PUTTING USERS AT THE CENTRE OF MAAS

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ABSTRACT

The rapid emergence of Mobility as a Service (MaaS) into the transport sector's lexicon has brought with it an air of expectation that suggests a future mobility revolution. The authors take an action-oriented approach putting MaaS theory into practice. Central to consideration is the user perspective: enabling people to benefit from mobility beyond the private car.

Starting with the theory, the paper examines what is understood to date about MaaS and elaborates upon the contention that MaaS is neither new nor revolutionary but is rather an evolutionary continuation of the pursuit of improved transport integration. The focus of attention is informational integration (rather than the transactional integration that has drawn attention of late in terms of MaaS). It's fundamental contribution to wider notions of MaaS is emphasised.

The second part of the paper illustrates the methodology and findings from a current project to develop and deliver a Journey Planning Tool (JPT) for the Aberdeen City Region. This case study demonstrates how the theory has been applied along a practical pathway to MaaS delivery. Two critical elements are outlined:

- The importance of engagement with different segments of the population to help ensure user centric MaaS systems are developed with functionality that delivers value to, and is adopted by, prospective users;
- The value, at the heart of MaaS, of a public-private partnership to create a publicly owned asset which delivers local objectives and a sustainable business model.

Finally, the case study of Aberdeen JPT is used to highlight how the present theory surrounding MaaS can be further shaped and developed through experience of its practical application.

1. INTRODUCTION

Mobility as a Service (MaaS) is a concept that has generated an "adrenal rush" within the transport industry in recent years (Hensher, 2017: 93). Yet in all but name, depending upon how it is defined and/or understood, MaaS has been evolving steadily over a much longer time period, as travel information services have progressed from addressing individual modes to encompassing multiple modes (Kenyon and Lyons, 2003). Despite this gradual evolution, MaaS, as now characterised by many

using the term itself (enabling convenient multi-modal travel beyond the private car with ease of journey planning, booking and payment through a single service offered by a mobility intermediary – see Figure 1), has been slow to materialise due to a range of commercial and technical challenges involved in bringing together mobility service providers in a cooperative manner.

MaaS, as later explained, is comprised of a series of inter-dependent layers that work together to deliver an offer of travel beyond the private car to (prospective) users. This paper takes what might appear to be a retrograde step by focusing principally upon the development of a multi-modal Journey Planning Tool (JPT) which forms only a part of what is now understood could constitute MaaS. Yet as the paper goes on to underline, this is a fundamental part of the MaaS offer.

Specifically, the paper sets out the development of a Journey Planning Tool (JPT) for the Aberdeen City Region (ACR) which was commissioned by Aberdeen City Council (ACC). The commission is an important step in ACC's aspiration to provide a MaaS offer to travellers. The authors have been centrally involved in delivering the commission. The intention of the paper is to share lessons learned from taking user-oriented theory on MaaS and putting it into practice and thereby offer insights at a time when other Local Authorities (LAs) are embarking on a similar journey to embrace MaaS.

Section 2 provides a selective overview of existing theory. Section 3 focuses on how such theory has been applied in the case of the Aberdeen JPT project. Section 4 considers lessons learned from the Aberdeen JPT development including revisiting and elaborating on the theory.

2. THEORY SURROUNDING MAAS

There is a growing body of academic literature relating to MaaS. In this paper we centre upon one particular paper that has emerged as part of Mott MacDonald's future mobility initiative. In "The importance of user perspective in the evolution of MaaS", Lyons, Hammond and Mackay (2019) examine literature spanning consideration of MaaS developments before and after the term itself was coined. They take a user perspective in doing so and put forward conceptual representations of what MaaS is and whether and how it may be engaged with by travellers. This section summarises these representations.

2.1 The user-centric mobility system beyond the private car

In order to be attractive to the user, MaaS aspires to offer an appealing alternative to owning and using a private car. The entire vision for MaaS is indeed "to see the whole transport sector as a co-operative, interconnected eco-system, providing services reflecting the needs of customers" (Hietanen, 2014:27).

