

Analyzing the enabling factors to implement MaaS in Asian, African and Latin American cities

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Abstract. The EU-funded SOLUTIONSplus project, which aims at kick starting urban e-mobility in developing countries, included the provision of a white label app customizable to the needs of the cities as part of its offer to its 7 demonstration cities in Asia, Africa and Latin America. Despite having the possibility of testing the customized app free of charge for the duration of the project, only 2 out of 7 cities, Quito (Ecuador) and Kigali (Rwanda), started and continued the process. Yet, only Quito was able to test the customized app in real operations. Thus, the paper analyzes the MaaS level and implementation barriers of the 7 cities and conducts an in-depth expert assessment of the technology, organization and environment enabling factors (TOE) to implement the MaaS concept in Quito, Kathmandu and Kigali. The results show that despite some progress towards an intelligent and integrated transport system in the analyzed cities, an important number of conditions that are a given in the Global North (e.g.: formality and integration of PT system), still need to be met in cities in developing countries before MaaS could be realized.

Keywords: Mobility as a Service (MaaS), Enabling Factors, Developing Countries.

1 Introduction

In an increasingly urbanized world, where more than half of the global population already lives in cities (2/3 by 2050), digital technologies will have a pivotal role in advancing sustainable urban development and formulating effective policies and measures for climate change mitigation. In parallel, the emergence of new mobility concepts and the widespread use of smartphones worldwide has brought along the emergence of a significant number of mobility applications aimed at improving the efficiency of urban mobility services both for freight and passenger transport. Local and

international mobility (and micromobility) apps such as Uber (Eats), Ola, Gojek, SafeBoda, Glovo, PedidosYA, tembici, Moveo, etc. already operate in Africa, Asia and Latin America, showing the great penetration and potential that app-based mobility services already have in the Global South. The integration of such services under the Mobility as a Service (MaaS) concept could contribute to modal shift and reduced energy consumption [2,3].

MaaS is a new transport and mobility concept that integrates existing and new mobility services (NMS) into a single digital platform, providing customized mobility options and offering personalized trip planning and digital payment possibilities [1]. MaaS has the potential to improve the travelling experience, reduce travelers' costs, efficiently manage travel demand, and improve environmental and social outcomes [2,3, 4]. MaaS has been gaining popularity in Europe / the Global North and has been implemented in several cities with positive results related to sustainable and low-carbon mobility [2,3]. However, in developing countries, in contexts of fragmented and often informal public transport systems, lack of data, cash economies, low digitalization levels, the implementation of such a concept comes with a lot of challenges [5]. While important scholarly contributions have been made to understand the barriers and enablers of MaaS [5,6,7,8], these studies primarily rely on literature reviews and expert interviews. In this article, we contribute to this body of knowledge—which has mainly focused on the European context—by validating these findings with data from real-world MaaS schemes in the global South.

The EU-funded SOLUTIONSplus project, which aims at kick starting urban e-mobility in developing countries, included the provision of a white label app customizable to the needs of the cities to enable access to the e-mobility services for the end-users as part of its offer to its 7 demonstration cities in Asia, Africa and Latin America [9]. In a MaaS approach, the app offered the integration of all services, payment and information useful for the end-users allowing the possibility of integrating e-bikes, e-3-wheelers, e-taxis, etc. to the existing public transport (PT) system.

Thus, the purpose of this paper is to define and analyze the enabling conditions needed to adopt the MaaS concept in developing countries. The analysis starts by assessing the MaaS level and the implementation process in the 7 SOLUTIONSplus demonstration cities in Asia, Africa and Latin America (Section 2.1). The analysis of the enabling factors in Section 2.2 focuses on Kigali, Kathmandu and Quito, the 3 cities in which the feasibility of implementation of a MaaS app in the context of the project was further explored.

