

Article

Business Model Blueprints for the Shared Mobility Hub Network

Elnert Coenegrachts * , Joris Beckers , Thierry Vanelslander  and Ann Verhetsel

Department of Transport and Regional Economics (TPR), University of Antwerp, 2000 Antwerp, Belgium; joris.beckers@uantwerpen.be (J.B.); thierry.vanelslander@uantwerpen.be (T.V.); ann.verhetsel@uantwerpen.be (A.V.)

* Correspondence: elnert.coenegrachts@uantwerpen.be

Abstract: Shared (electric) mobility is still facing challenges in terms of reaching its potential as a sustainable mobility solution. Low physical and digital integration with public transport, a lack of charging infrastructure, the regulatory barriers, and the public nuisance are hindering the uptake and organization of shared mobility services. This study examines the case of the shared mobility hub, a location where shared mobility is concentrated, as a solution to overcome these challenges. To find ideas informing how a network of shared mobility hubs can contribute to sustainable urban mobility and to overcome the aforementioned challenges, a business model innovation approach was adopted. Focus groups, consisting of public and private stakeholders, collaboratively designed five business model (BM) blueprints, reaching a consensus about the value creation, delivery, and capture mechanisms of the network. The blueprints, defined as first-/last-mile, clustered, point-of-interest (POI), hybrid, and closed mobility hub networks, provide alternative solutions to integrate sustainable transportation modes into a coherent network, enabling multi- and intermodal travel behaviour, and supporting interoperability, sustainable land use, and ensured access to shared (electric) travel modes. However, which kind of network the local key stakeholders need to commit to depends on the local policy goals and regulatory context.

Keywords: shared mobility; docked shared mobility; dockless shared mobility; shared mobility hub; transit-oriented development; business model innovation; network-centric business model; collaborative network; sustainable urban mobility



Citation: Coenegrachts, E.; Beckers, J.; Vanelslander, T.; Verhetsel, A. Business Model Blueprints for the Shared Mobility Hub Network. *Sustainability* **2021**, *13*, 6939. <https://doi.org/10.3390/su13126939>

Academic Editors: José Manuel Valsello and Juan Gomez

Received: 20 May 2021
Accepted: 15 June 2021
Published: 20 June 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Transport in Europe accounted for 27% of Europe's total GHG emissions in 2017 [1]. Cities in particular encounter additional issues related to transportation, such as increased noise and air pollution, increased traffic congestion, high parking pressure, less accessibility, and high accident costs due to intensified confrontation between all kinds of road users. The intensified urbanisation and corresponding densification of people using the same infrastructure and systems to move from point A to point B add to the challenges cities and urban planners are currently dealing with. Therefore, Europe has seen the establishment of such initiatives as Civitas [2], EIT Urban Mobility [3], and Eltis [4] to accelerate the transition towards smart and sustainable urban mobility. Shared mobility can support this transition and has the potential of becoming one of the pillars of a sustainable urban mobility system [5,6]. It increases the utilisation and efficiency of transportation assets, supports the shift towards sustainable modes of transport (i.e., zero-emission vehicles and active modes of transport), and reduces car-dependency, making the transport system more flexible and accessible [5]. However, in order to reach the full potential of shared mobility, there are still challenges to overcome [7,8]. First, the lack of physical infrastructure (e.g., dedicated bike lanes, charging infrastructure) and mismanagement of public space are hindering the uptake of shared and electric mobility. The emergence of electric docked and dockless shared micromobility services (i.e., e-scooters, e-bikes, and e-mopeds) highlighted

the lack of available public space, causing a clutter of shared micro-vehicles on pavements and public roads, and safety incidents [9]. Second, the lack of integration within the current transportation system, and public transport in particular, reduces the utility shared mobility could provide, certainly when focusing on the first- and last-mile trips [10]. The potential gain of this integration also depends on infrastructure adjustments and investments in the transit stations network [11]. Lastly, digital infrastructure is considered a critical element by researchers and practitioners to offer an efficient urban transport system which does not solely focus on the private car and increases the flexibility shared mobility can offer. Mobility-as-a-service (MaaS) solutions have been introduced to facilitate multimodal and intermodal travelling, integrating new mobility services and traditional travelling methods, as public transport, walking, and biking [12].

This paper studies the case of the shared mobility hub that could potentially address these challenges and thereby support shared mobility to become an integral part of the urban transport system. The shared mobility hub clusters different new and conventional mobility services at a physical location. Its functions, services, facilities, and infrastructure requirements depend on the local urban context, including the policy goals of the different stakeholders. In order to identify mechanisms the shared mobility hub can provide to tackle the challenges, and subsequently how the shared mobility hub should be organised and which activities should be carried out in order to achieve the proposed goals, this paper has gone through a business model design process, developing provisional business models for the shared mobility hub.

The concept of the business model has been extensively researched in academic literature but is not uniquely defined. A review by Massa et al. [13] of business model literature has indicated that three views emerge within the literature: “(1) the business model appearing as an attribute of real firms, (2) the business model appearing as cognitive and linguistic schemas, and (3) the business model appearing as formal conceptual representation” (p. 88). In the further stage of this research, the third definition of the business model will be used. This means that the business model is describing the aspects and activities of the (network of) organisation(s) that brings the (network of) organisation(s) closer to achieving its goals and objectives. This representation allows expressing, articulating and challenging new ideas, reducing the complexity how the organisation or network of organisations is going to create and capture value. Recent sustainability management research also underlines the importance of public value creation (e.g., social and environmental) next to the traditional value creation for private stakeholders when considering the business model [14–16]. This is certainly relevant in the field of urban mobility where public and private actors are operating in a public environment, looking for public as well as private value creation. This can lead to conflicting objectives. In this context, a public-private business model could be an opportune model to realign the interests, thereby facilitating sustainable mobility growth [17]. This implies however cooperation within a network of actors. A business model that expresses the activities, relations, objectives, and roles of the network actors and the network itself is required to identify ways for achieving the common and private goals. The process of designing a business model is defined as ‘business modelling’. It is a useful process to generate ideas about the mechanisms that will create, deliver, and capture the intended value [18]. In this regard, it allows the different stakeholders to express their needs and explain the expertise, knowledge, and (in)angible assets they possess that could help the network reaching their objectives [19].

This paper designs different conceptual network-centric models for the case of shared mobility hubs, relying on network-based business modelling design frameworks. They help to understand which types of network can be accomplished, which kind of value they will create, and how these value propositions can reduce the hurdles of shared mobility.

The remainder of this article is divided into five sections: Section 2 presents the relevant business modelling design frameworks on which we have built our network-based design framework. Subsequently, Section 3 describes the process of creating and experimenting with business model blueprints for the shared mobility hub. Furthermore,

Section 4 summarizes the main aspects of the five blueprints that have been developed. Section 5 interprets the value creation mechanisms. Finally, Section 6 concludes this paper, summarizing its main findings, along with policy implications and possible directions for future research.

2. Theoretical Framework

The business model has been used extensively to study existing organisations and their activities, but also to search for and evaluate new concepts and ideas. The business model and business model design perspectives are explained below.

2.1. The Business Model Concept

As stated above, this paper adopts the formal conceptual representation as an interpretation for the business model. A conceptual representation only includes the major aspects of the organization's way of doing business, while leaving out the very specific details. While this can improve the clarity of the underlying mechanisms, this interpretation does not put forward a standard way of describing the business model's elements [13]. For example, the notion of value or the scale at which the business model is analyzed, can differ amongst formal conceptual representations. Early management literature focused primarily on the business model from the point of view of a single firm, i.e., how single firms can create, deliver, and capture value, only considering the single firm's activities, resources, and its stakeholders' objectives [20]. It conceptualizes how firms do business, attract customers and create value. 'Value' was regarded within the context of economic value or value for the customer, resulting in profit for the firm's shareholders [21]. However, as pointed out by Massa et al. [13], a considerable range of academic literature does not consider the business model as solely a conceptual model to indicate how individual firms are going to capture economic value for their shareholders, but also to exemplify how firms take into account the broader environment they operate in, thereby creating, delivering, and capturing economic, social, and environmental value. It has been argued that the creation of sustainable value requires a cooperative approach, which involves a network of actors and activities [22,23].

The reason that a network-centric business model is more capable of creating sustainable value, is that it takes on a holistic system-wide view, considering all stakeholders of the network [15]. If this network consists of actors supporting public value creation (i.e., social and environmental benefits) on the one hand and private value creation (i.e., profit) on the other hand, the network will likely support the integration of sustainability in its business model. If the network is dynamic, capable of value creation, and cooperative, there will be value exchange across all actors, thus contributing to the network's process of value creation, delivery, and capture [24].

In order to implement and disperse a sustainable urban mobility solution, as intended with the installation of shared mobility hubs, it is beneficial to develop a network-centric business model, so that the network's partners adapt their business model towards the main objective, namely stimulating sustainable urban mobility [25]. As indicated by Rohrbeck et al. [19], business modelling together with the network of stakeholders can overcome the barriers related to sustainable innovation, such as high uncertainty about the potential outcome, high dependence on specific assets and knowledge of others due to the high complexity of the solution and the unwillingness of (financially) investing in such system. Moreover, by rethinking their current business models, the stakeholders could identify various ways towards the common objectives [26]. Therefore, we have taken a network-centric approach and developed the shared mobility hub business models, i.e., mechanisms that the network of organizations uses in order to stimulate sustainable urban mobility, during focus group discussions with public and private stakeholders engaged in shared mobility. In order to systematically examine which aspects should be included in the formal conceptual representation, a business model design framework has been used during the process of designing the network-centric business model. However, there are

various business model design frameworks. They differ with regard to the content, the scale, and the semantics when representing the business model [13]. This paper has reviewed different business model design frameworks, however only two were identified that were applying a network-centric perspective. The next section discusses in further detail the two business model design frameworks that have adopted a network-centric perspective. They supported the business modelling design process for the shared mobility hub.

