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How sustainable are urban transport services? A comparison of MaaS and UCC

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A R T I C L E I N F O

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A B S T R A C T

It is believed that a transition toward more sustainable transport will be a cornerstone of plans to reduce global emissions. Two services that show great potential to improve the sustainability of urban transport are Mobility-as-a-Service (MaaS) and Urban Consolidation Centers (UCC): MaaS is focused on the transport of people and UCC on freight transport. MaaS and UCC both involve a network of actors, present a clear vision for sustainability, can be applied in urban contexts, use new technologies, and are nascent transport solutions that are yet to be fully established and see large-scale implementation as transport services in urban areas. Despite showing significant potential, there are still some questions over how sustainable these transport services actually are. In this paper, we systematically review literature on MaaS and UCC; we analyze 137 papers to compare the environmental, social, and economic sustainability of these two urban transport services. In the review, these new transport services promise to deliver both social and environmental sustainability, but these promises have yet to be fulfilled. Several studies point to problems related to social and environmental sustainability. Similarly, the economic viability of these business models is yet to be proven. Future research topics are suggested.

1. Introduction

Today, there are fundamental sustainability issues that need to be addressed in several areas, such as energy, transport, and food (Farla, Markard, Raven, & Coenen, 2012; Köhler et al., 2019). These challenges include environmental, social, and economic considerations (Markard, Raven, & Truffer, 2012). Transport is an integral part of sustainable development due to its considerable social and environmental effects and direct link to economic growth. Globally, transport accounts for approximately 24% of direct CO_2 emissions and has a considerable impact on public health through noise and air pollutants as well as road safety (IEA, 2020). Transport is included in a number of the UN Sustainable Development Goals (SDGs). These include social aspects, such as making transport accessible, safe, and secure; environmental aspects, such as creating solutions that are compatible with the natural environment and reduce emissions and pollution; and economic aspects, such as developing cost-efficient infrastructure that contributes to the needs of society and business. According to Steg and Gifford (2005), there are, traditionally, two strategies for mitigating the negative effects of transport: technological change and behavioral change. Technological change aims to reduce the negative impacts of vehicles and distance travelled through energy-efficiency improvements or the development of alternative energy sources. Behavioral change aims to reduce the use of high-emission vehicles, e.g., by shifting to less polluting modes of transport, combining trips and consolidating shipments, changing destination choices, and reducing travel. Both technological and behavioral changes are considered crucial to the transition toward a more sustainable transport system (Pei, Amekudzi, Meyer, Barrella, & Ross, 2010).

This study focuses on urban transport services that aim to provide sustainable transport solutions. New urban transport solutions that use new technologies, such as Information and Communications Technology (ICT), are receiving significant attention as potential modes of sustainable urban transport. A major guide for societal change are the UN Sustainable Development Goals (SDGs), of which SDG 11 focuses on sustainable cities and communities, and particularly urban mobility. Today's urban transport services pose environmental, social, and economic challenges that need to be resolved. Innovations to address these sustainability concerns include novel technologies as well as new business models (Whittle, Whitmarsh, Hagger, Morgan, & Parkhurst, 2019). New technological solutions have been suggested to enable more sustainable transport services (Bagheri, Mladenović, Kosonen, & Nurminen,

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2020; Monios & Bergqvist, 2020; Skeete, 2018; Altuntaş Vural, Roso, Halldórsson, Ståhle, & Yaruta, 2020). Transport solutions must focus on emissions reduction, with transport identified as a significant contributor of emissions in today's society (Melander, 2018; Toledo & La Rovere, 2018). Sustainability is now part of any discussion of urban mobility, making it a pre-requisite for the introduction of new business models in urban transport (Cruz & Sarmento, 2020). Two recent literature reviews point to innovative solutions for urban mobility, exploring the potential of moving freight on urban public transport and integrating passenger and freight transport (Cavallaro & Nocera, 2021; Elbert & Rentschler, 2021). However, these are not sustainability focuses, and Elbert and Rentschler (2021) report that only a few papers in their review include environmental considerations.

