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Transport Authorities and Innovation: Understanding Barriers for MaaS Implementation in the Global South

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Abstract

Mobility-as-a-Service (MaaS) is a recent concept that is seeing increasing interest across the world. First studies and field trials in developed cities suggest that MaaS can influence people's mobility behavior and create more sustainable transport systems. However, many findings are not transferable to the Global South context, considering that in terms of transport infrastructure, institutional setups, and citizens' preferences, most developing cities present significantly different characteristics. Thus, many critical questions remain unanswered, e.g., 'How to implement MaaS in a developing context?', 'What are the main challenges?', and 'Who should lead this development?'. This research work considers a public-pushed development and aims to shed light on barriers that transport authorities might face. First, barriers are identified through a literature review at the intersection of transport research and public sector innovation. Second, the barriers are analyzed based on the technology, organization, and environment (TOE) framework. Third, Global South relevance is determined through a two-round expert survey. Data related issues (e.g., standardized open data) have been identified as the most critical barrier. Also, multimodal transport planning and coordinating intermodal trips seem to be crucial challenges, considering highly fragmented operator landscapes and the lack of integrated transport planning approaches. In addition, auto-centric developments, current institutional setups, and transport authorities' organizational structures could hamper a MaaS transition in the Global South. This article contributes to the emerging literature on MaaS governance and provides insights on the capabilities of developing cities to establish MaaS and other transport innovations.

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Keywords: Mobility as a Service (MaaS); Public sector innovation; Organizational adoption; Implementation barriers; Developing Countries; TOE framework.

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1. Introduction

Triggered by digital technologies and by societal changes, new mobility services (NMS) such as ride-hailing, carpooling, and car-, (e-)bike-, and (e-)scooter-sharing have recently disrupted the way how people move in and between cities. Mobility as a Service (MaaS) builds on this development and combines NMS with conventional modes of transport on a single platform accessible on demand (Jittrapirom et al., 2017). MaaS enables seamless, multimodal journeys and it is often acknowledged as an alternative to the private car. Scholars describe MaaS as an innovation (Surakka et al., 2018) and highlight its potential to promote sustainable mobility (Sochor et al., 2016). Indeed, first trials and MaaS schemes – e.g., UbiGo in Sweden (Sochor et al., 2016) and whim in Finland (Ramboll, 2019) – as well as simulation studies (Becker et al., 2020) report promising results including the observation of modal shifts and expect reductions in transport-related energy consumption. However, these findings have primarily been derived in the context of the Global North, where scientific publications (for a review, see Utriainen and Pöllänen, 2018) and conferences (such as the ICOMAAS series), government funding (e.g., within the EU Horizon 2020 funding program), and public-private partnerships (e.g., the MaaS Alliance) provide an ideal breeding ground for MaaS. In the Global South (GS), in contrast, MaaS is virtually a blank canvas. The authors conducted preliminary research on this topic using Metro Manila as a case study. They describe the potential role of MaaS in the post-pandemic future (Hasselwander et al., 2021b) and highlight the existing demand for MaaS, which leverages on strong multimodal travel behavior, the rapid uptake of transport apps, and users' expectation of a cheaper and more reliable service (Hasselwander et al., 2021a). Similarly, Ye et al. (2020) found strong willingness to adopt MaaS in a Chinese town in the suburbs of Shanghai. Based on experiences from MaaS trials in Taiwan, Chang et al. (2019) argue that more sustainable travel choices can be promoted through the integration of on-demand services. In line with this, Pickford and Chung (2019) propose an incremental approach towards MaaS ("MaaS Lite") in Hong Kong in which on-demand services would contribute to better first/last mile connectivity. Khaimook et al. (2019) investigated MaaS' potential to improve road safety. Results from their case study in Phuket, Thailand, suggests that MaaS indeed can encourage people to make safer travel choices. Singh (2020) describes a MaaS scheme in Kochi, India, and shows that the inclusion of informal transport modes and the use of smart cards present some modifications of the known model.