2.2. Business Model Design Frameworks

The elements a business model consists of (i.e., the content), are not clearly specified in literature, but they are generally referred to as the value propositions, the customer segments, product/service offerings, value creation mechanisms, and value capturing mechanisms [27]. A business model design framework helps to identify these elements and visualize the conceptual idea of how the organization or network of organizations are creating, delivering and capturing value [19]. Therefore, it can structure the ideas that are generated during the business modelling. Business modelling also generates different provisional business models. A good design process helps to assess the viability of these provisional business models before committing significant time and financial investment to them, but it requires a certain degree of creativity and flexibility to cope with the uncertainty of developing and implementing an innovative concept [18,28].

Several design frameworks which visualize and explicate the essential components of a business model have been established in literature. However, as pointed out by Massa et al. [13], these frameworks differ with regard to the content of the BM representation (i.e., what are considered to be the essential components in order to describe a business model) and the scale (i.e., what are the boundaries in which the BM's components are considered). Certain frameworks have focused on describing the ways a single firm can create, deliver, and capture value (i.e., economic value) for the business and its customers (e.g., Osterwalder and Pigneur [29], Gassmann et al. [30], Johnson et al. [31], and Demil and Lecocq [32]). However, these frameworks have an explicit focus on private value creation within a single firm, overlooking the value flows among other stakeholders, including society and the environment [33]. Other frameworks have extended the content of the BM design framework by including components related to social and environmental value creation, thereby supporting the development of business models focused toward sustainability (e.g., Joyce and Paquin [34], Bocken et al. [35], Calabrese et al. [36] and Upward and Jones [33]). Yet, these frameworks still start from the single firm as focal point for describing the BM components.

The network-centric set-up of the shared mobility hub business model, requires a design framework that supports business modelling with a network of stakeholders. This has to allow the different actors to orchestrate the business model towards a value creation, delivery and capturing system that takes into account every stakeholder's objectives. The service-dominant business model radar (SDBM/R) is "a representation of the way in which a network of organizations, including the providers and customer, co-creates a value for the customer through a solution-oriented service and generates revenue and benefits for all network partners" [37] (p. 16). This framework emphasizes the processes that every distinct actor performs in order to co-create value. It starts with defining the common objectives the network aims to realize. In order to understand how this will be achieved, the framework describes for every actor three components. First, the actor's value proposition is expressed, representing its contribution to the central co-created value. Second, the actor's co-production activity is defined, outlining the activities the actor will perform in order to fulfill its value proposition. The third component details the financial and nonfinancial costs and benefits that are associated with the actor's co-production activities. The framework has proven its utility as application for developing business models in the smart mobility domain, corresponding to the area of the shared mobility hub, as demonstrated by Turetken et al. [37] during fifteen workshops in which they addressed mobility challenges using the SDBM/R. However, the SDBM/R does not specify

the aspect that considers roles and relations of the network's actors, making it more difficult to establish a governance form for the network which should improve the effectiveness of the value network [38].

Another framework that took on a network-centric perspective, is the one constructed by Lindgren et al. [39]. They based their framework on the design canvas of Osterwalder et al. [40], adapting its building blocks toward a more network-centric perspective. Osterwalder's business model canvas [40] consists of nine interconnected building blocks (i.e., value proposition, target customer, distribution channel, customer relationship, value configuration, core competency, partner network, cost structure, and revenue model), which visually explicate the interdependent activities the organization undertakes to exploit an identified opportunity and what the architecture of the organization and its network of partners looks like in order to provide value to one or several segments of customers [41]. It has been widely adopted by practitioners (e.g., Strategyzer [42]), policy makers (e.g., Beltramello et al. [43]) and researchers (e.g., Schiavone et al. [44] who examine business model innovation of smart urban solutions).

Lindgren et al. [39] changed the unit of analysis—the network of organizations instead of the single firm. They proposed four pillars, i.e., product, customer interface, infrastructure management, and financial and non-financial aspects, to be defined when designing a network-centric business model. Related to these four pillars are nine components, i.e., value proposition (product), target customer, distribution channel and relationship (Customer interface), value configuration, core competency and partner network (infrastructure management), and cost structure and revenue model (financial and non-financial aspects). These nine components are described from the perspective of the network. First, the value proposition component describes which value and related to this, which bundle of products, processes and services the network is going to offer. Second, the target customer, distribution channel and relationship components detail which customer segments the value is offered to, how the network is going to reach the target groups and what kind of links are established between the network's actors and the target groups. Third, the value configuration, core competency, and partner network components describe which activities, resources and competencies are required to create and deliver the value, and which cooperative agreements between network partners are necessary. Last, the cost structure and revenue model elements explicit what the financial and non-financial costs and benefits are associated with the activities the network will perform. A network-centric business model can be designed by defining these nine components. However, this framework partly neglects the discussion about how every actor is going to contribute to the nine components, due to the lack of a visual representation of the separate actors' components. Therefore, a network-centric business model design framework has been constructed taking the advantages and shortcomings of the aforementioned frameworks into account. Section 3 illustrates this framework and elaborates on how it has been used to design the shared mobility hub business models.

3. Method

A three-staged approach was adopted in order to identify a generic model that successfully integrates shared mobility hubs within the urban environment. The first step in the research approach was to select and adapt a business model design framework that supports the process of business modelling. A network-centric BM tool is developed based on the two business model innovation frameworks mentioned in Section 2.2. The second stage is the actual data collection, or the collective design process. The third stage is the data analysis, or the development of business model blueprints. The next section explains the framework that has been used during the data collection phase.

3.1. Network-Centric Business Model Design Tool

While the canvas of Osterwalder has proven its utility as graphical representation for business models, it has been argued that its focal point lays at the individual firm's value

creation, also partly neglecting sustainable value creation [35]. Therefore, the framework of Turetken et al. [37] has been used as ground for the network-centric design tool, as it takes into account the network's and the separate network's actors' mechanisms that create, deliver, and capture their values. However, this framework from Turetken et al. [37] only briefly describes three main aspects of the business model, which can cause uncertainty regarding which elements should be included into the business model. Furthermore, it leaves out the aspect that details the roles of and interactions between the actors, complicating the governance of the network, potentially reducing its effectiveness [38]. Therefore, this paper combined the framework of Turetken et al. [37] with the framework of Lindgren et al. [39]. Lindgren et al. [39] provided a more detailed explanation regarding the elements of the business model, defined as the nine building blocks of Osterwalder et al. [40], but adapted towards a network-centric perspective. Figure 1 presents the consolidation of the two frameworks.

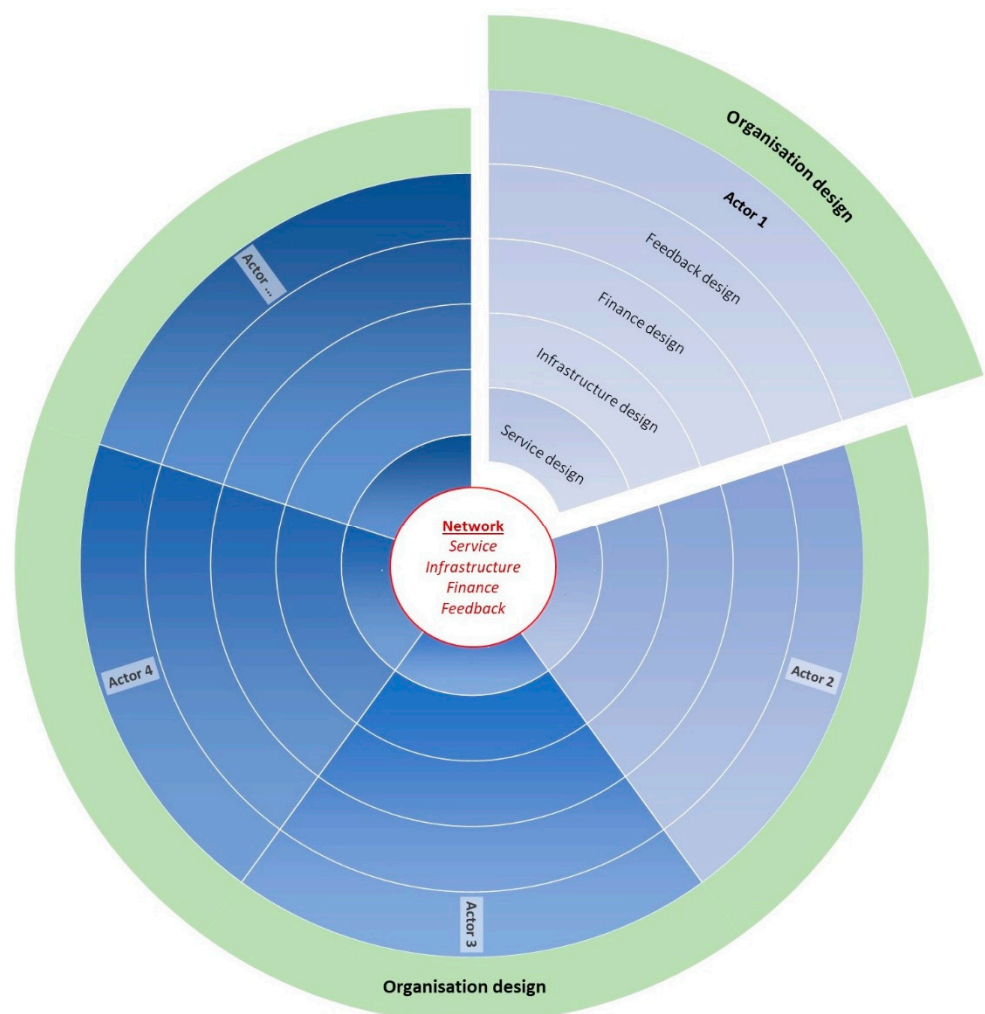


Figure 1. Network-centric business model design tool based on Turetken et al. [37] and Lindgren et al. [39].

The framework consists of five design domains: service, infrastructure, finance, feedback and organisation design. The service design includes the value proposition (synthesis of the value being created by the network), target group (the customer segments the value is created for) and service channel (the mediums that are used to reach the target groups). The infrastructure design encompasses the value configuration (the functions, activities, and services required to create the value proposition) and the core competency (the expertise, knowledge, and technology required to perform the activities and functions). Further,

the finance design covers the revenue model (how the value is going to be captured and transformed into financial benefits) and the cost structure (the costs that will be associated with the value creation processes). As the fourth domain, the feedback design describes the feedback channel (the systems that are required to receive, monitor and evaluate feedback from the target group). Lastly, the organisation domain is an overlapping layer that identifies the network's stakeholders and defines their relations, dependencies, and roles.

