a decentralised structure due to their extensive network of outlets. Conversely, Didi is both more decentralised in-service delivery but more centralised in management and operations, with its digital platform serving as a central conduit connecting drivers and users, thereby obviating the need for physical locations.

Staff: The staffing requirements for EVSS and Didi’s strategies also differ. EVSS require staff to manage parking and charging outlets as well as maintain EVs. However, agent-based hailing service like DIDI, rely on drivers as a part of service providers. The service without a driver in EVSS's model shifts their staffing needs, emphasising vehicle maintenance and battery management. Didi, on the other hand, focuses on driver management, recruitment, training, and retention and faces additionally service delivery risks linked to the human driver element.