2 Analysis

2.1 MaaS level and pilot implementation in SOLUTIONSplus cities

In an attempt to create a comparison tool for the level of penetration of the MaaS concept in different cities, Sochor et al. (2018) propose a topology that consists of 5 levels

based on the degree of integration [10], i.e.: 0 - no integration; 1 - integration of information; 2 - integration of booking and payment; 3 - integration of the service offer; 4 - integration of societal goals. As it can be seen in Table 1, the 7 SOLUTIONSplus cities fall between the Levels 0 (in transition to 1) and 2. This means that most cities already have access to some sort of route planning app and the more advanced ones are already in the process of integrating the in-app payment functionality.

Regarding the level of implementation under the SOLUTIONSplus project, it is shown that despite having the possibility of testing the customized app free of charge for the duration of the project, only 2 out of 7 cities, Quito (Ecuador) and Kigali (Rwanda), started and continued the process. Yet, only Quito was able to test the customized app in real operations. Nevertheless, it is worth noting that other demonstration cities such as Hanoi, Dar Es Salaam and Montevideo have taken their own path to develop mobility apps for specific needs.

Table 1. MaaS level and implementation in SOLUTIONSplus cities

City	MaaS level	Level of MaaS implementation under SOLUTIONSplus
Africa		
Kigali	L1	Discussions between the SOLUTIONSplus team and the representatives of the City of Kigali to develop a customized MaaS app took place between July 2021 and May 2023. However, a joint decision not to pursue it due to high constraints and limited time was taken.
Dar Es Salaam	L0 in transition to 1	Dar Es Salaam is developing its own planning and ticketing app for which the SOLUTIONSplus team had an advisory role. The conditions to implement a MaaS app between BRT buses and paratransit modes are not in place yet.
Asia		
Kathmandu	L0 in transition to 1	After a prefeasibility assessment conducted by DTU [11], it was determined that the conditions to implement a MaaS app were not yet in place in Kathmandu. In particular, related to the lack of an intelligent transport system, a business model and the regulations to incentivize transport operators to take part in a MaaS platform.
Hanoi	L2	It was decided to put all efforts in the development of a booking app for the e-2-wheelers being implemented in the pilot.
Pasig	L1	The governance of PT in Pasig would have required the involvement of a larger number of stakeholders, including the national government. Due to the complexity, after the assessment it was decided not to pursue it.
Latin America		
Montevideo	L1 in transition to L2	The Municipality of Montevideo declined the offer arguing that they already have their own municipal app called "Como ir", which at the moment only allows trip planning, but is supposed to integrate in-app payment once the ticket validators in the buses are replaced

Quito	L1	<p>A customized MaaS app including a trip planner, in-app payment and e-ticketing was developed in close collaboration with the municipal PTOs (BRTs and subway). In order to address the specific needs of the city, two complements were added: 1) a web app to top up the e-wallet with cash in the ticket booth and 2) A mobile app to validate the e-tickets until the automatic turnstiles are procured and installed in all stations. The 3 apps were piloted in Q4 2022 with 50 university students for a period of 4 weeks in 1 BRT station. The circumstances that led to the pilot implementation in Quito were: 1) the imminent launch of the subway line, by which the city is in the process of modernizing and integrating the PT system, which encompasses the Integrated Payment System (SIR), the Data Exploitation System (SAE) and the User Information System (SIU). The Municipality was reluctant to continue and scale-up the pilot due to the lack of knowledge of the new authorities about the MaaS concept, the regulatory framework for its implementation and the linkage to and benefits for the SIR. The main concerns were related to the business model and costs after the project end, as well as the ownership of the data and the application.</p>
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2.2 The enabling environment in Quito, Kathmandu and Kigali

A literature review was conducted to investigate the main requirements, but also the barriers that have been defined / identified both in the Global North and South for the implementation of the MaaS concept [5,6,7]. Based on that and following the methodology applied by Hasselwander et al. (2022), the technology, organization and environment (TOE) framework was used to classify what from now on will be called enabling factors [5]. A total of 20 number of variables have been identified as enabling factors for MaaS implementation. The elements considered under Technology refer to the level of digitalization in the selected cities. In terms of Organization enablers, policies, plans and the governance structure related to digitalization of transport and intelligent transport systems were analyzed. Under Environment, the enabling factors are related to the integration level of the public transport system and other transport services.