The pyramid diagram in Figure 1, depicts a 'hierarchy of need' representation of MaaS with a series of layers constituting what Lyons, Hammond and Mackay consider MaaS to be, namely the mobility system beyond the private car. The layers can be summarised as follows:

- *Operational integration* – which includes the *infrastructure and vehicles* layer that comprises the physical foundation for the transport system and which underpins the *mobility services* layer comprised of the transport services available for user consumption.
- *Informational integration* – the information services layer is what enables users to interrogate the availability of transport services, plan their journeys, and access customer support.
- *Transactional integration* – the transactional layer is what enables users to book and pay for the transport services they consume.
- *Mobility intermediary* – this is distinct to MaaS (as more recently coined and expressed) and involves providing an 'added value' interface that integrates all layers below, presenting them in a convenient, attractive and accessible way to the user above. The success of this layer is reliant on the underlying layers.

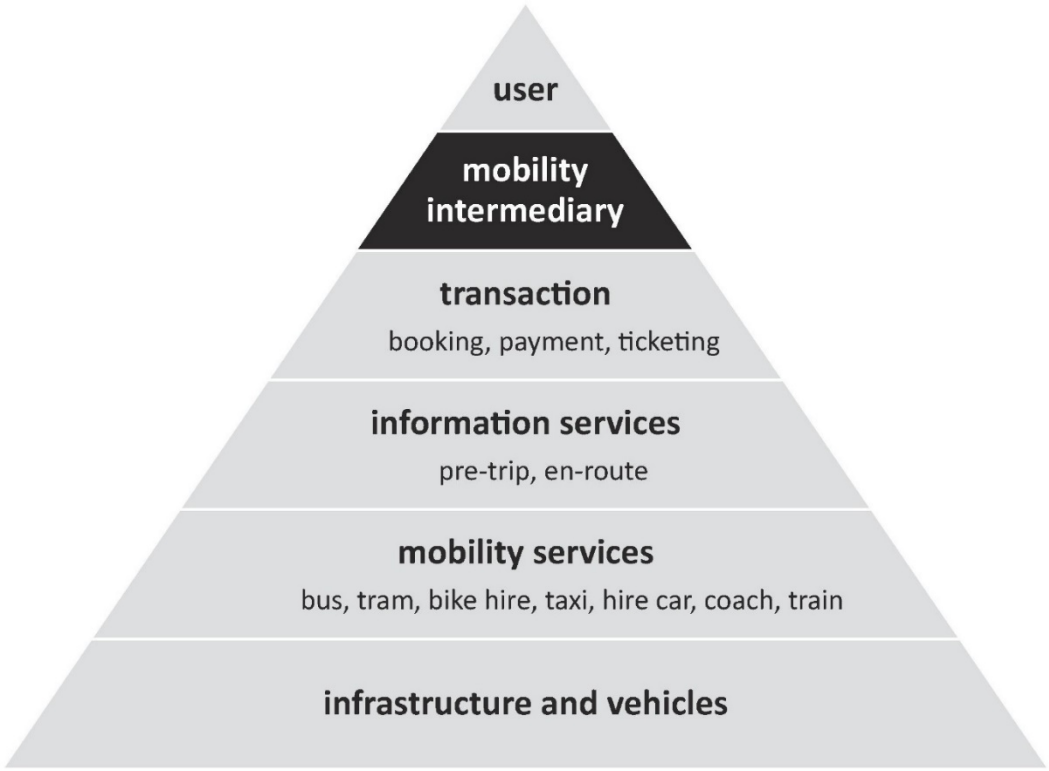


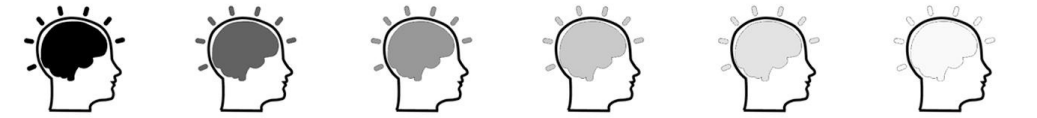
Figure 1: The mobility system beyond the private car (reproduced from Lyons, Hammond, and Mackay, 2019)

While contemporary MaaS interest has been in the new mobility intermediary layer, Figure 1 highlights that MaaS does not provide much value to users without a significant and high quality presence of the layers underneath, since "…providing people with a convenient alternative to the private car relies upon alternative and suitable means of transport being available, upon accessible information about them and upon ease of transaction in being able to use them." (Lyons, Hammond and Mackay,

2019). This representation is later explored in Section 4.3 within the context of the Aberdeen JPT, by highlighting the features prioritised by Aberdeen City Region citizens during co-design sessions.