The design process should start with the network at the centre. First, the service design of the network is defined. Subsequently, the actors discuss their service design in relation to the service design of the network, in order to determine how the individual actor's value proposition contributes to the network's value proposition. The third, fourth, and fifth steps consist of simultaneously defining the network's and distinct actors' infrastructure, finance and feedback design respectively. While going through these phases, the organisation design of the network is specified, explicating the roles of and relations between the actors, with the aim of establishing a governance form for the network in which every actor knows its role and responsibilities.

The framework facilitates the process of developing a business model blueprint for a complex and integrated solution in which multiple stakeholders are involved. The collaborative set-up supports the generation of ideas and exchange of expertise in order to identify mechanisms that effectively can implement the solution.

3.2. Collective Design Process

The business model design process should be a collective effort, where ideas can be put forward and consensus be reached. Focus group discussions were organised to go through the business model design process. They enable interactions between participants, which makes it possible to realign interests and learn from the expertise and knowledge of others [45]. The participants were public and private stakeholders engaged in shared mobility. Part of them were involved in the eHUBS project, piloting the implementation of shared mobility hubs in six different cities. The other part were selected based on a market research of the shared mobility landscape, in order to have a broad range of stakeholders that cover this landscape. In total, forty-eight participants discussed the business model of the shared mobility hub, including representatives from bike-, moped-, car- and scooter sharing organizations (16), transit network companies (3), MaaS-service providers (1), charging infrastructure operators (3), advertising companies (2), knowledge institutions (8), local public transport operators (2) and public authorities (13) from small to large-sized cities in North-West Europe.

Each focus group discussion consisted of approximate ten participants, representing a diverse group of shared mobility stakeholders, and was led by a moderator. The moderator structured the dialogue by posing questions that referred to the elements of every design domain (e.g., What could be the objective(s) of a shared mobility hub network (service design)? Which technology can support the network (infrastructure design)?) (see Appendix A for a comprehensive list of questions). All discussions were held at the same time. The focus groups first discussed the value proposition(s) of a shared mobility hub network and the elements (i.e., aspects of the design domains) to achieve the value proposition(s). After ninety minutes going through the design process, the participants rotated to a different focus group to discuss the elements that are required to achieve the value proposition(s) of the previous group. This approach assured that various stakeholders could express their ideas and incorporate the suggestions of others, supporting the development of generic blueprints.

3.3. Developing the Business Models Blueprints

The solutions and answers provided by the stakeholders are structured according to the list of questions that was used as guidance during the focus groups discussions. The questions relate to the design domains of the framework, thus the answers can be categorised into one of the five domains from the individual actor's perspective or into one of

the four design domains from the network's perspective. This facilitated the development of the business model blueprints. All the value propositions could be summarised into five distinct service designs. For each unique value proposition, the organization, infrastructure, finance, and feedback design domains were detailed by compiling the elements that were regarded indispensable by the focus groups to reach the considered value proposition. This led to the development of five business model blueprints, which are discussed in Section 4.

4. Results

The five business models primarily differentiate from each other on the basis of their unique value proposition (i.e., network's service design). This relates to the composition of the shared mobility hub network, the geographical context where the shared mobility hubs will be integrated and the target groups they try to reach. Apart from the unique service designs, the business model is constructed by the elements of the other design domains. The five business models have, related to their unique value proposition, some design elements that are specific to this business model. However, there are also aspects from the design domains that can be applied in different business models. These elements are listed in Table 1, presented below.

Table 1. Aspects of the design domains applicable in multiple business model blueprints.

Design Domain	Elements
Organization design (OD)	<p>Local authority can fulfill different roles:</p> <ul style="list-style-type: none"> - Owner of the shared mobility hub - Network facilitator (i.e., assemble the network of stakeholders to implement shared mobility hub) - Regulator, enforce appropriate service levels from stakeholders - Create level playing field for shared mobility providers - Allocating and repurposing locations towards shared mobility hubs - Subsidizing authority <p>Public transport authority can perform the role of owner and operator of the shared mobility hubs and allocate land at public transport areas towards shared mobility hubs</p> <p>Shared mobility providers can operate their transportation services, perform redistribution and recharging efforts and have ownership of dedicated infrastructure for shared vehicles.</p> <p>Private non-mobility related companies (e.g., POI-owner) can fulfill different roles:</p> <ul style="list-style-type: none"> - Owner of the shared mobility hub - Network facilitator (i.e., assemble stakeholders to implement shared mobility hub) - Allocating and repurposing land towards shared mobility hubs
Infrastructure design (ID)	<p>Technology that is required to</p> <ul style="list-style-type: none"> - monitor the availability of shared vehicles - give access to all shared services <p>Digital channels (e.g., digital display, digital application) to inform the target group about available services located at the hub</p>
Finance design (FiD)	<p>Pricing schemes such as pay-per-use/subscription model</p> <p>Investment costs, related to land repurposing and installation of shared mobility hub infrastructure, can be covered by subsidies (from public authority or public transport operator)/operating permits/advertisements</p> <p>Operating costs, related to maintenance mobility hub and shared vehicles, rebalancing and recharging efforts, can be covered by user's fee and per trip subsidy</p>

Table 1. Cont.

Design Domain	Elements
Feedback design (FeD)	Feedback system on community/neighborhood/company level (surveys)
	Risks related to
	- too strong focus on shared electric vehicles, affecting financial viability of shared electric services
	- high substitution of public transport trips by alternative shared vehicle trips, decreasing potential sustainable impact
	- low usage of transportation services at mobility hubs, decreasing overall network's performance and reliability

Next the value proposition and unique elements from the other design domains are specified for each business model in the following sections. This way the reader can grasp the essence of every business model. However, a more detailed comparison between the design domains of the different business models can be found in Appendix B, while the roles and involvement of the stakeholders in the different business models are specified in Appendix C.

Section 4.6 applies the business model blueprints below to the city of Antwerp. This illustrates how a business model can hypothetically be implemented in a city-specific context in order to contribute to a more sustainable mobility system.

4.1. First-/Last-Mile Mobility Hub Network

The first BM's, "first-/last-mile mobility hub network", main value proposition is stimulating intermodal travel behavior by implementing a first-/last-mile solution, that complements public transport and provides an alternative for car-only trips. This requires a fine mesh shared mobility hub network that is integrated within the public transport network, thereby extending the catchment area of public transit and reaching more potential users. First and foremost commuters can benefit from this network, because they can conveniently travel from point A, their origin (i.e., home), to point B, their destination (i.e., workplace), by using hubs located nearby their origin, a public transport stop, and the destination, bridging the first-/last-mile gap.

The local government, public transport operator(s) and private companies like shared mobility providers and business park owners should cooperate in order to identify potential areas and stimulate their target groups to make use of the mobility services. Shared mobility providers will have to ensure availability of their fleet so that commuters can rely on the shared mobility system. Therefore, rebalancing operations are required.

Furthermore, a MaaS application has high relevance, as it can contribute to a convenient multimodal travel experience. There are opportunities to integrate the fees for using the shared mobility services with the public transport fee and to implement a demand-responsive pricing fee in order to improve availability, which is a key aspect for this model. In this regard, data analysis is an important activity to be carried out in order to gain insight into the usage and trip chaining of the services and improve the reliability of the network. In addition, storage and charging infrastructure for private vehicles at the hub can be added, extending the possibilities for commuters to bridge the first-/last-mile gap.

4.2. Clustered Shared Mobility Hub Network

The second BM, "clustered shared mobility hub network", focuses on clustering shared mobility services, enhancing awareness about shared mobility and thereby generating demand for these services. The shared mobility hubs are mainly located in suburban neighborhoods or small city centers, centralizing the supply of shared mobility modes in that region. This, together with infrastructure provisions such as charging stations, will stimulate shared mobility providers to be active in otherwise underserved areas. Shared mobility can be considered as supplement to the public transport offer, which can be low in these areas, in order to reduce the reliance on private car for non-commuting trips. The offer

of shared mobility modes at the shared mobility hub should be discussed in close contact with the neighborhoods' residents. Local governments should engage with neighborhoods' residents, local businesses, and shared mobility providers in order to establish a shared mobility hub that is tailored to their needs. Operators who operate a back-to-one system, where the shared vehicles should be returned to the same location, are more appropriate for this network of shared mobility hubs.

In addition, there is the opportunity to extend the shared mobility hub with functions other than transportation. Infrastructure should allow for additional services (e.g., charging points for private vehicles, local shops, parcel lockers and terraces for bars and restaurants), generating additional social and economic activity.

Questions were mainly raised about the financial viability of this model, as the risk of low usage is relatively high considering the low population density of these areas. Local authorities are confronted with shared mobility providers unwilling to operate unless the local authority bears the financial risks. Moreover, small local authorities could not have the sufficient bargaining power to require a minimum service level, leading to a low quality and non-reliable shared mobility system.

4.3. Point-of-Interest (POI) Mobility Hub Network

The third BM blueprint, "point-of-interest (POI) mobility hub network", establishes a network that connects different point-of-interests, so that these high demand areas can be more easily reached by alternative modes of transportation. This extends the transportation options visitors have, thereby increasing the attractiveness of the POIs and lowering the car dependency. It furthermore reduces the congestion and the need for parking lots at the POIs. The POI network is complementary with the public transport network, creating a convenient multimodal travel experience for the different target groups such as tourists, visitors of local shops and leisure activities and commuters (who can also benefit from this network). Availability at these high traffic/high demand areas is key, as many users will rely on the system. It is therefore essential to organize a qualitative redistribution and operating scheme. Local governments should facilitate communication between POI owners, shared mobility providers and public transport operators. Furthermore, they can seek commitment of real estate developers to install shared mobility hubs at privately-owned zones. Similar to the first-/last-mile mobility hub network, MaaS has an important role to play. It supports the integration and coordination with existing transportation options towards the POIs. There are also opportunities to combine a fee for the transportation services with the entrance fee for the POIs. In addition to the infrastructure for shared mobility services, infrastructure for private vehicles can be incorporated, such as charging stations for electric bikes or cars, making the shared mobility hub more enticing for the visitors and thus the POI owner. Therefore, the POI owner can financially support the establishment of a shared mobility hub at its location. As these locations are high-traffic areas, advertisement can also be considered to partly finance the shared mobility hub network.