In this research, we intend to contribute to the limited knowledge on MaaS in developing countries. We propose a public-pushed development towards MaaS and aim to shed light on potential implementation barriers that transport authorities might face on this road.

2. The Role of Transport Authorities

A growing part of the MaaS literature is focusing on governance issues and the role of transport authorities (TAs). Case studies in Finland found that public sector engagement can be a catalyst for MaaS development (Mukhtar-Landgren and Smith, 2019), but also that more supportive roles could enable an even quicker uptake (Audouin and Finger, 2018). Meurs et al. (2020), in the context of a MaaS pilot project in Heyendaal, the Netherlands, confirm that a supportive role of public authorities is vital for successful MaaS initiatives. Fenton et al. (2020) argue that this does not only relate to support on local level, but rather that a multi-level governance is required. In this context, different governance approaches have been identified (Hirschhorn et al., 2020), which involve a set of hard (e.g., legislative reforms, operational contracts) and soft (e.g., public strategies, R&D programs) policy instruments (Mukhtar-Landgren and Smith, 2019). Jittrapirom et al. (2018) highlight that these policies should be implemented in a dynamic, adaptable manner to increase robustness in uncertain future situations. Pangbourne et al. (2020) urge that public intervention is necessary for efficiency and transport equity reasons. Some experts even foresee a more proactive role of the public sector at operational level and argue that they are the most appropriate player to lead, plan, and/or operate MaaS schemes (Polydoropoulou et al., 2020b). While little is known about the (potential) role of TAs for the development of MaaS in the GS, we argue that they should take up an anticipating role for twofold reason. First, the case of ride-hailing underlines that in a private-lead scenario, NMS would rather not contribute to a sustainable development and instead increase negative transport externalities by poaching patronage from public transport. Second, public transport systems in the GS – where informal transport services (e.g., minibuses, motorcycle taxis) are the predominant travel mode – are often rather rudimentary and lacking a holistic and integrated approach of planning. To address both environmental and transport-related problems, reforms of public transport regimes are therefore urgently needed. In this context, MaaS could be a data-driven approach to support much needed transport integration, route rationalization, transport planning and analysis, and so forth. Hence, we envision a scenario in which the public sector plans and governs the MaaS scheme, under consideration of sustainability goals, and using the available levers (i.e., pricing, subsidies, bundling techniques, reward points, etc.) to promote and favor green mobility behavior. This would translate either into a public-controlled or a public-private development (Smith et al., 2018). In both scenarios, TAs need to enlarge their scope and mission: taking up the role of the MaaS integrator in the public-private, and additionally filling the role of the MaaS operator in the public-controlled scenario.

3. Methods and Data

In order to identify implementation barriers (IBs) for MaaS, we conduct a literature review at the intersection of different fields of research, i.e., MaaS in developed countries, transportation in developing countries, and public sector innovation. Among the identified IBs, we extract those that are relevant in the context of TAs and in their efforts to establish MaaS. Next, we apply the technology, organization, and environment (TOE) framework to categorize the barriers (Table 1). TOE is a widely used framework that describes the entire process of (technical) innovations and how the three aspects' context influences innovation adoption and implementation (Baker, 2012). To determine to what extent the identified IBs apply to implementing MaaS in the GS and whether there are additional IBs specific to the GS context, we conduct an online expert survey consisting of two iterations. The experts (N=44) are selected based on the literature review, an internet search, and from the professional networks of the authors. They either (i) directly work on MaaS in GS context, (ii) work on MaaS and are familiar (e.g., through previous work) with transport and mobility in the GS, or (iii) work in the transport sector in the GS and are familiar with the MaaS concept. In the first iteration, the experts are asked to assess the relevance of the IBs based on a scale from 1 (not relevant at all) to 5 (highly relevant) and describe any other IBs that they expect. The second survey is structured similarly, however, this time, the respondents are asked to assess the newly suggested IBs from the previous round. The descriptive statistics of the data allow us to compare the assessed IBs and rank them based on their significance for developing cities. The results are then discussed against a backdrop of relevant studies in the literature. Finally, we derive policy implications and develop a model of MaaS implementation for TAs in the GS.