2.2 Levels of MaaS Integration

A 'Levels of MaaS Integration (LMI)' taxonomy was presented by Lyons, Hammond and Mackay (2019) with the intention of exploring whether, how and to what extent MaaS (in various forms) offers added value to users of the mobility system beyond the private car (see Figure 2). The taxonomy centres on the layers beneath the mobility intermediary layer in Figure 1, and the extent to which these layers are integrated and thereby underpinning the MaaS offer for users. In creating this LMI taxonomy it was assumed that the goal of MaaS is "to develop a mobility alternative (or complement) to the private car that tends towards offering a convenient and seamless door-to-door travel experience that is not cognitively demanding to plan for and execute" (Lyons, Hammond and Mackay, 2019).



Higher cognitive user effort | Lower cognitive user effort

Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
No integration: no operational, informational or transactional integration across modes	**Basic integration:** Informational integration across (some) modes	**Limited integration:** informational integration across (some) modes with some operational integration and/or transactional integration	**Partial integration:** some journeys offer a fully integrated experience	**full integration under certain conditions:** some but not all available modal combinations offer a fully integrated experience	**full integration under all conditions:** full operational, informational and transactional integration across modes for all journeys

cognitive user effort: the effort involved in relying upon the mobility system beyond the private car to fulfil mobility goals
operational integration: interchange penalties are low and door-to-door journey experience is 'seamless'
informational integration: journey planning and execution information for available modes is offered through one interface
transactional integration: payment and any required booking and ticketing is offered through one interface

Figure 2: Levels of MaaS Integration (LMI) taxonomy (reproduced from Lyons, Hammond and Mackay, 2019)

2.3 Individual choice making and the adoption of MaaS

The appeal of using the mobility system beyond the private car is heavily dependent on the circumstances of the prospective user. The behaviour schema shown in Figure 3 shows how a prospective user might determine whether to engage with, and adopt, a new MaaS offer. Of note is that behaviour change is prompted by a change of circumstances. As the paper will later identify, a society-wide change of circumstances has arisen as a result of the global pandemic.