4.4. Hybrid Mobility Hub Network

The fourth BM prototype, "hybrid mobility hub network", focuses on the formation of a hybrid network of shared mobility hubs that provides an extensive range of transportation modes, from free-floating to station-based shared mobility services. The combination of free-floating and station-based schemes increases the services' flexibility and the area covered by them, with a view to enable door-to-door transportation. Similarly as the POI mobility hub network, it addresses different trip purposes, such as daily commutes, leisure and shopping trips. This also provides the opportunity to introduce a MaaS application, in which the user can easily find its most preferred transportation mode or combine modes during one trip. Furthermore, a key aspect of this model is the centralized and combined fleet management (i.e., redistribution, maintenance, charging) for both station-based and free floating modes. In this regard, local authorities have to introduce minimum service levels (e.g., which areas should be covered, how many vehicles should always be

operational, how long a malfunctioning vehicle can remain in the public space, etc.) so that qualitative and complementary shared mobility services are offered. An additional element to this integration between free-floating services and the shared mobility hub, are the financial incentives that can be provided towards users for recharging a free floating vehicle at the charging infrastructure provided at the shared mobility hub. The integration also offers possibilities to reduce the financial costs of establishing a shared mobility hub network, when free floating operators financially contribute for using the charging or maintenance services.

When considering the environmental and financial barriers and risks of this model, the following are highlighted: users can mainly substitute their public transport trips by the shared mobility modes, thereby not reducing their car use and decreasing the revenues for public transport; free-floating devices are too numerous on certain locations (e.g., on the pavements), leading to frustrations of other public space users; low actual use of shared mobility services, leading to insufficient revenue for the providers and an unreliable shared system; free-floating providers capture market share of station-based providers in areas with shared mobility hub presence (or vice versa), thereby affecting the profitability of the competitor and thus the reliability of the shared system.

4.5. Closed Mobility Hub Network

The final blueprint, “closed mobility hub network”, focuses on the formation of a closed network of shared mobility hubs that is grounded on a demand from residents or private companies (e.g., business park owners, real estate developers). The availability of shared mobility services is ensured at these hubs, since they are for the exclusive use of subscribers. This model also enables private companies to provide additional value for residents and employees by expanding their transportation possibilities. For these reasons, car users can be convinced to reduce their car-use and choose alternative modes of transport. The shared mobility hubs should also offer additional services and facilities, such as parcel lockers and charging points for personal vehicles.

An essential element of this model is the implementation of technology that allows or denies access to the shared mobility hub and its facilities. This prevents vandalism of these hubs and its shared mobility modes.

Local authorities should facilitate dialogue between private companies, business park owners, and shared mobility providers. It is opportune to incorporate in a further stage the private hubs within the public hubs network, so that employees have an extended network of hubs available.

This model is assumed to have a lot of potential for convincing initial users to make use of shared mobility services. It ensures users access to shared mobility, making it a transportation system they can rely on for trips departing from this location. Nonetheless, shared mobility providers find it difficult to operate a profitable service for this network, as the number of potential users is low. Employers can engage this problem by bearing part of the financial risks of the shared mobility providers, while providing additional benefits in kind to their employees.

4.6. BMs Illustrated by the Case of Antwerp

Antwerp is the most congested city in Flanders [46] and experiences mobility related problems. In order to tackle some of the challenges this poses, the city government has decided to look for alternative ways of transportation, such as shared vehicles, for its citizens. In 2011, it started its public station-based bikesharing program called Velo within the city center. The system has already been expanded to the surrounding municipalities. Moreover, the city has allowed and supported, through its market enabling platform called Smart Ways to Antwerp, different private shared mobility providers to operate within the Antwerp city region [47]. In total, nine shared mobility service providers, focused on the B2C market, are active in Antwerp and its surrounding municipalities. This mature shared mobility environment and the recognized approach of the city government to

regulate shared mobility services [48], makes the city of Antwerp an appropriate case to hypothetically explore how a network of shared mobility hubs can be implemented and showcase the potential contribution of the different business models. Figure 2 indicates where the shared mobility hubs from the different business models should be located for the case of Antwerp.

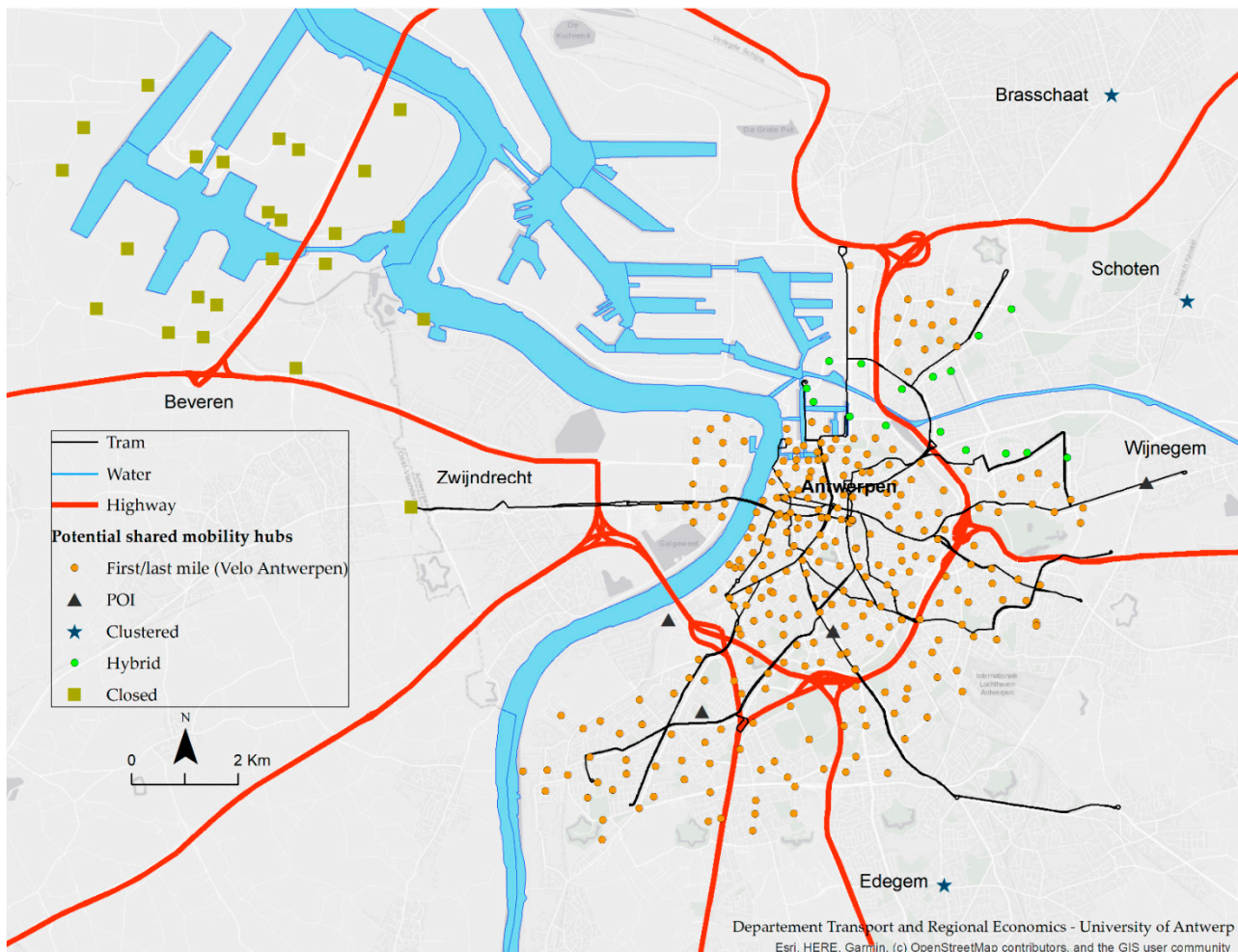


Figure 2. Business model blueprints illustrated for city of Antwerp.

A first-/last-mile shared mobility hub network requires a dense network that would complement the public transport network of De Lijn in Antwerp (the black lines on Figure 2 indicate the tramlines). This would allow daily commuters from outside the city center to bridge the first-/last-mile gap and commuters living within the city center to choose for another sustainable transportation mode if the capacity of the public transport network is exceeded. The city Antwerp would have to look for available areas where shared mobility hubs can be installed. Potentially, the existing network of Velo stations (the orange circles on Figure 2) could be used to integrate other docked shared vehicles into it. This would enable travelers to choose a shared vehicle that fits their current travel needs. As daily commuters are searching for predictable transportation options, reliability and availability of the network is necessary. Therefore, the city of Antwerp would have to establish minimum service levels to the shared mobility providers in order to coordinate the network. Furthermore, a MaaS application would be necessary to fully exploit the potential of this BM, in order to provide a seamless intermodal travel journey and convince car-commuters to use this network. Moreover, here, there are opportunities

to capitalize on existing efforts as Antwerp already has several MaaS providers, both B2B- and B2C-oriented, active in its region.

A potential clustered mobility hub network (the blue stars on Figure 2) would be focused towards suburban areas, such as the well-off municipalities that surround the metropolitan area of Antwerp and fall just outside the regular public transport connections to the city (e.g., Brasschaat, Schoten, Edegem). Resultantly, the large majority of trips take place by private cars [49]. The local authority could repurpose central public space for clustering the supply of shared mobility vehicles. It would be a round-trip system, meaning that users have to pick up and return the vehicle to that location. The hub provides an alternative for car-use for trips to local shops, family or recreational locations. The local authority should look to integrate other services in this hub, such as a parcel locker or private bike storage infrastructure. Moreover, this model would require some public financial support for the shared mobility service providers (shared cargobikes and shared cars are highly appropriate for the kind of trips focused on in this case), as these locations have a low density and low demand for alternative transportation modes, making it difficult to operate a profitable service.