Governments are taking action to improve urban environments by developing more sustainable transport policies, and individual citizens are also concerned with the future of urban development. Hence, finding more sustainable urban transport solutions engages many stakeholders, including governments, industries, organizations, and individuals. However, there are still many uncertainties over future technological developments and regulations and which new urban transport solutions will reach scale (Fritschy & Spinler, 2019; Melander, Dubois, Hedvall, & Lind, 2019; Monios & Bergqvist, 2020). Hence, there is a need to synthesize extant literature on sustainable business models for providing urban transport services.

In this research, we are interested in new urban transport services that: (i) rely on multiple actors that need to collaborate and share information, (ii) have complex business models, and (iii) are viewed as having potential to improve the sustainability of the transport system. The study is limited to the urban context and to one transport service focused on transporting people and one on transporting goods, Mobility-as-a-Service (MaaS) and Urban Consolidation Centers (UCC) respectively. These two business models are illustrative examples of urban transport services that are aimed at improving sustainability and rely on collaboration between multiple actors.

This paper is based on a literature review that includes 137 papers on the urban transport services MaaS and UCC. The transport services studied involve collaboration between multiple actors, including those in the private and public sectors as well as individuals. The purpose of our paper is to review extant literature on the MaaS and UCC business models. Although MaaS and UCC are viewed as having potential to improve sustainability within transport, it is not clear to what extent they can deliver this. Hence, this study aims to review the social, environmental, and economic sustainability of these urban transport services and discuss how sustainable the MaaS and UCC business models are in practice. There are high expectations for the sustainability of these transport services, and we analyze to what extent they can fulfil this promise. The paper also provides some future research topics to be explored.

The review points to a number of discrepancies regarding the sustainability of MaaS and UCC business models. While they promise to deliver more environmentally sustainable transport services, there is some discussion as to whether they are as sustainable as first assumed. Similarly, the business models show potential of being economically viable but have had some difficulty proving this over the long-term.

The paper is structured as follows. First, the MaaS and UCC transport services are described, followed by our method. Then, we provide an analysis of the sustainability of these urban transport services. Thereafter, we discuss how multiple actor engagement, ICT, integration of freight and passenger transport, electromobility, and behavioral changes can enable more sustainable urban transport. Finally, conclusions, future research, and limitations are provided.

2. Transport service description

2.1. MaaS

MaaS represents a new paradigm for the transport sector and has only been the subject of research for a few years. It is considered a radical innovation that has the potential to revolutionize transport systems (Sochor, Arby, Karlsson, & Sarasini, 2018). MaaS puts user needs at its center, offering a flexible, personalized, and on-demand mobility service. MaaS combines various modes of transport, such as public transport, car sharing, taxis, bikes, etc., meaning that multiple actors are involved in making it a viable option in urban settings. To coordinate transport, MaaS uses a platform that covers all mobility operators. Trips can be purchased with a single payment that combines multiple modes of transport. This requires the availability of real-time information within a complex system, including timetables, traffic data, and user demand, that needs to be collected from various sources. There are several definitions of MaaS given by different publications, see for example Sochor et al. (2018) and Jittrapirom et al. (2017). The integration of ICT is included in several definitions, and the core concepts include personalized service, user needs, and systems of actors.

2.2. UCC

In contrast to MaaS, UCC is not a new concept and has been tried in various forms over the last few decades to mitigate the negative effects of urban freight transport. A UCC can be defined as a cross-docking terminal that collects and consolidates small consignments entering and exiting a city or area, reducing vehicle traffic by increasing vehicle load utilization (Olsson & Woxenius, 2014). It is a logistics facility located close to the area it serves, either in a city center or at a specific site, such as a shopping center or office building. A UCC represents the last- and/or first-mile distribution of a supply chain, commonly at the intersection of urban and inter-urban areas. In their literature review, Allen, Browne, Woodburn, and Leonardi (2012) identify three main categories of UCCs: (1) UCCs that serve all or part of an urban area, (2) UCCs that serve large sites with a single landlord, such as airports, hospitals, and shopping centers, and (3) UCCs that serve major construction sites. However, UCCs are difficult and complex to implement. The same review, which identified 114 UCC schemes in 17 countries, concluded that one of the major barriers to successful UCC schemes is financial sustainability; it is common for UCC trials and pilots to end once initial funding is used up or public subsidies removed (Allen et al., 2012). This is especially true of UCCs that serve all or part of an urban area, mostly due to the number of stakeholders involved and the complexity of the system (Björklund, Abrahamsson, & Johansson, 2017). In these cases, ICT can be considered a critical factor in optimizing the supply chain and service development (Björklund et al., 2017).