The survey has been answered by 29 experts in the first round and 21 in the second. This corresponds to a response rate of 65.9% and 47.7%, respectively. The profile of the expert panel is shown in Fig. 1. The sample comprises a cross section of different areas and backgrounds, whereas 'Academic/Research' represent the largest sector. Regarding regional expertise, there is a strong representation of Asia/Pacific which is the largest region (by population and land area) of the GS and where many (if not most) of the MaaS projects are underway. The experts identified themselves as very familiar with the MaaS concept and with transport and human mobility in developing context (Table 1 & 2).

Fig. 1. Profile of the Expert Panel for (a) Survey Round 1 (N=29) and (b) Survey Round 2 (N=21)

4. Results and Discussion

4.1. Expert Survey Round 1

Table 1 shows the results of the first round of the expert survey. A total of 34 IBs have been assessed, whereby the average value corresponds to 3.60 with a standard deviation (SD) of 1.32.

Since MaaS is a data-driven approach to providing multimodal transport, various challenges arise in the technology context. The experts identified data related issues (4.41) and the difficulty to integrate and plan different transport modes and coordinating intermodal trips (4.38) as the most critical IB. Although TAs in the Global North would probably have to face similar challenges, these IBs are likely more pronounced in the developing context, given the lack of physical infrastructure (3.97) and the unavailability of key technologies (3.97). In practical terms, this means that if, e.g., intelligent transport system infrastructure and essential ICT tools and technologies (such as RFID, GPS) are not available, this would impede MaaS implementation significantly.

The organization context involves challenges directly related to TAs. The expert panel particularly highlights the TAs lack of experience and uncertainties regarding roles and responsibilities in the MaaS ecosystem (4.17) as well as TAs entrenched structures, slow decision processes, and their lack of innovative strategies and integrated planning approaches (4.14). TAs in the GS indeed seem to be less prepared for MaaS than their likes in developed countries, such as the German *Verkehrsverbünde* that are planning and organizing integrated public transport services since decades. Furthermore, institutional setups of TAs in developing countries are often described as extremely slow and convoluted (Pojani et al., 2020), which in the past has delayed or even prevented the implementation of transport innovation projects. The lack of financial resources and funding (3.97) as well as complex and non-competitive public procurement practices (3.97) are additionally expected to hamper the development of Maas.

Considering that MaaS involves multiple stakeholders, it is not surprising that TAs are expected to face a large variety of IBs in the environment context. According to the experts, barriers on the supply side outweigh those on the demand side. The most critical IBs relate to the highly fragmented and individualized operator landscape (4.14) and the low level of operational transport modes and integrated mobility services (4.10). Indeed, a large number of self-account drivers of informal means of transport and the lack of regard for a holistic approach in urban transport planning are characteristic for the GS (Ferro et al., 2013). This impedes both the physical integration of transport services and the required cooperation with transport service providers (3.76). Another IB relates to the lack of private sector engagement and opposition from transport groups and associations (3.31) which in the past has hampered the implementation of transport reforms (Ferro et al., 2013). IBs that concern potential users are expected to have a somewhat low relevance. The lowest ranked IBs relate to low technology adoption, poor digitalization, and low smartphone penetration in the population (2.59) as well as concerns regarding privacy and security of user data and low trust in digital/monetary transactions (2.48). Even though there seem to be some dissensus among the experts, they rather do not expect that MaaS implementation depends on the size and densification of the city (2.97; SD of 1.50) and that MaaS is only attractive for specific population segments (3.07; SD of 1.29). The latter represents a significant difference compared to findings in developed context highlighting that MaaS particularly attracts younger individuals (e.g., Caiati et al., 2020; Schikofsky et al., 2020). First studies in the GS, nevertheless, indeed report a different picture and found high interest in MaaS across different age groups (Hasselwander et al., 2021a; Ye et al., 2020). The most relevant IB on the demand side (yet with a score below of the average) has been identified as strong reliance on private cars (3.52). Even though MaaS is often praised as an alternative to the private car, to the authors' knowledge, there has not been any evidence for this assumption so far. In contrast, existing studies on MaaS adoption consistently report that avid car users are likely not willing to change their travel habits (e.g., Caiati et al., 2020). In this context, it is important to notice that while in most industrialized countries car-ownership is stagnating at a high level or even decreasing, high motorization growth rates despite (still) low-levels of car-ownership are observed in many GS countries (Kutzbach, 2009). Typically, wherever rising per capita income is observed, more people can afford and do purchase private cars. Finally, legal concerns and the necessity of legislation change (3.69) has received a lower value than could be expected. Existing literature describe various legal conflicts, e.g., related to government regulated pricing and ticket selling (Smith et al., 2019), commuting related taxation policies (Hesselgreen et al., 2020), public procurement processes and franchising of public transport services (Wilson and Mason, 2020), and so forth. In GS context, these could be of less relevance due to the less formal and less evolved structures of public transport which could facilitate MaaS planning and operation (at least from a legal perspective).