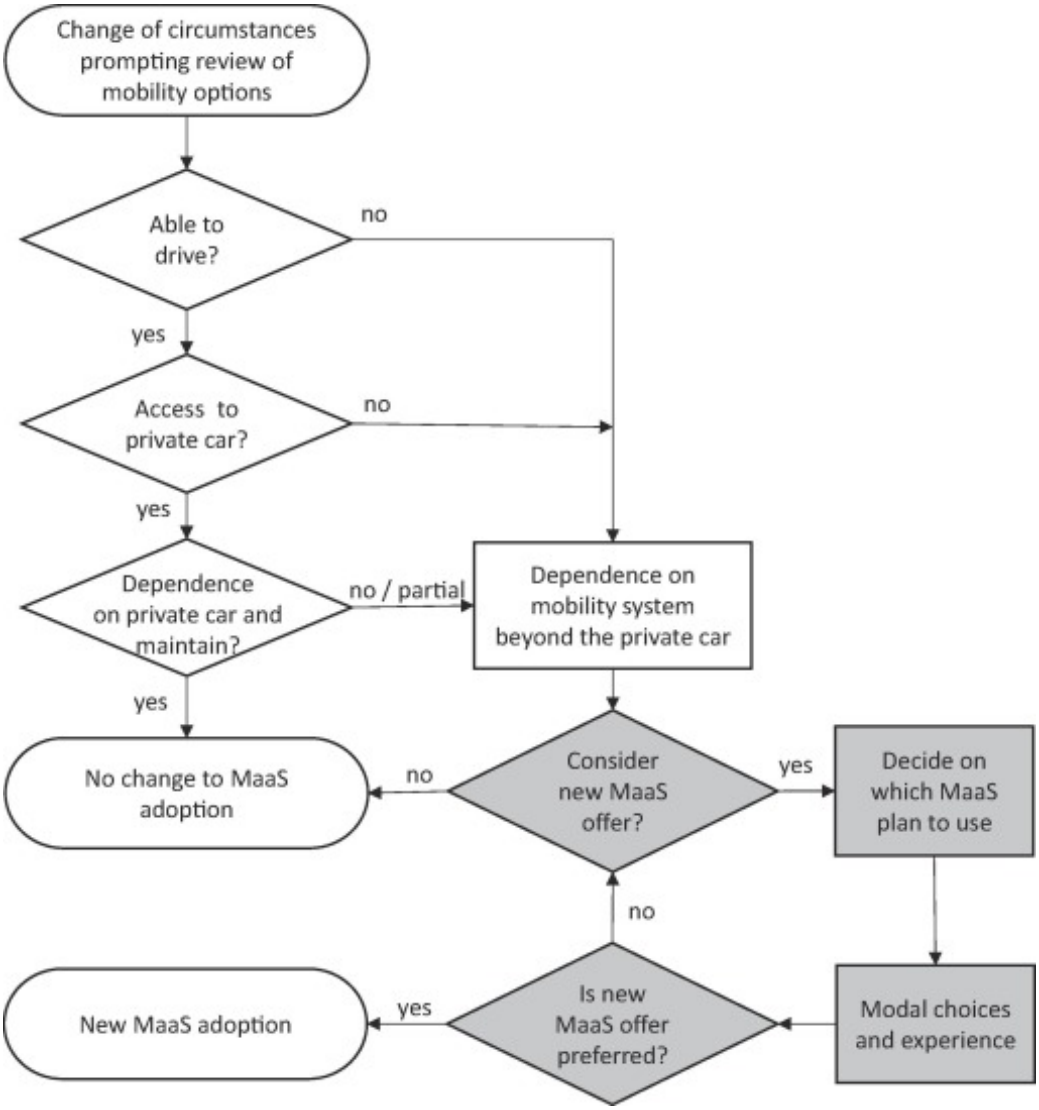


Figure 3: Individual choice making and the adoption of MaaS (reproduced from Lyons, Hammond and Mackay, 2019)

These theoretical and conceptual representations of MaaS were used as the basis for developing the Aberdeen JPT which is now described in Section 3.

3. APPLYING THEORY TO ABERDEEN JOURNEY PLANNING TOOL PROJECT

3.1 Aberdeen Journey Planning Tool – project overview

ACC identified the development of a JPT as a distinct Project Measure which forms part of the EU CITIVAS PORTIS project, which is 100% funded by the European Commission from the Horizon 2020 Funding Programme (the total budget for the local region is approximately £3.2 million). The Portis project is testing “innovative and sustainable urban mobility solutions in five European port cities”. ACC, Aberdeenshire Council, Aberdeen Harbour Board, NESTRANS and Robert Gordon University are the local PORTIS partners and are implementing a range

of measures as part of the PORTIS Project. This includes a dynamic traffic management study which aims to integrate ITS systems into the common data platform which forms part of the ACC Urban Traffic Management Control (UTMC) system.

ACC identified the opportunity to procure a multi-modal JPT which aggregates all data collected from various transportation sources to enable streamlined, real time journey information to be provided direct to the device of the user, for journey planning purposes. The aim is to ensure that the JPT becomes the customer facing application of choice for citizens of, and visitors to, the Aberdeen City region.

Central to the procurement of the JPT was a co-design process to aid the design and deployment of the product. The co-design process was to be undertaken through engagement with potential users of the JPT from a range of demographic groups and transport interests. In addition, ACC wished to procure expertise to develop a sustainable financial model for the JPT and, as part of this, its potential extension into MaaS.

Mott MacDonald (MM) and Fuse Mobility (Fuse) teamed up to respond to the invitation to tender and were successfully awarded the project. The team covered the following skill and service areas:

- MaaS platform including journey planning (Fuse)
- Mobility co-design and co-creation services (Fuse and MM)
- Future mobility policy and MaaS consulting (MM and Fuse)
- UTMC design, management, and maintenance (MM)

A strong collaborative relationship has formed between the public and private entities involved, with roles summarised as follows:

- ACC – public authority, owner of the JPT, commissioner, overall strategy for JPT and MaaS, informational integrator.
- Fuse – MaaS platform provider, co-design leaders.
- MM – informational integrator, co-design support, policy review, professional advisory services.

3.2 JPT product overview

The JPT is built on the Fuse platform. This microservice based platform is cloud hosted and built for flexible deployment and adaptation, ease of modification, interoperability and scalability. The platform has a range of integrations and functionalities which can be switched on to enable mobility options in the JPT. The underlying Fuse platform integrates with a range of public transport data sources and uses the Google mapping and directions system to provide a base facility to deliver the cycling and walking functionality. The platform can be deployed with different UI/UX formats accessing common services and as such has been deployed for a wide range of different users and use case scenarios including NaviGoGo in Dundee (Scotland's fist MaaS service) and the current

Tactran ENABLE MaaS Project. The personalisation service within the platform, and associated algorithms, allow registered users to obtain personalised pricing and transport restriction/offer information to support informed (easier) use of the mobility system.