A POI mobility hub network would offer shared mobility hubs at POIs within or outside the Antwerp city center, such as the Wijnegem shopping mall, the brewery of De Koninck located in the city center, the football stadium and a land development project located South of the city center (indicated by black triangles on Figure 2). Public transport connections are already provided to these high demand areas. The network of shared mobility hubs could then bridge the first-mile towards the public transport connection or provide more transportation options towards the POI, thereby increasing the attractiveness of the POI and the modal share of sustainable options. The POI owner could repurpose some of its private space for the mobility hub (e.g., some parking places) and invest in the necessary docking infrastructure. The city of Antwerp would not have to free up scarce public space and can integrate these mobility hubs within the existing transportation network (e.g., the Velostation at the brewery can be redesigned to a shared mobility hub). The high visibility and high flow of people passing the POI, makes this model interesting for advertisement, in order to cover some of the investment costs.

A hybrid mobility hub network is related to the first-/last-mile network, but could increase the catchment area of the current public transport network of De Lijn even more as it bridges the first-/last-mile gap for citizens of surrounding municipalities around the city center, where the density is lower. The low density implies higher investment costs for fixed docking stations. Therefore, freefloating vehicles could be introduced, so that the first-last-mile gap can still be bridged without having a high financial commitment as local authority. They surround the Velostations located at the borders of the current Velo network (indicated by the green circles on Figure 2). However, the city of Antwerp should require high service levels from the freefloating service providers so that these suburban neighborhoods are well-covered. In return, subsidies can be provided or permits to operate in more dense areas can be granted to the freefloating service providers. Moreover, the freefloating vehicles could increase the flexibility of the existing shared mobility hub network within the city center (i.e., the current Velostation network), possibly attracting additional users. A MaaS application would also opportune for this model to achieve its potential.

Lastly, the closed mobility hub network is opportune if the efforts to repurpose land towards and invest in shared mobility hubs are too high for the city of Antwerp, because of the unavailability of public land or low population density of certain areas. Therefore, an external partner could invest in shared mobility hubs so that their customers/employees can also make use of alternative transportation options. In the city of Antwerp, the Port of Antwerp could be an excellent location for the implementation of a closed system of shared vehicles, where the port authority and the companies located at the port can invest in shared mobility hubs. The yellow squares on Figure 2 indicate the shared mobility hubs, located at the end of a tramline and at the business areas from port companies. This closed

system would only be available for the people working at those companies, but would be integrated within the public network of shared mobility hubs so that the first-mile to the port borders can be bridged. This could improve the share of sustainable mobility within the Port of Antwerp, which is now vastly car-focused.

This case of Antwerp illustrates how the five business model blueprints each have a different network's value proposition for the city of Antwerp, which describes what kind of value the network will create by means of implementing the shared mobility hub network and how the different network's actors contribute to this value proposition.

Section 5 considers the strengths and the shortcomings of the generic business model blueprints in relation to the three main challenges of shared mobility described in Section 1.

5. Discussion

The five business model blueprints are theoretical ways of how a network of shared mobility hubs and its involved stakeholders can mitigate the main barriers that can prevent the further usage rate of shared mobility services and reduce its potential for sustainable mobility, namely the lack of dedicated physical and digital infrastructure and the limited integration with public transport. In which way the different blueprints do this (i.e., which value they create) and which barriers local authorities could face when implementing are discussed in this section. Furthermore, this section includes limitations of the research.

5.1. Business Model Blueprints

Shared mobility is still not an integral part of the urban mobility system. However, in order to further support and increase the utilisation of shared mobility modes, three challenges are considered: the provision of physical infrastructure, the provision of digital infrastructure and the integration with other private and public modes of transport (e.g., public transit). As indicated by Cohen and Shaheen [50], local municipalities can elevate the benefits of shared mobility through policy making related to these challenges (i.e., urban design, land use planning, and transport planning). The implementation of a shared mobility hub network is an example of urban design and land use planning that addresses these challenges and that could stimulate the further uptake of shared mobility. The ways (i.e., value created) a shared mobility hub network can mitigate the hurdles and become a facilitator for shared mobility, is discussed below. The network-centric approach this study took, in order to involve and align the interests of all relevant stakeholders, allowed developing five public-private business model blueprints. Moreover, Cohen and Kietzmann [17] identified the public-private model as most opportune to achieve sustainable mobility within the shared mobility context.

As opposed to other studies that followed a multi-stakeholder business model design process to explore the potential of shared and smart mobility within the urban environment using a design framework that focuses on the single-firm (e.g., [44,51]), this research has used a design tool that is grounded on the theory of collaborative networks [37,52]. This has allowed the network around the shared mobility hub, consisting of local authorities, shared mobility providers, MaaS-service providers, charging point operators, and real estate developers, to reach a consensus about the value a shared mobility hub can create (i.e., network's value proposition) and how every actor can contribute to this.

This article finds five business model blueprints whose main proposition is to stimulate the uptake of shared (electric) mobility, thus encouraging the substitution of conventional car use by sustainable transportation modes and maximising the use of available transport resources, leading to a more sustainable urban mobility model. However, as indicated above, three challenges should be addressed so that the potential uptake of shared (electric) mobility is maximised.

The first-/last-mile model offers a high integration with public transport, increasing the catchment area and attractiveness of public transport. This model provides a significant amount of dedicated infrastructure for shared mobility through a dense and fine-mesh network of shared mobility hubs. Moreover, it offers opportunities to establish a digital

integration and infrastructure. The intermodal travel behaviour it stimulates requires a digital integration across different travel modes (i.e., MaaS platform) in order to offer a seamless user experience. However, this model requires a high commitment from the local authorities to partly finance and repurpose land for the installation of a dense network of shared mobility hubs. Moreover, the shared mobility providers should perform efficient and effective rebalancing operations, in order to ensure availability of services for the target group of commuters. The costs associated with these complex operations could reduce the potential interested providers, leading to an insufficient supply of shared mobility services, and an unreliable network for users. Lastly, the benefits of integration with public transport are unsure, as the dense network of shared mobility services can serve as a substitute for public transport, instead of a complement. It has to reach the commuters travelling by car, not the commuters who already travelled by means of public transport.

The clustered shared mobility hub network model provides infrastructure that mainly increases the awareness for shared mobility and extend the transportation options for areas (i.e., suburban or rural regions) that are underserved by public transport and heavily rely on the private car. There is no integration with public transport and digital integration between different modes is also less necessary as intermodal and multimodal trips are not targeted. This model is focused on casual round trips for social, recreational and shopping purposes. It does not offer an extensive network of shared mobility hubs. Therefore, it has less potential to enhance some benefits of shared mobility (e.g., the flexibility of starting your trip at one hub and ending your trip at another hub close to your destination), but it does not require high financial investments and land repurposing efforts from the local authorities.

The POI-hub network model focuses on the provision of dedicated infrastructure for shared mobility at POIs. The implementation of this network can be (financially) supported by POI-owners, thus reducing the investment barriers (in financial and land use terms) for local authorities. The integration with public transport can be made if there is also a public transport offer at the POI. However, this is not the main aim of the model, as it primarily wants to increase multimodal (cfr. intermodal) travel behaviour towards the POI by efficiently providing different travel options in an organised way. Furthermore, a digital infrastructure can be of high importance for this model, in order to inform the POI-visitors about the different travel possibilities they have.

The hybrid mobility hub network model provides further benefits compared to the first-/last-mile and POI models by including free floating services. These vehicles can be left anywhere in a certain zone, providing more flexibility compared to solely the station-based services. However, the shared mobility hubs in this network do not aim to provide dedicated parking infrastructure for the free floating services, thus still leaving potential issues with regard to cluttering of public space. The model does offer opportunities for integration with public transport, as the free floating as well as station-based services can increase the catchment area of public transport. This also contributes to the opportunities for digital infrastructure. A MaaS-platform can enable a convenient intermodal travel experience and inform users about all transportation modes (including the free floating vehicles). Furthermore, it are the complex recharging and redistribution operations, that were indicated as barrier within the first-/last-mile hub network model, that can be reduced by implementing this model. For this purpose, a centralised fleet management is introduced to share the costs between station-based and free floating services for these operations. However, it should be noted that these modes can compete with each other, leading to a reduced uptake of the station-based or free floating service [53,54], compared to the situation where only station-based services are offered.

Lastly, the closed mobility hub network model provides dedicated infrastructure for shared mobility, but only at private environments. This ensures availability of the shared mobility services for the users who have access to these locations. It also takes away the hurdle for local authorities looking for available public space and sufficient financial support. However, this model does not integrate with public transport and does not

provide digital infrastructure, reducing its feasibility for intermodal travel behaviour and for replacing regular car trips. In a further stage, these mobility hubs can be integrated within a public network of shared mobility hubs, including the benefits of this integration and increasing the uptake of the shared mobility services.

It is important to highlight that the impact of the integration between shared mobility and public transport remains unclear [55]. As said, they can complement, but also substitute each other. Furthermore, the uptake of shared mobility services is also closely related to local parking policies, such as on-street parking prices, parking pressure and the allocation of parking spaces for shared mobility modes [56,57]. Besides the main facilities, such as charging and parking infrastructure, the mobility hubs offer for shared mobility, the amount of shared mobility hubs that compose the network is also an important element to consider in order to increase the uptake [58]. The business model blueprints do specify how these networks of shared mobility hubs stimulate the uptake of shared mobility services by addressing the lack of appropriate physical and digital infrastructure and the limited integration with public and private modes of transport, and how these networks could be operationalised.

5.2. Limitations

It was the intention of this study to explore which value a network of shared mobility hubs can create and how the network should be organised in order to achieve this value, from a business model perspective. The five business model blueprints, which this paper identified as potential mechanisms for value creation, will not be the only models that cities can consider in order to implement a successful network of hubs.

The study did include a broad range of stakeholders to have a comprehensive discussion about the business models, but the process of designing them does have some flaws. First, the focus groups did not directly involve the end user of shared mobility services. Their interests were partly looked after by the local authorities. Some of the participating authorities did already take into account their citizens' interests by organising citizen participation sessions beforehand. Second, the moderator and participants play a decisive role in steering the outcome of the design process. This effect was eased by organising different focus group discussions, where the participants also rotated, with the aim of ensuring a more comprehensive view (i.e., taking into account the perspective of different stakeholders) of the potential mechanisms.