3. Methodology

We conducted a literature review to synthesize the existing body of research and opted to use the Scopus database, a comprehensive source for scholarly publications containing thousands of journals. When conducting literature reviews, the criteria for inclusion and exclusion need to be specified (Fink, 2013). We were interested in literature investigating the sustainability of MaaS and UCC, including social, environmental, and economic aspects. Therefore, we performed a structured keyword search of titles, abstracts, and keywords. We used two sets of keywords for our two searches: (1) “MaaS” or “Mobility-as-a-service” and “sustainab*”, and (2) “UCC” or “Urban Consolidation Center” and “sustainab*”. We limited our search to only articles (e.g., not book chapters) written in English. The two searches resulted in 106 and 59 papers respectively. The abstracts were read to confirm the content of the articles; from this, 32 papers from the UCC search and 35 papers from the MaaS search were eliminated because they did not have a clear transport focus and were instead focused on, e.g., waste management, construction management, telecommunications, agriculture, or infrastructure, or did not consider sustainability issues. Thereafter, all the papers were read in their entirety. We used snowballing to identify additional papers from our review sample. That process yielded an additional 19 papers on UCC and 20 on MaaS, resulting it a total of 137 papers in the review. Fig. 1 shows the process of our literature search.

We analyzed each transport service according to our framework, consisting of social, environmental, and economic sustainability. This was done by identifying aspects of social sustainability, environmental sustainability, and economic viability for both the MaaS and UCC business models. Information from the reviewed papers related to the elements in our framework was put into mega-matrices (Miles & Huberman, 1984). These matrices provided intra-group analysis (an analysis for each transport service) as well as inter-group analysis (comparing sustainability of these two transport services).

4. Analysis of the reviewed papers

4.1. Social sustainability

4.1.1. MaaS

MaaS is described as having the potential to provide extensive contributions to social sustainability. By implementing MaaS, it is possible for private car ownership and usage to be reduced, to build more accessible and livable cities, provide access to more efficient modes transport, and make more efficient use of existing infrastructure (Sochor et al., 2018; Utriainen & Pöllänen, 2018). Nikitas, Kougias, Alyavina, and Njoya Tchouamou (2017) point out that the social benefits of MaaS could include better access to opportunities such as health care and leisure, greater social inclusion, and healthier and more active lifestyles.

However, a few papers in our review question the social sustainability of MaaS. Hensher (2018) questions the social sustainability benefits of MaaS, such as improved accessibility, and whether it is consistent with the broad goals of society, stating that there is limited evidence of this. From a health perspective, Pangbourne, Mladenović, Stead, and Milakis (2020) point out the lack of travel options that require physical activity, such as walking or cycling, in MaaS. The authors argue that a MaaS package might result in the neglect of physical activity due to the door-to-door promise of the model. The authors also discuss the possibility of exclusion in a closed MaaS network, where individuals may be excluded due to dissent, cost, or aversion to technology. The authors call for discussions on the potential problems for urban residents outside the MaaS system. MaaS's reliance on registration and digitalization could exclude some social groups (Hensher, Mulley, & Nelson, 2021; Pangbourne et al., 2020). In Europe, privacy considerations are a major concern due to the General Data Protection Regulation (GDPR), which requires digital issues such as data acquisition, sharing, and protection to be managed (Cottrill, 2020).