Table 1. Assessment of Implementation Barriers for MaaS (Expert Survey Round 1, N=29)

	AVE	SD	Score				
			5	4	3	2	1
MaaS expertise	4.38	1.16	19	6	2	0	2
Expertise on transport and mobility in developing context	4.34	0.90	16	9	2	2	0
Technology Barriers							
Data related issues (Standardization and aggregation of data, lack of open data, or unwillingness to share data)	4.41	1.02	20	3	5	0	1
Difficulty of integrating and planning different transport modes and coordinating intermodal trips	4.38	0.94	16	11	0	1	1
Lack of physical infrastructure (e.g., bike-sharing systems, charging stations for electric vehicles) to support MaaS	3.97	1.12	13	6	6	4	0
Difficulties related to technical integration / Unavailability of key technologies (including smart ticketing systems, ICT infrastructure, API's)	3.97	1.32	16	2	7	2	2
Perceived/expected benefits of MaaS (maturity of the concept)	3.83	1.14	10	10	3	6	0
Conflicts of branding (MaaS app vs. brands of service providers)	3.31	1.28	6	8	7	5	3
Platform related security issues (e.g., external attacks) and technology failure	3.28	1.16	5	8	7	8	1
Smartphone- and internet-related difficulties (battery life, mobile network access)	3.10	1.35	5	7	8	4	5
Organization Barriers							
Lack of experience / Uncertainties regarding roles and responsibilities across the actors in a new, emerging ecosystem	4.17	0.93	13	10	4	2	0
Transport authorities' entrenched structures, slow decision processes, and their lack of innovative strategies and integrated planning approaches	4.14	1.03	13	10	4	1	1
Lack of top management support	4.00	0.96	10	12	4	3	0
Lack of financial resources and funding	3.97	0.98	10	11	5	3	0
Complex, non-transparent, and/or non-competitive public procurement practices	3.97	1.12	12	9	3	5	0
Degree of centralization of the transport authority (and subordinated agencies)	3.90	1.11	11	8	7	2	1
High economic risks, huge marketing costs, and a long time to return on investment	3.45	1.02	5	9	9	6	0
Lack of ICT expertise	3.41	1.21	6	9	7	5	2
Environment Barriers							
Highly fragmented and individualized operator landscape	4.14	1.06	13	11	2	2	1
Low level of operational transport modes / integrated mobility services	4.10	0.94	12	10	5	2	0
Challenge to coordinate and reorganize different businesses/services and identify a viable/scalable business model	4.00	0.80	8	14	6	1	0
Stakeholders are unwilling to cooperate / refuse broker model	3.76	1.24	10	9	5	3	2
Legal concerns and conflicts / Process of legislation change takes too long	3.69	1.04	7	11	6	5	0
Lack of successful adoptions (serving as blueprints and inducing bandwagon pressure)	3.66	1.04	6	12	7	3	1
Challenge to design suitable mobility packages and offerings	3.52	1,27	7	10	6	3	3
Strong reliance on private cars	3.52	1.38	8	10	4	3	4
Lack of public sector engagement / political opposition	3.45	1.15	4	14	4	5	2
Necessity of a "window of (political) opportunity" / dependence on election cycles	3.41	1.15	5	10	8	4	2
Lack of private sector engagement / Opposition from transport groups and associations	3.31	1.00	3	10	10	5	1
Entry barriers for new startups or competitors to join potential MaaS platforms	3.18	1.13	5	5	8	11	0
Users refuse mobility plans (i.e., subscribing and paying in advance)	3.17	1.28	5	8	6	7	3
Users do not perceive added value / are unfamiliar with new transport modes and the MaaS concept / not willing to change travel habits	3.17	1.49	7	8	2	7	5
MaaS is only attractive for specific population segments (i.e., young individuals)	3.07	1.28	4	9	4	9	3
MaaS implementation depends on the size and densification of the city	2.97	1.50	7	4	5	7	6
Low technology adoption, poor digitalization, and low smartphone penetration in the population	2.59	1.05	1	5	8	11	4
Concerns regarding privacy and security of user data / low trust in digital transactions	2.48	1.33	2	6	5	7	9