Furthermore, the analysis of the qualitative results is based on the perception of the researcher and the comments of cities actually implementing pilot shared mobility hubs. However, the structured approach during the design process, which classified the open answers according to the design domains of the design framework, enabled a systematic analysis and development of the final blueprints.

Lastly, this study does not provide any evidence-based research about the potential of these networks, except the preliminary experience of six cities piloting the implementation of a shared mobility hub network. It has an exploratory perspective, so it cannot quantitatively justify the models that are designed. However, the business model design approach allows experimenting with, discussing, and gathering new and innovative ideas, before committing to their implementation.

6. Conclusions

This project was undertaken to design and evaluate different generic business models for the shared mobility hub concept. The design process was performed by a network of relevant actors, consisting of shared mobility providers, local authorities, public transport operators, and MaaS service providers. A network-centric business model design framework supported the development, so that different interests could be taken into account and alignment between them could be reached. In total, five business model blueprints were developed.

These blueprints identify five different kinds of shared mobility hub networks, targeting different end-users and involving different stakeholders. Every model aims to reduce car-dependency, by introducing physical infrastructure (i.e., the shared mobility hub) together with shared mobility services, focused on activities that, e.g., facilitate integration with public transport, increase awareness for shared mobility services, ensure the availability of shared mobility services, increase the flexibility of shared mobility services, or expand the total amount of transportation options.

6.1. Future Research

It remains to be seen if the industry will embrace the concept of shared mobility hubs, or evolve into a purely free floating market. Future research focused on shared mobility hubs can assess the implementation of the different kind of shared mobility networks. Which barriers and risks do the different stakeholders face when implementing a network of shared mobility hubs? How can these risks and barriers be mitigated? How can stakeholders such as mobility service providers be kept involved in the operation of the network? The preliminary experience from the pilot projects already raised barriers regarding the high initial investment costs of a dense shared mobility hub network (e.g., first-/last-mile network, POI network, hybrid network). This raises the question of whether these investment costs are justified from a societal perspective, or if these resources should be allocated towards measures facilitating other, more efficient and sustainable, mobility services. However, some commercial stakeholders such as shared mobility providers indicate it is hard to make a profit when operating within a less dense network. This raises the question how these stakeholders can be committed to operate and maintain such network (e.g., clustered hub network). Moreover, a definition for the success of different models, in terms of a quantitative framework, has to be established. Further study is required to examine how the conceptual idea of the shared mobility hub fits within the theory of transit-oriented development (TOD). Some of the models (i.e., first-/last-mile and POI) can easily connect with the concept of TOD, while others (i.e., closed network) are not related with the definition of TOD. It is interesting to look into assessment methods of TOD and see if they are suitable for appraising a shared mobility hub network.

6.2. Policy Implications

The knowledge and ideas acquired by the theories of business model innovation and collaborative networks were utilised to adapt the SDBM/R and use a customised framework to develop network-centric business model blueprints. The blueprints may support local authorities to tackle some of the challenges and barriers that hinder a successful implementation of shared mobility services in the urban environment. The different value propositions could guide the local authorities in choosing the appropriate shared mobility hub network. For example, if it is hard to reallocate public space for shared mobility hubs, local authorities could look into the POI mobility hub or closed mobility hub network model and see which stakeholders has to be involved. Moreover, the findings suggest several courses of action for shared mobility providers, local/regional authorities and other stakeholders to collaboratively establish such a network of shared mobility hubs. Cities or regions do not have to commit to one business model blueprint, but can establish different models according to the specific context of their neighbourhoods and their surrounding regions. However, the investment and commitment required of local authorities is large. They have to be willing to reallocate sufficient amount of public space and provide financial support to install the necessary infrastructure. It has to be integrated within a long-term vision for urban mobility, as the potential of shared mobility hubs is only reached if the network's density is adequate to grasp a sufficient amount of end-users willing to reduce their car-dependency.

Author Contributions: Conceptualization, E.C.; methodology, E.C.; validation, E.C.; formal analysis, E.C.; data curation, E.C.; writing—original draft preparation, E.C.; writing—review and editing, E.C., J.B., T.V. and A.V.; visualization, E.C.; supervision, J.B., T.V. and A.V. All authors have read and agreed to the published version of the manuscript.

Funding: This research was conducted under the eHUBS project, an INTERREG North-West Europe Project funded by the European Regional Development Fund and supported by the FWO (Grant 1270021N). J.B. is a postdoctoral fellow fundamental research of the Research Foundation–Flanders.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. List of Questions Used during the Focus Group Discussions

Design Domain	Questions
Organisation design	Who are the different stakeholders? (Public authorities, shared mobility providers, advertising companies, charging point operators, Public transport operators, Private, non-mobility related, companies (e.g., real estate developers, business park owners), etc.)
	What are the different roles of the network partners?
	Which relations exist between the different actors?
	What are the responsibilities of the different actors?
Service design	What is the value proposition of the shared mobility hub? Which market failure(s) is it addressing? What are the objectives of implementing the shared mobility hub?
	What is the geographical context/environment the shared mobility hub operate in?
	What is the socio-economic context/environment the shared mobility hub operate in?
	Who are the different target groups/end-users?
	What are the main needs and motivations of the different target groups?
	What are every actor's value propositions?
	How can a shared mobility hub contribute to these value propositions?
	What does the service platform looks like? (digital kiosk/application/online)
Which functions can be used through the service platform?	
Infrastructure design	Which functions/services are offered at the shared mobility hub? Which key activities do the actors carry out?
	Which technology can support the network?
	Which technical barriers can the network encounter?
	What is the design/composition of the shared mobility hub?
Finance design	What investments are needed?
	What are the potential funding sources (government funding, sponsoring, advertisement, real estate development, private investment)?
	What are the different operational costs streams?
	What are the different revenue streams?
	What is the pricing scheme of the shared mobility hub?
	How are the revenues/costs shared between the actors?
	What is the optimal contracting structure (publicly owned, privately operated/publicly owned & operated/privately owned & operated)?
Feedback design	How can the end-users provide feedback?
	What are the risks associated with the shared mobility hub-model and how can they be mitigated?
	What are potential barriers to the use of the shared mobility hub?

Appendix B. Overview of Business Model Blueprints

Business Model Blueprints	First-/Last-Mile Mobility Hub Network	Clustered Mobility Hub network	Point-of-Interest (POI) Mobility Hub Network	Hybrid Mobility Hub Network	Closed Mobility Hub Network
Design Domain					
Service Design	<p>Connected network of SM hubs, integrated in public transport network. Availability of shared mobility modes should be ensured to have reliable transportation system</p> <p>Aim to stimulate intermodal travel behaviour</p> <p>First-/last-mile solution requiring a dense network connecting relevant locations for the target groups</p> <p>Main target group are daily commuters.</p> <p>Highest potential at dense city neighbourhoods</p> <p>Important to have an easily accessible environment</p>	<p>Locations centralising the supply of shared mobility modes in certain areas, creating a recognisable place where a shared mobility offer can be found</p> <p>Aim to generate demand for shared mobility</p> <p>Encourage shared mobility providers to provide their services in otherwise underserved areas</p> <p>Main target group are neighbourhood's residents</p> <p>Highest potential at small neighbourhoods or outlying areas where public transport offer is minimal</p> <p>Opportunity to create safe environment stimulating additional economic and social activity (e.g., bars, local shops)</p>	<p>Network of SM hubs to safely and conveniently access different point-of-interests</p> <p>Integrated within public transport network</p> <p>Aim to stimulate multimodal travel behaviour</p> <p>Extend transportation options to point-of-interests, increasing their attractiveness and lowering the need for parking lots</p> <p>Main target groups are tourists and visitors of shops and leisure facilities</p> <p>Highest potential at areas with concentrated number of social and economic activities and high congestion</p> <p>Opportunity to seek the commitment of real estate developers in extending the network of SM hubs</p>	<p>Network of SM hubs providing extensive shared mobility modes (free-floating and station-based)</p> <p>Aim to increase area covered by shared mobility services, thereby stimulating uptake of shared mobility modes</p> <p>Active fleet management is required but can be carried out by one central actor (for both free-floating and station-based modes)</p> <p>Main target groups are commuters and tourists</p> <p>Highest potential at dense city centres and neighbourhoods</p> <p>Opportunity to centralise maintenance/charging for all shared mobility modes</p>	<p>Closed network of SM hubs to ensure availability of shared mobility modes to demanding actors</p> <p>Aim to stimulate uptake of alternative transportation modes</p> <p>Extend the transportation possibilities for private customers, thereby adding value for the target groups</p> <p>Main target groups are real estate developers and business park owners</p> <p>Potential locations are based on the demand of private actors</p> <p>Opportunity to provide additional services (e.g., charging points for private cars, parcel lockers)</p>