A key part of this project has been the deployment of the Mott MacDonald Open Data Service (ODS) to act as the translation layer between the Fuse Mobility platform and the Osprey UTMC system. The ODS is a component of Mott MacDonald's Osprey UTMC solution. The purpose of the ODS is to provide a simplified mechanism by which the rich and complex UTMC data held in Osprey can be easily accessed using standards-based technologies familiar to 3rd party system developers who are not expert in the UTMC domain or Common Object Request Broker Architecture (CORBA). The ODS consists of a core data management solution which provides access to UTMC data via a published API.

Together the Fuse platform and its integration with the Osprey UTMC system provided the potential to develop a JPT which met prospective user requirements and policy requirements.

3.3 JPT project methodology

The project team undertook a novel approach to create a JPT that is fully supported by a thorough policy review and co-design input from prospective users. The methodology applied to the project is summarised in Figure 4 below:

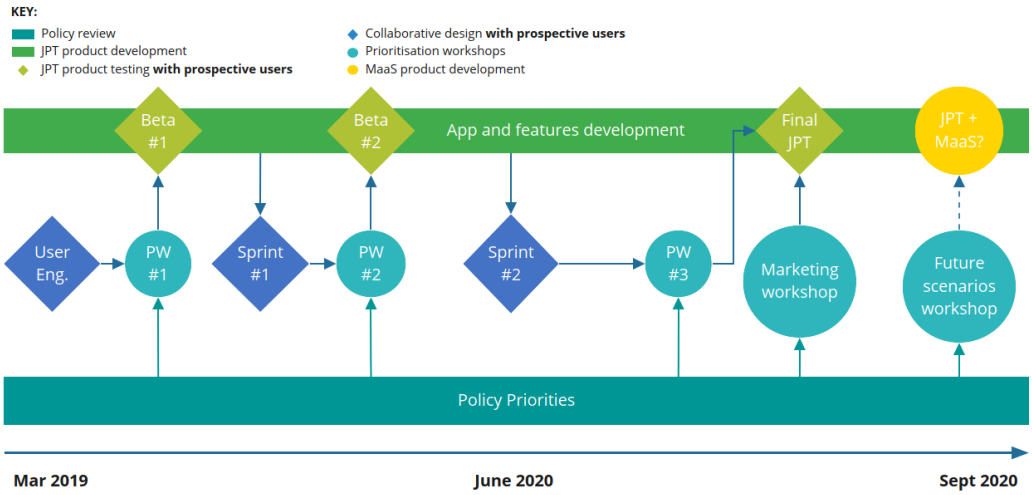


Figure 4: Aberdeen JPT project methodology

The approach taken within each of the elements shown in Figure 4 was as follows.

Policy review: The project commenced in December 2019 with an extensive review of relevant policies and measures of interest to ACC across local, regional and national levels. This review was undertaken

using a matrix that indicatively scored which policies and initiatives could be supported by both the base JPT that will be developed during this funded project (i.e. the informational integration layer), plus the potential for these policies and initiatives to be supported by a further developed MaaS solution (i.e. the addition of the transactional integration layer). Five policy objectives were then identified, determined and agreed with ACC – drawing on a range of existing objectives from CITIVAS, Portis, and ACC. The five policy objectives were used throughout the project to frame and shape the development of the JPT, including the prioritisation of JPT features (see below).

JPT product development and testing: Development of the JPT itself (as detailed in Section 3.2) has been ongoing from the beginning of the project: starting with a base JPT product which was then tested with ACR citizens and visitors which, in a co-design process, helped to enhance the functionality and design of the JPT to create beta versions #1 and #2, with the final JPT due for delivery in Autumn 2020. Beta testing has been undertaken with a subset of co-design participants and other parties recruited by ACC.

Collaborative design: The project team have engaged collaboratively with 35 prospective users throughout the project. The first engagement was in March 2020 within four User Engagement Research workshops aimed at user groups determined by ACC as prospective (overlapping groups of) users: drivers, students, age 60+ and cyclists. These workshops were used to: (i) gain insight into the core needs of these prospective user groups; and (ii) elicit an initial long list of suggested features for the journey planner to include.