Bike sharing is a transport mode included in the MaaS offering that has been viewed as having varying impact on social sustainability. On the one hand, bike sharing provides affordable and convenient access to transport, thus increasing mobility (Gu, Kim, & Currie, 2019; Jennings, 2015), and it is believed that fewer cars will reduce the need for parking spaces in urban areas, enabling other activities such as walking, biking, commerce, and leisure (Luna, Uriona-Maldonado, Silva, & Vaz, 2020). On the other hand, the drawbacks of shared transport from a social sustainability perspective has been discussed extensively in regards to bike-sharing business models in China (e.g., Gu et al., 2019; Ma et al., 2019; Ma, Lan, Thornton, Mangalagiu, & Zhu, 2018). Problems with bike sharing include (i) oversupply, (ii) problems of user misbehavior, and (iii) exclusion. (i) The oversupply is a result of rapid scale-up processes driving over-investment, over-competition, and over-delivery in a short period of time. This has led to a flood of shared bikes in urban public spaces (Ma et al., 2018) that are scattered randomly in urban areas and left blocking sidewalks (Gu et al., 2019). (ii) User misbehavior includes theft, vandalism, and illegal parking (Ma et al., 2018). (iii) Some bike-sharing business models may exclude the urban poor who live outside the city center and may be unable to afford the security requirements such systems often require (Jennings, 2015). It is also argued that shared transport business models are not adjusted to meet the needs of all citizens, and that it may be predominantly younger adults living in urban centers who use shared transport (Whittle et al., 2019).

4.1.2. UCC

UCCs can contribute to quality of life improvements for citizens, tourists, and visitors while fulfilling demand for logistics services in the city center (Björklund et al., 2017). This is because it reduces the number of heavy goods vehicles (HGVs) needed to deliver goods to receivers, often located in busy urban areas (Van Duin, Van Dam, Wiegmans, & Tavasszy, 2016). UCC can thus contribute to the increased traffic safety and appeal of urban spaces. Furthermore, as smaller vehicles or cargo bikes are often used in UCC schemes, drivers of large HGVs will not be required to enter crowded urban spaces as often, potentially leading to better working conditions and less stress for drivers. Another positive effect for carriers and the environment is increased routing efficiency. A recent study shows that social costs decrease when a UCC is implemented due to the emissions reductions provided (Daniela, 2021).

4.2. Environmental sustainability

4.2.1. MaaS

MaaS is projected to deal with urban mobility challenges, such as reducing traffic congestion (Nikitas et al., 2017; Utriainen & Pöllänen, 2018), while offering the opportunity for customers to choose more sustainable modes of transport and travel during off-peak hours (Sochor et al., 2018). A pricing model based on expected traffic at the point of travel could be used to reduce congestion (Cooper, Tryfonas, Crick, & Marsh, 2019). There are already MaaS schemes that include features to influence users' travel decisions, such as promoting public transport and rewarding them for 'green' journeys (Jittrapirom et al., 2017). Hensher et al. (2021) point out that a Sydney trial showed some potentially positive outcomes from reduced private car use and emissions. Similarly, Becker, Balac, Ciari, and Axhausen (2020) show that by including shared mobility in MaaS schemes it is possible to reduce energy consumption significantly. However, a number of authors point out the need for caution when discussing the environmental sustainability benefits of implementing MaaS, as they may have been exaggerated. For instance, Utriainen and Pöllänen (2018) argue that car sharing is not

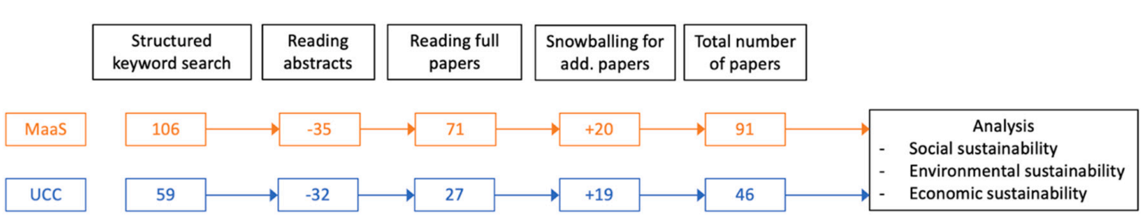

Fig. 1. The process of the literature search and analysis.