Business Model Blueprints	First-/Last-Mile Mobility Hub Network	Clustered Mobility Hub network	Point-of-Interest (POI) Mobility Hub Network	Hybrid Mobility Hub Network	Closed Mobility Hub Network
Design Domain					
Infrastructure Design	<p>Technology required to:</p> <ul style="list-style-type: none"> -monitor availability of shared mobility modes -gather data on trip chaining -provide travel advice based on a mix of personal preferences, policy preferences and time efficiency (i.e., MaaS application) -access and use all shared mobility modes (i.e., smart card/application/token) -provide information about public transport connections <p>Infrastructure required to:</p> <ul style="list-style-type: none"> -store private vehicles (e.g., personal bikes, scooters, mopeds) -adapt the offered supply of shared mobility modes (i.e., flexible infrastructure) -provide information and signalisation <p>Analogue and digital channels to enable services (e.g., leaflet, physical store, telephone service, screen, application)</p>	<p>Technology required to:</p> <ul style="list-style-type: none"> -monitor availability of shared mobility modes -access and use shared mobility modes and charging infrastructure (i.e., smart card/application/token) <p>Infrastructure required to:</p> <ul style="list-style-type: none"> -enable additional services (e.g., parcel lockers, terraces, charging points for private vehicles) -adapt the offered supply of shared mobility modes (i.e., flexible infrastructure) -provide information and signalisation -ensure a safe environment -provide recognisable branding elements <p>Analogue and digital channels to enable services (e.g., leaflet, physical store, telephone service, application)</p>	<p>Technology required to:</p> <ul style="list-style-type: none"> -monitor availability of shared mobility modes -gather data on trip chaining -provide travel advice based on a mix of personal preferences, policy preferences and time efficiency (i.e., MaaS application) -access and use all shared mobility modes (i.e., smart card/application/token) -provide information about public transport connections <p>Infrastructure required to:</p> <ul style="list-style-type: none"> -store private vehicles (e.g., personal bikes, scooters, mopeds) -provide information and signalisation (mainly toward POIs) -provide recognisable branding elements <p>Analogue and digital channels to enable services (e.g., leaflet, physical store, telephone service, screen, application)</p>	<p>Technology required to:</p> <ul style="list-style-type: none"> -monitor availability of shared mobility modes -gather data on trip chaining -provide travel advice based on a mix of personal preferences, policy preferences and time efficiency (i.e., MaaS application) -access and use all shared mobility modes (i.e., smart card/application/token) -mark allowed drop-off areas -efficiently redistribute and charge station-based and free-floating vehicles <p>Infrastructure required to:</p> <ul style="list-style-type: none"> -adapt the offered supply of shared mobility modes (i.e., flexible infrastructure) -provide information and signalisation -centralise the maintenance of shared mobility modes (free-floating and station-based) <p>Analogue and digital channels to enable services (e.g., leaflet, physical store, telephone service, screen, application)</p>	<p>Technology required to:</p> <ul style="list-style-type: none"> -monitor availability of shared mobility modes -access and use all shared mobility modes (i.e., smart card/application/token) -make access to SM hub exclusive <p>Infrastructure required to:</p> <ul style="list-style-type: none"> -adapt the offered supply of shared mobility modes (i.e., flexible infrastructure) -access the SM hub (i.e., gateway) <p>Digital channel to enable services (e.g., application)</p>

Business Model Blueprints	First-/Last-Mile Mobility Hub Network	Clustered Mobility Hub network	Point-of-Interest (POI) Mobility Hub Network	Hybrid Mobility Hub Network	Closed Mobility Hub Network
Design Domain					
Finance Design	Different pricing schemes but to ensure availability demand-responsive pricing can be implemented Opportunity to integrate public transport's fee into subscription fee for shared mobility services (i.e., MaaS subscription) Funding sources can be subsidies from public authorities and public transport operators, operating permits and advertisements	Pay-per-use pricing scheme Opportunity to integrate fee for additional services into subscription fee for shared mobility services Additional revenues from additional services (e.g., charging private vehicles) Funding sources can be subsidies from public authorities, operating permits, advertisements and rent from local service providers (e.g., parcel locker, bike repair services)	Different pricing schemes but to ensure availability demand-responsive pricing can be implemented Opportunity to integrate public transport's fee and entrance fee for POI into subscription fee for shared mobility services (i.e., MaaS subscription) Funding sources can be subsidies from public authorities and public transport operators, operating permits and advertisements	Different pricing schemes (e.g., subscription fee, pay-per-use) Opportunity to integrate public transport's fee and entrance fee for POI into subscription fee for shared mobility services (i.e., MaaS subscription) Financial incentives can be offered to redistribute the shared mobility fleet Funding sources can be subsidies from public authorities and public transport operators, operating permits and advertisements	Different pricing schemes (e.g., subscription fee, pay-per-use) Opportunity to integrate price of the shared mobility offer and access to the SM hub into one subscription fee Funding sources can be subsidies from public authorities, operating permits and investments from real estate developers and private firms
Feedback Design	QR code to give feedback on SM hubs' facilities and services Feedback-system on community and neighbourhood level (yearly surveys) Main risks and barriers are related to: -the substitution of public transport trips by shared mobility modes, thereby not reducing the car use -Viability of several SM hubs, leading to a low demand, low availability and low reliability of the shared transportation network -too strong focus on e-vehicles affecting the viability of the shared mobility services	QR code to give feedback on SM hubs' facilities and services Feedback-system on community and neighbourhood level (yearly surveys) Main risks and barriers are related to: -low usage of shared mobility services, leading to insufficient revenues for providers -low bargaining power of small cities and neighbourhoods, leading to low service levels and affecting the reliability of the shared system -too strong focus on e-vehicles and therefore affecting the viability of the shared mobility services	QR code to give feedback on SM hubs' facilities and services Feedback-system for visitors of the POI (e.g., digital screen, yearly survey at the POI) Main risks and barriers are related to: -the substitution of public transport trips by shared mobility modes, thereby not reducing the car use -Viability of several SM hubs, leading to a low demand and loss of valuable space at the POI -too strong focus on e-vehicles affecting the viability of the shared mobility services -insufficient space to accommodate further growth of the SM hub, reducing the reliability of the shared transportation network	QR code to give feedback on SM hubs' facilities and services Feedback-system on community and neighbourhood level (yearly surveys) Main risks and barriers are related to: -the substitution of public transport trips by shared mobility modes, thereby not reducing the car use -Inconvenience for public space users by numerous free-floating devices on the street -competition between free-floating and station-based providers, thereby affecting the viability of the SM hub -too strong focus on e-vehicles affecting the viability of the shared mobility services	QR code to give feedback on SM hubs' facilities and services Feedback-system on community and neighbourhood level (yearly surveys) Digital feedback channel of private companies (for residents and employees) Main risks and barriers are related to: -the substitution of public transport trips by shared mobility modes, thereby not reducing the car use -low usage of shared mobility services, leading to insufficient revenues for providers -insufficient connection with open-accessible SM hubs in other areas, risking to lose users who cannot reach their destination

Appendix C. Network's Organisation Design Domain

Actors	Network	Public Authority	Public Transport Operator	Shared Mobility Provider(s)	Mobility Enabling Service Providers (Charging Point Operators, MaaS Provider)	Non-Mobility Related Commercial Service Providers	Private, Non-Mobility Related, Companies (e.g., Real Estate Developers, Business Park Owners)
Engagement in type of business model blueprint	First-/last-mile Clustered POI Hybrid Closed	First-/last-mile Clustered POI Hybrid Closed	First-/last-mile POI Hybrid	First-/last-mile Clustered POI Hybrid Closed	First-/last-mile Clustered POI Hybrid Closed	First-/last-mile Clustered POI Hybrid	First-/last-mile POI Hybrid Closed
Role of actor	Responsible for design of SM hub (offer of mobility services and additional facilities and related physical elements to provide mobility and additional services) Foster behavioural change (create neutral SM hub brand) Provide available and convenience shared (e-)mobility offer	Facilitate the formation of a network; assemble network of stakeholders Collect and aggregate transport data from mobility providers. Foster behavioural change (create neutral SM hub brand) Define the level playing field; open foundation for creating different kinds of SM hubs involving different stakeholders Maintain and operate the SM hubs' facilities Invest and enable shared mobility services (through subsidies) Regulate; discourage use of private cars; create level playing field for shared mobility providers. Act as a mediator between partners	Provide qualitative public transport Foster behavioural change (marketing) Maintain the SM hubs' facilities Implement and install SM hubs within public transport network	Provide shared mobility modes Foster behavioural change (marketing) Redistribute, recharge and maintain the shared mobility modes Invest in the infrastructure of SM hub Maintain the SM hubs' facilities	Provide charging points Provide MaaS-solution	Provide facilities at the SM hub (e.g., lockers, local shops, bars)	Implement and install SM hubs at high demand areas/POIs (universities, shopping malls, business parks, etc.) Implement and install SM hubs at residencies, in order to reduce parking space-obligations Invest in the infrastructure of SM hubs

References

1. EEA. Greenhouse Gas Emissions from Transport in Europe. Available online: https://www.eea.europa.eu/ds_resolveuid/7009a89effc04d8ea8b5f94ff0a39912 (accessed on 9 November 2020).
2. Civitas. Cleaner and Better Transport in Cities. Available online: <https://civitas.eu/> (accessed on 29 September 2020).
3. EIT Urban Mobility. A European Initiative to Create Liveable Urban Spaces. Available online: <https://eit.europa.eu/our-communities/eit-urban-mobility> (accessed on 29 September 2020).
4. Eltis. The Urban Mobility Observatory. Available online: <https://www.eltis.org/> (accessed on 29 September 2020).
5. Alonso Raposo, M.; Ciuffo, B.; Ardente, F.; Aurambout, J.-P.; Baldini, G.; Braun, R.; Christidis, P.; Christodoulou, A.; Duboz, A.; Felici, S.; et al. *The Future of Road Transport—Implications of Automated, Connected, Low-Carbon and Shared Mobility*; EUR 29752 EN; Publications Office of the European Union: Luxembourg, 2019. [CrossRef]