The results of the analysis using the TOE framework are summarized in Figures 1, 2 and 3. As it can be seen, only very few factors are fully met in the 3 cities. Nevertheless, in most factors the Quito, Kathmandu and Kigali comply partially, which means there is already some level of advancement.

City	Quito	Kathmandu	Kigali	In summary
Enabling factor	Expert Assessment			
Access to smartphones and mobile internet	PARTLY	PARTLY	PARTLY	Access to a smartphone doesn't seem to be a barrier, at least not in the age group expected to use the app, and not in urban areas. Mobile internet access has risen in these cities, but the affordability of data plans still represents a restriction for an important percentage of the population.
Availability of payment gateways (e.g.: PayPal)	PARTLY	PARTLY	YES	MTN Mobile Money is widely used for transport services in Kigali. In Kathmandu and Quito there some payment gateways, such as e-Sewa and DeUna, but their use for transport services is limited or non-existent.
Penetration of mobility apps (e.g.: Uber) 1) Availability and use 2) In-app payment (credit card usage, payment gateways, etc.)	YES	YES	YES	There are, however, several mobility apps, local and international, operating in the 3 cities. However, the possibility to pay in-app with credit / debit cards or payment gateways is still limited in most cases.
Availability of journey planner (e.g.: Google maps, Waze, municipal apps, etc.)	PARTLY	PARTLY	YES	Global apps such as Google maps work in the 3 cities. However, with different functionalities. While in Quito and Kigali it is possible to see the bus routes and the estimated times, in Kathmandu it only shows the walking route.
Users' acceptance and profile	PARTLY	PARTLY	PARTLY	There positive experiences of the widespread use of mobile money and e-wallets in Kigali and Kathmandu. It is expected, as in other contexts, that the primary target group is young people. However, depending on the user friendliness, affordability and benefits of using the app, a larger and more diverse number of users could be attracted.
Data collection and standards 1) Standardization and aggregation of data, open data or willingness to share data 2) Real-time data collected 3) GTFS files available	PARTLY	NO	PARTLY	The use of ITS by PTOs is still quite limited / fragmented. (Real-time) data collection, sharing and ownership is still an unresolved issue in the 3 cities. The only city from the 3 with a GTFS available was Quito.
Privacy and security of user data is not a limitation for users	YES	YES	PARTLY	Concerns regarding data privacy / security in the general population of these cities is low in comparison with European countries / cities. In the case of Kigali, however, the privacy and security of user data are quite relevant for the national authorities.

Fig. 1. Technology enabling factors in Quito, Kathmandu and Kigali

City	Quito	Kathmandu	Kigali	In summary
Enabling factor	Expert Assessment			
Transport digitalisation policy objectives	PARTLY	PARTLY	PARTLY	The 3 cities analyzed have some type of plan, framework or strategy either at the national or local level, where the use of ICT to improve public transport is mentioned. The MaaS concept, however, is only explicitly mentioned in Quito's SUMP, yet without further detail.
General transport authority / degree of centralization / governance	PARTLY	NO	NO	There's not a unique authority. Transport governance is pretty disperse. Quito is trying to create a general transport authority, but the process will take time.
Knowledge & capacities 1) Experience / Clarity regarding role and responsibilities / expected benefits 2) ICT expertise	PARTLY	NO	NO	There's lack of knowledge / clarity about the MaaS concept, its application, operationalisation and benefits. In the case of Quito, however, we counted with the support of a public official that had clarity about the concept and benefits. It was one individual, at the institutional level it's still an unknown concept.
Transport authorities structures, fast decision processes, innovative strategies and integrated planning approaches	NO	NO	NO	The complexity of transport governance, including the relationship between public and private actors, and the low speed of processes, makes the introduction of MaaS difficult.
Political will and institutionalization 1) Top management support 2) Public sector engagement / Political support 3) Necessity of a window of (political) opportunity / political cycle	PARTLY	YES	YES	In general terms, these municipalities were engaged. The processes in these 3 cities were able to move forward only because of the top management support provided. However, the system and the governance is not mature enough for its full implementation. In the case of Quito, the political cycle played a huge role, as the new authorities were not as supportive of the project as the previous ones.
Financial resources and funding	PARTLY	NO	NO	The municipalities didn't have their own resources because MaaS is not yet in their priorities / radar. In Quito, there are resources as the Integrated Payment System (SIR) is being implemented as part of the PT modernization.
Clarity about the business model / ownership of app / data collection	NO	NO	NO	Business model and data ownership are among the main concerns when deciding to move forward. There was very little knowledge in the counterparts about how to implement the MaaS concept in the given environment.
Enabling regulatory framework	PARTLY	PARTLY	PARTLY	At the moment, the regulations in the analyzed countries are either at a very early stage or very restrictive. In particular, we encountered some regulations that make the collaboration with international companies for the development of MaaS or other mobility applications difficult. In Rwanda, for instance, cloud storage can't happen outside of the country. In Ecuador, on the other hand, the fare collection of PT has to be in the corresponding bank account of the PT authority within 24hours.