more environmentally friendly than normal car usage as it still results in congestion, but the authors point out that car-sharing companies tend to offer newer and smaller cars that are more environmentally friendly. Hensher (2018) argues that MaaS is often described as being able to deliver sustainability gains such as reduced congestion and transport emissions, but the author questions this claim citing the limited evidence for it. In a similar vein, Pangbourne et al. (2020) point out that while MaaS could lead to a reduction in personal car ownership, it remains to be seen what the impact will be in terms of kilometers driven. Jang, Caiati, Rasouli, Timmermans, and Choi (2021) argue that if current car owners switch to MaaS and choose to use only public transport, then environmental sustainability will increase; however, if they choose car-rental and car-sharing options, then it may be reduced. Pangbourne et al. (2020) also point out that MaaS promises instantaneous mobility to individuals. However, this promise becomes a challenge in a transport network with a finite capacity. It is also not aligned with transport policy objectives of reducing congestion, GHG emissions, and air pollution.

4.2.2. UCC

The overall objective of a UCC is to consolidate goods going into and/or out of a specific area, often a city center, to transship cargo from large polluting HGVs to smaller, more environmentally friendly and flexible transport units, i.e. smaller electrical vehicles or cargo bikes (Allen, Browne, Woodburn, & Leonardi, 2014). All papers in the literature review state that there is considerable potential to reduce freight-related emissions (CO_{2-}, PM- and NO_x) using UCCs. Several case studies, literature reviews, and simulation studies show this to range from 25 to 80%, depending on the scheme and volumes considered (Allen et al., 2012; Clausen, Geiger, & Pöting, 2016; Dupas, Taniguchi, Deschamps, & Qureshi, 2020; Kin, Verlinde, van Lier, & Macharis, 2016; Lin, Chen, & Kawamura, 2016; Papoutsis, Dewulf, Vanelslander, & Nathanail, 2018; Van Duin et al., 2016; van Heeswijk, Larsen, & Larsen, 2019). However, as Lin et al. (2016) state, the effects of implementing UCC schemes depend on numerous factors, such as location, additional governmental policies (i.e., vehicle restrictions), type of vehicles, utilization rate, and routing. UCCs could in some cases contribute to greater distances travelled but still be economically and environmentally sustainable given economies of scale or high customer density (Lin et al., 2016). Björklund and Simm (2019) point out that the potential environmental benefits of UCCs are likely to be found in aspects such as packing and loading of vehicles, inventory management, and modal split/change.

4.3. Economic viability

4.3.1. MaaS

Organizations need to develop profitable business models, which means developing contractual models for private-public cooperation and understanding how changes in a policy framework will affect customer behavior (Sochor et al., 2018). Several authors point to the importance of business viability if MaaS is to be implemented in urban areas (Narupiti, 2019; Polydoropoulou et al., 2020; Polydoropoulou, Pagoni, & Tsirimpa, 2018). Polydoropoulou et al. (2020) point out that revenue streams from MaaS depend on the business model as well as the actors included in the system. The main revenue streams relate to the provision and sale of MaaS services. Revenues also depend on the revenue distribution model and commissions, which in turn depend on whether MaaS services are provided through subscriptions or a pay-as-you go model (Ho, Hensher, Mulley, & Wong, 2018). There is also the possibility of revenues from advertising and subsidization. In an Australian study, Mulley et al. (2020) find that the willingness to pay for MaaS is lower than the cost of providing the services, which raises questions around the economic sustainability of the model. Taking another view, Nikitas et al. (2017) argue that economic benefits could also refer to increased access to jobs, services, and markets, as well as making urban areas more attractive.

Some studies show that there are differing views on business models and their viability. In the study by Smith, Sochor, and Karlsson (2018), some interviewees believed that MaaS offers public transport authorities an opportunity to attract new customers and increase their revenues. However, other interviewees feared that MaaS might erode public transport authorities' business models, creating a scenario in which other transport services cannibalize existing public transport services while possibly only targeting profitable markets.