6. Vandecasteele, I.; Baranzelli, C.; Siragusa, A.; Aurambout, J.P.; Alberti, V.; Alonso Raposo, M.; Attardo, C.; Auteri, D.; Barranco, R.; Batista e Silva, F.; et al. *The Future of Cities—Opportunities, Challenges and the Way Forward*; EUR 29752 EN; Publications Office of the European Union: Luxembourg, 2019. [\[CrossRef\]](#)
7. Yanocha, D. *Optimising New Mobility Services*; International Transport Forum Discussion Papers; OECD Publishing: Paris, France, 2018.
8. Shaheen, S.; Cohen, A.; Chan, N.; Bansal, A. Sharing strategies: Carsharing, shared micromobility (bikesharing and scooter sharing), transportation network companies, microtransit, and other innovative mobility modes. In *Transportation, Land Use, and Environmental Planning*; Deakin, E., Ed.; Elsevier: Amsterdam, The Netherlands, 2020; pp. 237–262. [\[CrossRef\]](#)
9. International Transport Forum. *Safe Micromobility*; International Transport Forum: Paris, France, 2020.
10. Shaheen, S.; Chan, N. Mobility and the Sharing Economy: Potential to Facilitate the First- and Last-Mile Public Transit Connections. *Built Environ.* **2016**, *42*, 573–588. [\[CrossRef\]](#)
11. Guo, Y.; He, S.Y. Built environment effects on the integration of dockless bike-sharing and the metro. *Transp. Res. Part D Transp. Environ.* **2020**, *83*, 102335. [\[CrossRef\]](#)
12. Wong, Y.Z.; Hensher, D.A.; Mulley, C. Mobility as a service (MaaS): Charting a future context. *Transp. Res. Part A Policy Pract.* **2020**, *131*, 5–19. [\[CrossRef\]](#)
13. Massa, L.; Tucci, C.L.; Afuah, A. A Critical Assessment of Business Model Research. *Acad. Manag. Ann.* **2017**, *11*, 73–104. [\[CrossRef\]](#)
14. Boons, F.; Lüdeke-Freund, F. Business models for sustainable innovation: State-of-the-art and steps towards a research agenda. *J. Clean. Prod.* **2013**, *45*, 9–19. [\[CrossRef\]](#)
15. Schaltegger, S.; Hansen, E.G.; Lüdeke-Freund, F. Business Models for Sustainability. *Organ. Environ.* **2016**, *29*, 3–10. [\[CrossRef\]](#)
16. Evans, S.; Vladimirova, D.; Holgado, M.; Van Fossen, K.; Yang, M.; Silva, E.A.; Barlow, C.Y. Business Model Innovation for Sustainability: Towards a Unified Perspective for Creation of Sustainable Business Models. *Bus. Strategy Environ.* **2017**, *26*, 597–608. [\[CrossRef\]](#)
17. Cohen, B.; Kietzmann, J. Ride On! Mobility Business Models for the Sharing Economy. *Organ. Environ.* **2014**, *27*, 279–296. [\[CrossRef\]](#)
18. Teece, D.J. Business Models, Business Strategy and Innovation. *Long Range Plan.* **2010**, *43*, 172–194. [\[CrossRef\]](#)
19. Rohrbeck, R.; Konnertz, L.; Knab, S. Collaborative business modelling for systemic and sustainability innovations. *Int. J. Technol. Manag.* **2013**, *63*, 4–23. [\[CrossRef\]](#)
20. Barney, J. Firm Resources and Sustained Competitive Advantage. *J. Manag.* **1991**, *17*, 99–120. [\[CrossRef\]](#)
21. Magretta, J. Why Business Models Matter. *Harv. Bus. Rev.* **2002**, *80*, 86–92.
22. Lüdeke-Freund, F. Sustainable entrepreneurship, innovation, and business models: Integrative framework and propositions for future research. *Bus. Strategy Environ.* **2020**, *29*, 665–681. [\[CrossRef\]](#)
23. Schaltegger, S.; Hörisch, J.; Freeman, R.E. Business Cases for Sustainability: A Stakeholder Theory Perspective. *Organ. Environ.* **2019**, *32*, 191–212. [\[CrossRef\]](#)
24. Allee, V. Value network analysis and value conversion of tangible and intangible assets. *J. Intellect. Cap.* **2008**, *9*, 5–24. [\[CrossRef\]](#)
25. Gauthier, C.; Gilomen, B. Business Models for Sustainability: Energy Efficiency in Urban Districts. *Organ. Environ.* **2016**, *29*, 124–144. [\[CrossRef\]](#)
26. Amit, R.; Zott, C. Creating Value Through Business Model Innovation. *Mit Sloan Manag. Rev.* **2012**, *53*, 41–49.
27. Fjeldstad, Ø.D.; Snow, C.C. Business models and organization design. *Long Range Plan.* **2018**, *51*, 32–39. [\[CrossRef\]](#)
28. Chesbrough, H. Business Model Innovation: Opportunities and Barriers. *Long Range Plan.* **2010**, *43*, 354–363. [\[CrossRef\]](#)
29. Osterwalder, A.; Pigneur, Y. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*; John Wiley & Sons: Hoboken, NJ, USA, 2010.
30. Gassmann, O.; Frankenberger, K.; Csik, M. *The Business Model Navigator: 55 Models That Will Revolutionise Your Business*; Pearson UK: London, UK, 2014.
31. Johnson, M.W.; Christensen, C.M.; Kagermann, H. Reinventing Your Business Model. *Harv. Bus. Rev.* **2008**, *86*, 57–68.
32. Demil, B.; Lecocq, X. Business Model Evolution: In Search of Dynamic Consistency. *Long Range Plan.* **2010**, *43*, 227–246. [\[CrossRef\]](#)
33. Upward, A.; Jones, P. An Ontology for Strongly Sustainable Business Models. *Organ. Environ.* **2016**, *29*, 97–123. [\[CrossRef\]](#)
34. Joyce, A.; Paquin, R.L. The triple layered business model canvas: A tool to design more sustainable business models. *J. Clean. Prod.* **2016**, *135*, 1474–1486. [\[CrossRef\]](#)
35. Bocken, N.M.P.; Rana, P.; Short, S.W. Value mapping for sustainable business thinking. *J. Ind. Prod. Eng.* **2015**, *32*, 67–81. [\[CrossRef\]](#)
36. Calabrese, A.; Forte, G.; Ghiron, N.L. Fostering sustainability-oriented service innovation (SOSI) through business model renewal: The SOSI tool. *J. Clean. Prod.* **2018**, *201*, 783–791. [\[CrossRef\]](#)
37. Turetken, O.; Grefen, P.; Gilsing, R.; Adali, O.E. Service-Dominant Business Model Design for Digital Innovation in Smart Mobility. *Bus. Inf. Syst. Eng.* **2019**, *61*, 9–29. [\[CrossRef\]](#)
38. Provan, K.; Kenis, P. Modes of Network Governance: Structure, Management, and Effectiveness. *J. Public Adm. Res. Theory* **2007**, *18*, 229–252. [\[CrossRef\]](#)
39. Lindgren, P.; Taran, Y.; Boer, H. From single firm to network-based business model innovation. *Int. J. Entrep. Innov. Manag.* **2010**, *12*, 122–137. [\[CrossRef\]](#)

40. Osterwalder, A.; Pigneur, Y.; Tucci, C. Clarifying Business Models: Origins, Present, and Future of the Concept. *Commun. AIS* **2005**, *16*. [[CrossRef](#)]
41. Osterwalder, A.; Pigneur, Y. An Ontology For E-Business Models. *Value Creat. E-Bus. Models* **2004**, *1*, 65–97. [[CrossRef](#)]
42. Strategyzer. The Business Model Canvas. Available online: <https://www.strategyzer.com/canvas/business-model-canvas> (accessed on 15 December 2020).
43. Beltramello, A.; Haie-Fayle, L.; Pilat, D. *Why New Business Models Matter for Green Growth*; OECD Publishing: Paris, France, 2013. [[CrossRef](#)]
44. Schiavone, F.; Paolone, F.; Mancini, D. Business model innovation for urban smartization. *Technol. Forecast. Soc. Chang.* **2019**, *142*, 210–219. [[CrossRef](#)]
45. Morgan, D.L. Focus Groups. *Annu. Rev. Sociol.* **1996**, *22*, 129–152. [[CrossRef](#)]
46. TomTom. Traffic Index Ranking. 2019. Available online: https://www.tomtom.com/en_gb/traffic-index/ranking/ (accessed on 8 June 2021).
47. Stad Antwerpen. Shared Mobility. Available online: <https://www.slimnaarantwerpen.be/en/shared-mobility> (accessed on 8 June 2021).
48. Kishchenko, K.; De Roeck, M.; Salens, M.; Maroey, C.V. The Antwerp Marketplace for Mobility: Partnering with private mobility service providers as a strategy to keep the region accessible. *Transp. Res. Procedia* **2019**, *39*, 191–200. [[CrossRef](#)]
49. Verhetsel, A.; Thomas, I.; Beelen, M. Commuting in Belgian metropolitan areas. The power of the Alonso-Muth model. *J. Transp. Land Use* **2010**, *2*, 109–131. [[CrossRef](#)]
50. Cohen, A.; Shaheen, S. *Planning for Shared Mobility*; American Planning Association: Chicago, IL, USA, 2018. [[CrossRef](#)]
51. Polydoropoulou, A.; Pagoni, I.; Tsirimpia, A.; Roumboutsos, A.; Kamargianni, M.; Tsouros, I. Prototype business models for Mobility-as-a-Service. *Transp. Res. Part A Policy Pract.* **2020**, *131*, 149–162. [[CrossRef](#)]
52. Camarinha-Matos, L.M.; Afsarmanesh, H. Collaborative networks: A new scientific discipline. *J. Intell. Manuf.* **2005**, *16*, 439–452. [[CrossRef](#)]
53. Lazarus, J.; Pourquier, J.C.; Feng, F.; Hammel, H.; Shaheen, S. Micromobility evolution and expansion: Understanding how docked and dockless bikesharing models complement and compete—A case study of San Francisco. *J. Transp. Geogr.* **2020**, *84*, 102620. [[CrossRef](#)]
54. Feng, D.; Cheng, L.; Du, M. Exploring the Impact of Dockless Bikeshare on Docked Bikeshare—A Case Study in London. *Sustainability* **2020**, *12*, 6110. [[CrossRef](#)]
55. Oeschger, G.; Carroll, P.; Caulfield, B. Micromobility and public transport integration: The current state of knowledge. *Transp. Res. Part D Transp. Environ.* **2020**, *89*, 102628. [[CrossRef](#)]
56. Balac, M.; Ciari, F.; Axhausen, K.W. Modeling the impact of parking price policy on free-floating carsharing: Case study for Zurich, Switzerland. *Transp. Res. Part C Emerg. Technol.* **2017**, *77*, 207–225. [[CrossRef](#)]
57. Shaheen, S.A.; Cohen, A.P.; Martin, E. Carsharing Parking Policy. *Transp. Res. Rec. J. Transp. Res. Board* **2010**, *2187*, 146–156. [[CrossRef](#)]
58. Faghih-Imani, A.; Eluru, N. Determining the role of bicycle sharing system infrastructure installation decision on usage: Case study of montreal BIXI system. *Transp. Res. Part A Policy Pract.* **2016**, *94*, 685–698. [[CrossRef](#)]