Two sets of collaborative design sprints (Co-Design Sprints) formed the remaining engagement with prospective users. Co-Design ‘Sprint 1’ followed the build of JPT beta #1 in April 2020 and was focused on first impressions of the design and features included within beta #1, as well as on prioritising the long list of additional features that emerged from the User Engagement Research. Sprint 1 comprised two workshops engaging ACC representatives and ACR citizens. Sprint 1 was not able to gain a sufficiently diverse range of participants including addressing protected characteristics. Co-Design ‘Sprint 2’ then followed the build of JPT beta #2 in May 2020, by which point the Covid-19 pandemic was well underway (an issue returned to later). Sprint 2 successfully engaged a more diverse range of co-designers within our target user groups, as we engaged with a range of students (young carers, college and university students), those age 60+ (including sheltered housing residents, those with visible and invisible disabilities, those without smart phone or internet), drivers (from people who drive out of necessity, such as for employment, to those who’s default transport preference is the car), and active travellers (from confident, experienced cyclists to inexperienced, unconfident cyclists, and those with young children who often walk with a

pram). Sprint 2 was focused on getting feedback on beta #2 and the prioritisation of features within the context of Covid-19 travel.

Prioritisation workshops: Prior to undertaking the product development of betas #1 and #2 and the final JPT, the team conducted a series of prioritisation workshops to identify criteria for selecting features to be included in each round of product development. This process was underpinned by the policy review and priorities agreed with ACC, with a rating system being used to assess how strongly a proposed JPT feature could help support delivery of policies/measures highlighted in the policy review (above). The assessment also considered the strength by which each feature was prioritised in the co-design sessions, the ability for a feature to improve the accessibility of the JPT, and how many developer days each feature would take to build.

4. KEY OUTPUTS FROM ABERDEEN JPT PROJECT

The methodology outlined in Section 3 commenced in December 2019, with the JPT due to be launched in Autumn 2020. The policy review and co-design elements of the project have already been completed and key outputs from this work are set out within this section.

4.1 Policy provides an important and clear vision-led steer

The project started with an extensive review of policies and measures at all levels – from local to national – that were deemed relevant to the JPT project. This policy review underpinned the entire project, going on to heavily influence, and provide a useful steer for, undertaking elements of the co-design and prioritisation workshops which determined the practical development of the JPT itself. The review enabled the team to reveal the policy areas where the JPT (and subsequent onward development of a MaaS offer) could deliver strong support to policies' fulfilment. The principal distinction between the JPT and a further developed MaaS offer is the addition beyond the JPT of the transaction layer in Figure 1.

The policy review revealed the vast range of policies and measures that the JPT has the potential to support. On a national scale the JPT (and a further developed MaaS system) could positively support the following core areas:

- Employment – accessibility to jobs;
- Education – accessibility to various types of education facilities;
- Health and wellbeing – encouraging active travel, accessibility to healthcare facilities;
- Environment – encouraging and enabling sustainable travel, lowering emissions, tackling climate change.

As well as helping Scotland to achieve several national policies, on a local/regional level the JPT can support and empower local policies and initiatives; from improving awareness and use of active travel modes;

ensuring park and ride facilities are well utilised; and ensuring investments in improving the rail network are visible.

With certain policies there is a larger impact in progressing from a JPT to MaaS, with MaaS reinforcing and maximising the impact on social, economic and environmental policies. This is mainly due to the additional ability for users to book, pay for, and validate their journeys using MaaS, as well as the increased flow of information to both users and ACC. The key areas where MaaS could add a significant amount of value include, but are not limited to, the following:

- Embracing transport innovation;
- Enabling businesses to be competitive;
- Improving the quality and availability of information;
- Providing a transport system that is accessible to all;
- Improving access to key destinations (employment, health, education, etc);
- Integrating investment across transport, energy and digital.

The review also enabled the team to agree on five policy objectives that would be used throughout the entire project to prioritise features and to steer the project towards achieving wider societal goals across social, economic and environmental aspects, these were as follows:

- To enhance accessibility and improve social inclusion.
- To improve the integration of all available sustainable transport modes.
- To support the unique economy of the Aberdeen City Region.
- A cleaner, greener transport system.
- A transport system that facilitates healthy and sustainable living.

Undertaking and using the policy review revealed how agreed policy objectives have the potential to frame the development of MaaS in a way that is ultimately desirable to the user (i.e. inclusion of a greater variety of sustainable modes, ability to plan journeys in a way that promotes health and wellbeing, and an accessible service that improves social inclusion). On top of this there is also a regulatory framework that can enhance the layers of MaaS (the regulation of public transport, data sharing regulation, etc.). A suggestion for how these lessons learned can further shape the academic theory is set out in Section 5.