4.3.2. UCC

As pointed out by Ciardiello, Genovese, Luo, and Sgalambro (2021), there are few successful UCC projects in Europe, with most UCCs failing to achieve financial sustainability and operating autonomously after their initial experimental phase, which tends to be supported by public funds. Economic viability of UCCs depend on the scheme. In schemes with a single landlord and at construction sites, there is usually an economic incentive to finance and establish a UCC scheme, as the costs will be recovered through either efficiency gains or other actors who benefit from the scheme, e.g. carriers who can avoid trips to several receivers or in congested areas (Allen et al., 2012). For UCCs that serve all or part of a city, economic viability is more difficult. Several case studies show that it is difficult to establish a financially sustainable UCC scheme in this setting (Kin et al., 2016; Nordtømme, Bjerkan, & Sund, 2015; van Heeswijk et al., 2019). In these schemes, the actors involved are often more concerned with the costs of implementing the scheme than the potential profits (Tsiulin, Hilmola, & Goryaev, 2017). In these settings, it is common for a public administration or authority to subsidize the operation in its initial phase until freight volumes have increased or the UCC operator has found additional value streams via value-adding services. To increase profitability, it is crucial to enlarge the scope of the UCC operation and include other services (Malhene, Trentini, Marques, & Burlat, 2012). Services that are commonly provided by UCC operators are waste collection/recycling, storage, pre-retailing, tailored delivery, and out-of-hours delivery (Allen et al., 2014; Björklund et al., 2017; Malhene et al., 2012; Paddeu, Parkhurst, Fancello, Fadda, & Ricci, 2018; Van Duin et al., 2016). According to Allen et al. (2014), some services are attractive to freight receivers due to time and space savings that could increase sales for the retailers, while Johansson and Björklund (2017) conclude that the services are attractive due to the cost savings they provide. Scaling up the operation and attracting higher freight volumes are also stated to be essential for financial viability (Quak, van Duin, & Hendriks, 2020)(). Scaling up a UCC scheme in itself can contribute to a more feasible business model. Introducing schemes in other cities enables cost sharing for research, development, IT systems, and negotiating better terms with large customers (Björklund et al., 2017). This also contributes to the attractiveness of the solution. Björklund et al. (2017) also mention the importance of being able to change the business model over time, adapt to new conditions, attract new customers, and offer new innovative services.

Paddeu et al. (2018) show that economic unsustainability and dependence on public subsidies are two issues preventing UCCs from being economically sustainable. Although Janjevic and Ndiaye (2017) show that profitable operations are possible in theory, profits are prone to fluctuation and are subject to efficient use of resources, with human resources in particular being a major cost for UCCs. Hence, the financial viability of UCC schemes is one of the major issues hindering their development. However, Kin, Spoor, Verlinde, Macharis, and Van Woensel (2018) show that UCC becomes more economically viable when authorities implement greater restrictions, e.g. narrower time windows, and when the volume is increased with other companies. Similarly, van Heeswijk et al. (2019) show that UCCs appear to be economically unviable without supporting measures. Their simulations show that temporary subsidies and zone-access fees are the most effective measures for achieving a profitable UCC.

The sustainability of MaaS and UCC have been extensively discussed in the literature, for an overview of both the positive and negative impacts of the transport services for sustainability see Table 1.

Table 1
Overview of sustainability aspects.

	MaaS	UCC
Social sustainability	+ Affordable transport + Creating a more accessible urban environment by combining multiple transport modes + Enabling healthier choices, such as cycling and walking - Doubt over whether healthier options will be used - Tailor-made transport results in less walking and cycling - Exclusion of certain groups of people	+ Reduced use of HGVs in urban environments + Reduced health issues from freight transport, such as pollution and traffic accidents + Better working environments for transport operators
Environmental sustainability	+ Promises to deliver environmentally sustainable transport services to urban areas + Reductions in gas emissions + Reduced congestion + Potential to reduce the number of cars in urban areas - May have less impact on environmental sustainability than first believed - Limited evidence of improved environmental sustainability	+ Evidence of GHG emissions reductions of 25–80% + Increased load factor of last mile deliveries + Reduced congestion in dense urban areas - Needs high volumes for substantial effects
Economic sustainability	+ Potential to be economically viable - Yet to prove economic sustainability - Questionable if MaaS should be allowed to use subsidized public transport - Potential to cannibalize existing public transport	+ Potential to be economically viable - Few cases where substantial volumes have been achieved for financial viability - Often relies on subsidies - Relies on creativity and entrepreneurship - Often relies on supportive measures, such as policies or regulations