4.2. Expert Survey Round 2

In the second round, 13 newly identified IBs have been assessed (Table 2). The average value corresponds to 3.64 with a SD of 1.23. Note that the second survey has been send to the same expert panel but was not answered by the exact same sample (although the expert profile for both rounds is similar) and that there was a lower response rate.

The difficulty of integrating and planning different transport modes has been discussed above. For cities in the GS, this particularly relates to the integration of informal paratransit services (4.38), which was the highest ranked IB in this round. The need for adjustments (3.48) – considering that there is no standard model for implementation – arguably also applies to MaaS projects in developed context. However, for TAs in the GS, this could be more challenging due to their lack of experience and capacities (as discussed in the organization context). The lack of payment enablers and high costs of transition to electronic payments (3.48), indeed, appears to be very relevant for developing cities. Except for some mass transit solutions (e.g., MRT, BRT) that deploy smart card systems, cash payments are usually the common practice for public transport services in the developing world. While smart card solutions require the equipment of costly infrastructure in transit terminals (and vehicles), digital payments require the additional cooperation with payment enablers.

The IBs in the organization context support the expectation that managing data-driven systems such as MaaS is a great challenge. While TAs' support in data-sharing and integrated systems is needed (4.05), it is questionable whether they have the institutional capacity to manage the aggregated information (4.05). Finally, the lack of (or unsuccessful) education and communication initiatives to create awareness for MaaS does not seem to be a very relevant IB (3.19).

Although a strong reliance on private cars by the population has been assessed rather uncritical for MaaS implementation, a deep bias for private automobile use and ownership among the elite (4.24) – a minority group with disproportionately high impact on policy discussions – could hamper MaaS development. While the necessity of cooperation has been highlighted in the previous round, developing and maintaining trust among the involved stakeholders (3.86) was assessed relevant in this round. This seems plausible, considering that due to high costs and the long time to return on investment, MaaS initiatives should always be designed for the long term. The lack of existing or the lack of interest of platform providers (3.52) would only be of relevance in a public-private development. If this would lead to the absence of competition, this could impair the MaaS system's performance and drive up costs.

Table 2. Assessment of Implementation Barriers for MaaS (Expert Survey Round 2, N=21)