Fig. 2. Organizational enabling factors in Quito, Kathmandu and Kigali

City	Quito	Kathmandu	Kigali	In summary
Enabling factor	Expert Assessment			
Integrated and regulated operator landscape 1) Form of Route Service contracts between Authorities and transport operators 2) Formal, multimodal and integrated PT system (physical and tariff) 3) Low informality rate in transport services	PARTLY	NO	PARTLY	In the 3 cities, there is some form of route service contracts that formalises and regulate transport. In the recent years, the 3 cities have tried to improve the processes. However, the PTO landscape is still very fragmented in Kathmandu, and partially fragmented in Quito. Paratransit / informal transport is only relevant in Kathmandu. Thus, the level of integration of the system varies, but is still not ideal in any of the 3 cities.
Private sector engagement / Support from transport groups and associations	PARTLY	PARTLY	YES	The development has not reach the level of opposition. However, the level of integration that the proper functioning of the MaaS concept requires will need important negotiations with all PTOs. Thus, in the case of Quito and Kathmandu, where PT integration is not completed, it can lead to some level of opposition.
Integrated payment system for PT	PARTLY	NO	PARTLY	Kigali has a smart card that can be used in all PT operators. Quito is currently working on the introduction of an Integrated Payment System, which will include the proper infrastructure, the IT systems and fund reconciliations. In Kathmandu, there have been some failed attempts. In the 2 latter, cash is still the mean of payment in PT, while in Kigali mobile money is used.
Existence and integration with other transport services (bike sharing, e-scooter sharing, etc.)	PARTLY	NO	PARTLY	In the 3 cities there are transport services, be it bike sharing, e-scooters or moto-taxi services. Some of them linked to mobility / booking apps. However, there's no proper integration between other services and PT. In Kigali and Quito there are some located close to PT stations, but there's not a proper multimodality strategy.
Successful adoptions (in the country/region) serving as blue print	PARTLY	PARTLY	PARTLY	There are some mobility apps in the 3 region trying to start a MaaS service with many limitations. However, so far, in most cities they only have trip planning functionalities.

Fig. 3. Environment enabling factors in Quito, Kathmandu and Kigali

3 Conclusions

As it has been shown throughout the paper, the implementation of the MaaS concept require the fulfillment of a set of technology, organization and environment conditions. The MaaS level analysis shows that despite the fact that some of the analyzed cities are still in level 0, they are already transitioning to level 1. Most cities are in level 1, some transitioning to level 2. Thus, the cities analyzed, despite their differences, reveal a slow, but steady progress towards the adoption of the features of an intelligent and integrated transport system that will enable MaaS. There are, however, still a series of barriers that need to be overcome related to the digitalization level, as well as in the transport system and governance, before the MaaS concept implementation is feasible in developing countries. A step-by-step approach could be desirable, starting by the gradual integration of all PTOs into the system in one digital platform and then the addition of other mobility service providers.

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