5. Discussion and conclusions

5.1. Multiple actor engagement for sustainable transport

MaaS and UCC are clearly aimed at improving sustainability while relying on collaborations between multiple actors. The complexity of the networks required for both services limits the economic viability of the services, as revenues need to be distributed among collaborators. Furthermore, the services involve both public and private organizations to some degree, and the inherent differences in the objectives and value perceptions of these actors adds to this complexity (Munksgaard, Evald, Clarke, & Nielsen, 2012). Hence, the values of the transport services are considered to be different, and there are divergent sustainability drivers for their implementation and scale-up. Another aspect to consider in relation to the value created by the services is the role that different actors play in both developing and maintaining the services, as discussed by Björklund and Simm (2019) in relation to UCC. Taking full advantage of the sustainable aspects of urban transport services will require better understanding of the actors involved in establishing the services and their interactions, as well as of the external actors affected by the transport services. Resources like ICT could facilitate this complex network.

5.2. ICT as an enabler for sustainable transport

As shown above, both MaaS and UCC promise benefits for social and environmental sustainability. However, both need supportive measures to be economical sustainable and reach a scale at which their positive effects can be felt. While ICT is integrated into MaaS, it could play a more supportive role in UCC to create more efficient transport systems and further the development of the service. For people to make more sustainable choices on travel, they need more detailed information. Hence, information on the environmental and health implications of people's travel behavior is needed (Lopez-Carreiro, Monzon, Lopez, & Lopez-Lambas, 2020). Here, developments within ICT could facilitate the sharing of such information with the wider public. Similarly, ICT could assist in more efficient vehicle journeys for freight and increasing information exchange within the complex network of actors to improve the usability of UCC and related services. However, ICT in relation to UCC has not yet been discussed in academic literature (Björklund & Johansson, 2018). ICT could hence play a central role in improving the transport services studied and contribute to more sustainable and accessible transport systems.

5.3. Integrating freight and passenger transport

Bruzzone, Cavallaro, and Nocera (2021) suggest that integrating freight and passenger transport could result in greater efficiency and sustainability in the transport system. Similarly, Le Pira, Tavasszy, Correia, Ignaccolo, and Inturri (2021) argue that including freight transport in MaaS schemes could result in higher utilization for passenger transport and thus reduce freight transport in urban areas. A recent literature review by Elbert and Rentschler (2021) on using public transport for freight transport presents similar findings to our literature review. In addition, Elbert and Rentschler (2021) find that there is technology available to combine freight and public transport, however, the technology required for operations and system planning is still lacking. Similarly, a review by Cavallaro and Nocera (2021) also point to the need for digital tools to integrate freight and passenger transport. This is in line with our review of MaaS and UCC, which shows that there is a need for further development, implementation, and usage of ICT to achieve wider implementation of these sustainable urban transport solutions.

5.4. Electromobility and changes in behavior for sustainable transport

More recent publications on MaaS have referenced the concept of electric Mobility as a Service (eMaaS), which includes more sustainable modes of transport, such as electric cars, as part of sharing models (Anthony Jnr, Abbas Petersen, Ahlers, & Krogstie, 2020; Hensher, Nelson, & Mulley, 2022). Similarly, Fazio, Giuffrida, Le Pira, Inturri, and Ignaccolo (2021) point to e-scooters to potentially reduce car ownership and improve environmental sustainability, while Brezovec and Hampl (2021) argue that including electric vehicles, such as cars and scooters, as a part of MaaS could reduce car ownership. However, convincing people to change their behavior, moving from car ownership to new sustainable mobility solutions, may prove difficult. A study by Sjöman, Ringenson, and Kramers (2020) showed it to be hard to replace privately owned vehicles with new sustainable transport solutions. Similarly, Alyavina, Nikitas, and Tchouamou Njoya (2020) argue that it may be difficult for car owners to change to using MaaS services. In addition, Alyavina et al. (2020) make the argument that MaaS users may substitute public transport with car-sharing solutions in MaaS schemes, which could then result in less sustainable travel. By introducing electric vehicles, people may end up choosing to travel by electric car instead of public transport. Hence, new sustainable transport options may make it more difficult for individuals to make sustainable choices.