	AVE	SD	Score				
			5	4	3	2	1
MaaS expertise	4.48	0.81	13	6	1	1	0
Expertise on transport and mobility in developing context	4.67	0.48	14	7	0	0	0
Technology Barriers							
Difficulty of integrating (informal) paratransit services	4.38	1.02	14	3	2	2	0
Need for adjustments: There is no standard model for implementation	3.48	1.29	5	7	4	3	2
Lack of payment enablers/high costs of transition to electronic payments	3.48	1.33	6	6	2	6	1
Organization Barriers							
Necessity of political support in data-sharing and integrated systems to support MaaS	4.05	0.97	8	8	3	2	0
Lack of institutional capacity in governments to manage information	4.05	1.16	10	5	4	1	1
Lack of (or unsuccessful) education and communication initiatives about MaaS	3.19	1.29	4	5	5	5	2
Environment Barriers							
Deep bias for private automobile use and ownership among the elite	4.24	0.77	8	11	1	1	0
Developing and maintaining trust among involved stakeholders	3.86	0.79	3	14	2	2	0
Lack of existing platform providers to open their business model / Lack of interest from scaled-up MaaS players in low-margin markets of the developing world	3.52	1.44	6	8	1	3	3
Other transport projects should have priority (e.g., active transport infrastructure)	3.48	1.29	4	9	4	1	3
Lack of confidence in traveling with mass transit and shared services (due to COVID)	3.43	1.33	6	5	3	6	1
Cultural and attitudinal issues about usage of alternative modes	3.29	1.23	4	6	4	6	1
Major ride-hailing apps have created a reluctance towards public transport apps	2.90	1.18	3	3	5	9	1

4.3. Policy Implications

The results of the analysis highlight the interrelation of the three contexts (Fig. 2) and show that implementing MaaS schemes in the GS is a difficult proposition that requires a fundamental amount of time, resources, and know-how. The technological context thereby represents the crux for MaaS development: the most critical IBs relate to data related issues, the difficulty of transport integration and planning, and the lack of supporting infrastructure. The organization context shows that external funding and expertise as well as internal reforms and the re-organization of TAs are needed in order to adequately manage data and information and to plan multi-modal transport services. While the environment context involves manifold IBs, it appears that many of them are less critical for MaaS implementation (e.g., those related to the legal framework and potential users). Here, despite low car ownership, the biggest challenge appears to be the auto-centric development led by minority elites. This bias – which is affecting policy directions, urban planning practices, and infrastructure investments – needs to be resolved. Also, policies addressing the informal setup of public transport regimes and to incentivize cooperation among transport operators are urgently needed.

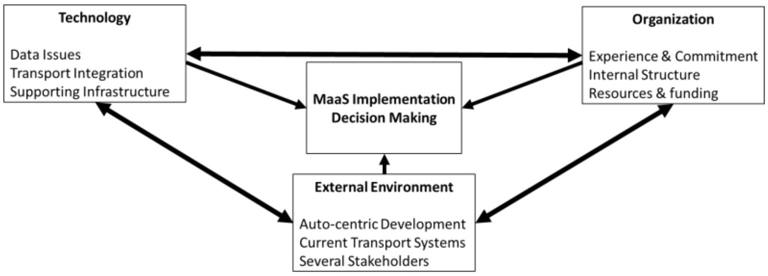

Fig. 2. Model of MaaS implementation for Transport Authorities in the Global South

5. Conclusion

The present study contributes to the incipient literature on MaaS governance issues. We addressed this topic in the context of the GS which has been widely overlooked so far. Through the identification and discussion of the specific IBs, we provide additional insights on the capabilities of developing cities to establish MaaS and other transport innovations. Addressing the lack of public sector perspective in transport innovation studies (i.e., how to foster technological change), we apply the T-O-E framework to the context of TAs and MaaS. Considering the large study dimension and the heterogeneity of the regions of the GS, we need to mention that our sample size is relatively small. Note, however, that following the theoretical saturation criterion, we stopped the data collection at the point where we obtained no more new information/insights (i.e., additional barriers). Note, also, that it was difficult to identify relevant MaaS schemes and experts working in this field due to the lack of a generally accepted definition of MaaS (Jittrapirom et al., 2017) and the fact that MaaS is just starting to gain traction in the GS. The data from this study can be used for a more profound analysis and discussion. For example – as the authors intend in future work – to model IBs using interpretive structural modeling (ISM) or similar techniques to understand the relationship between the IBs, develop simplified graphical representations of complex systems, and to analyze its implications for the implementation of MaaS in the GS.

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