4.2 Co-design identifies core needs of prospective users

The user engagement research workshops used a combination of techniques to determine the core needs of prospective users of the JPT. As a result of the initial engagement, their core needs were identified as: *personalised* (i.e. the JPT needs to meet user needs and present information that is tailored to them as individuals), *localised* (i.e. the JPT needs to be directly relevant to the context of the users life within, or their visit to, the ACR and integrate information on more than just transport, such as local events) and *live and predictive* (i.e. the JPT needs to reflect

what is happening in the real-world to minimise surprises for users). These three core needs could be considered universal for a JPT; however, it is important to confirm them in the unique context of the ACR.

Whilst the user engagement research enabled the identification of core user needs, the co-design sprints went a step further by highlighting the key features that resonate with prospective users. The process presented the opportunity for participants to add to and then prioritise features based on their usefulness to the co-designers personally, and also on their perceived attractiveness to new users.

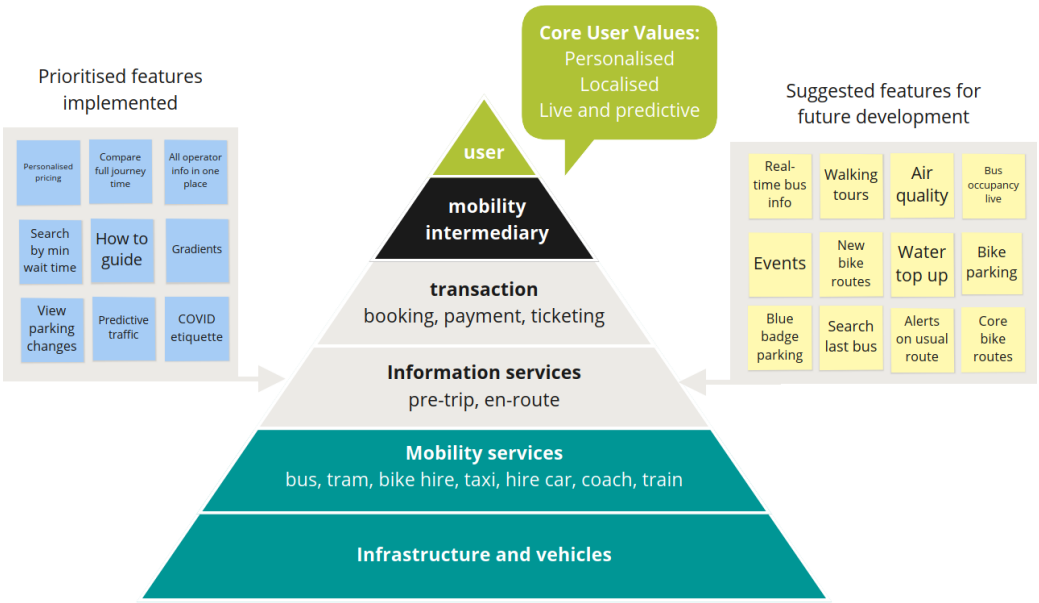


Figure 5: Co-design insights - core user needs and consequent JPT features suggested

Figure 6 shows the features that emerged from both the user engagement research and the co-design sprints. While the co-design centred upon the information services layer, many of the suggested features for the JPT relate to the operational layers below. Transactional integration was not in scope of the co-design but was nevertheless raised by participants (indicative of the attraction of progressing beyond the JPT in due course with a MaaS offer) with fulfilment of trips and the ability to book and pay for all travel emerging as proposed features. During the user engagement research and co-design sessions it was continually expressed by a large variety of users that having *all required travel information in one place* would be very useful to them. Transactional integration such as booking, payment and ticketing was very much seen as a “nice to have” and would add value to the MaaS offer, but the main enhancement to the mobility system beyond the private car is delivering the information layer in Figure 1.

Stills from the JPT (the design of which was guided by the process above) are shown in Figure 7. These show some of the features implemented within the JPT as a result of the co-design process, including the how to guide (a), search by minimum wait time (b), personalised pricing (c), full

journey time (d), operator information in one place (e), and predictive traffic (f).