5.5. Conclusions

This paper has provided a review of urban transport services, focusing on the sustainability of MaaS and UCC. The review points to a number of discrepancies regarding the sustainability of these transport services. First, although there is potential for improving social sustainability by providing affordable, accessible, and healthier transport through MaaS, there are doubts over whether these healthier options will be used (Pangbourne et al., 2020). In addition, users will need to access digital solutions and share data, which may exclude certain groups of people (Hensher et al., 2021). Similarly, a UCC for goods will only have an impact on social sustainability given sufficient volumes. Second, these urban transport services promise to deliver more environmentally sustainable transport services by reducing emissions, congestion and limiting the number of vehicles in urban areas. However, these urban transport services may have less impact on environmental sustainability than first believed and still need to prove the real benefit they can provide to environmental sustainability in the transport system. Third, while these urban transport services show potential for economic viability, they have so far struggled to prove this long term. Some implementations of these business models rely on government funding for pilot projects, and these are yet to show long-term economic viability.

An important enabler and motivator for the development of these urban transport services is the increased focus on sustainability in transport. This sustainability focus includes social sustainability, providing more livable cities with more convenient transport and less congestion, and more environmentally sustainable transport services in urban areas. Here, multiple actors are pushing for improved transport services, including governments, individual users, and society as a whole. In particular, governments' visions of a more integrated and sustainable transport system are enabling new business models (Cruz & Sarmento, 2020).

Although transport users are showing a growing preference for flexible transport options, this market is still in its infancy, and there needs to be a change in user habits to gain acceptance for these new business models as viable transport service options. In relation to this, there is the issue that these urban transport services may not be as socially and environmentally sustainable as first believed, making a number of actors reluctant to support their implementation. Hence, there is debate as to whether these new markets are actually providing a sustainable transition for urban transport. In addition, the economic viability of these urban transport services can be questioned. When introducing new sustainable transport solutions, economic sustainability for all actors needs to be considered (Elbert & Rentschler, 2021). In the case of MaaS, there is, for instance, the question of whether the use of public transport should be subsidized (Mulley & Kronsell, 2018). For UCCs, very few cases have passed their initial phase, and most pilots cease operation after subsidies are withdrawn, although there are a few examples of long-term operation and financial viability (Quak, van Duin, & Hendriks, 2020)(; Tsiulin et al., 2017). This success is often ascribed to entrepreneurship and creativity in providing new types of added-value services as well as supportive policies, planning, and the location of the UCC.

5.6. Future research

From the review, we have developed three research issues that need further exploration: (i) How can new digital technologies enable urban transport services to be more sustainable? Here we are referring to technologies that are yet to be implemented on a larger scale in the transport system, such as using geofencing to monitor traffic in urban environments. (ii) From a policy perspective, it would be interesting to develop a model that can be applied to ensure the sustainability of new urban transport services. Such a model could be used at government level to systematically assess the sustainability of urban transport services. (iii) What is needed for urban transport services to become successful in large-scale implementation (after being proven at project scale)? The critical step in moving from a subsidized pilot project to full implementation needs further research to determine what makes urban transport services successful after a trial period. Here, it would be interesting to explore sustainable business models that combine economically oriented value propositions with environmentally and socially oriented value propositions (Bocken, Rana, & Short, 2015; Lüdeke-Freund, 2010).

5.7. Limitations

Our study has a number of limitations. We relied exclusively on the Scopus database, and although it is large database with thousands of peer-reviewed journals, there are alternative databases that could have been used. We also limited our search to peer-reviewed articles, thus excluding conference papers, books, and book chapters. We also limited our review to two transport services: MaaS and UCC. Another limitation is that MaaS focuses on the transport of people, while UCC concerns freight transport. However, these urban transport services have many similarities related to our analysis that make a sustainability comparison useful: they all involve a network of actors, have a clear sustainability vision, are applied in urban contexts, use new technologies and ICT, and are all nascent transport options that are yet to be fully established and implemented as large-scale transport services in urban areas.

Declaration of Competing Interest

The authors have no competing interests to declare.

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