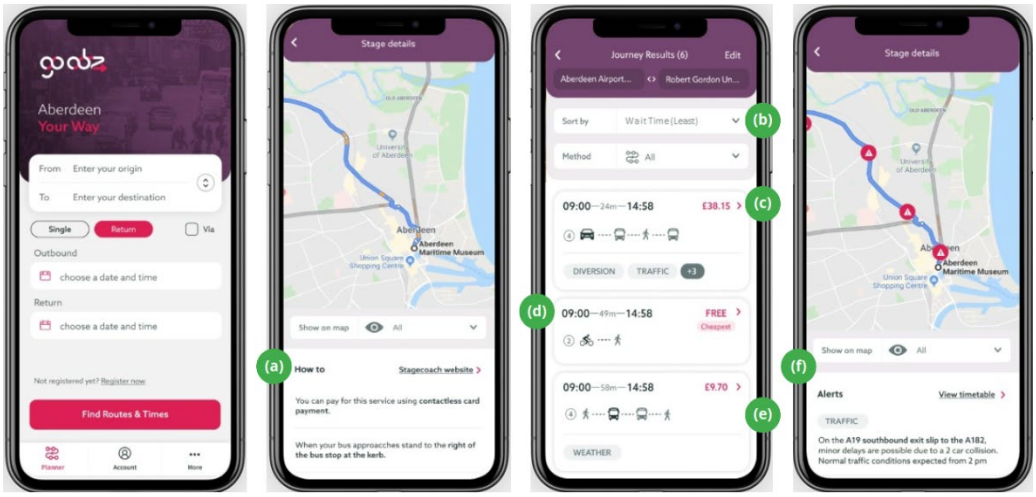


Figure 6: Aberdeen JPT app

4.3 Accessibility is fundamentally important

The purpose of the JPT is to foster trust and confidence in shared and active modes. This trust and confidence can be lower amongst those with specific mobility needs.

Co-design has highlighted specific features to ensure accessibility for wheeling/walking and enhanced trust and confidence in travel. These include being able to search on minimum wait times at public transport stops (as shown in Figure 7, as standing for a long time can be a problem); maximum wait times (to allow easier transfers); availability of toilets en-route; and planning around gradients to ease walking. These have been integrated into the JPT. Other requirements include locations of Blue Badge parking which is on the JPT roadmap for future implementation. While these specific features are seen to be valuable for travellers with specific mobility needs, they are of course of value across a very wide range of users. Indeed, other core features are deemed to be valuable by older people and people with a range of disabilities. Of note is the value to users of the availability of all modal information in one place and the personalisation of prices and information to an individual's needs.

In delivering these features the JPT used WCAG 2.1 AA standards. This ensures the JPT supports assistive technologies (e.g. enables web to speech reading and the use of the keyboard to navigate). The JPT also inherits the accessibility properties set on the phone (e.g. text sizes, voice commands). Brightness and colour contrasts are also tested at the development stage. This helps ensure the JPT is as inclusive as possible. However, in engaging with potential users' further guidance has been prioritised including the requirement to liaise with British Sign Language.

As important as specific features and standards is the emerging requirement for non-App based touchpoints for the JPT. These include: a

web based version of the JPT for non-smart phone users; notifications of networks changes and/or tailored information mailed directly to registered users; and the use of third parties to offer journey planning advice in communal living space (e.g. designated JPT users within sheltered accommodation who could support neighbours). In addition, the web-based version of the JPT was seen to support pre-trip planning activities which was undertaken more by people with lack of confidence in the transport network. While these are outside of the CIVITAS Project funding, they will be investigated as part of the ongoing sustainable business case development within ACC.

Engagement to ensure inclusive access was essential to the design of the JPT. Ongoing engagement should further develop this ecosystem of designers and potential users, thereby supporting continued JPT enhancements.

4.4 JPT as an asset for resilience (highlighted by Covid-19)

The timing of the development of the Aberdeen JPT and its subsequent initial launch was impacted by Covid-19. The core app was originally due to be launched in March 2020, which coincided with the lockdown related to the Covid-19 pandemic. This delayed the launch of the JPT because it was contradictory to promote the planning of journeys at a time when travel was being discouraged at a national level. Yet the pandemic and societal response has given rise to very substantial dynamics in travel behaviour. People's circumstances have been and continue to change, such that there is likely to be greater need and appetite for reviewing travel options and taking advantage of informational support available. In this respect, the availability of the JPT could support Aberdeen's recovery and the significance of Figure 3 is brought to the fore as the change of circumstances prompts individuals to review their mobility options through the JPT.

Due to the timing of co-design Sprint 2 falling in May 2020 we had the opportunity to engage with prospective users specifically on the topic of travel needs in relation to Covid-19. This revealed that immediately post-Covid may present a fairly unique opportunity for a JPT to succeed, as people will look to plan their travel more due to many uncertainties while travelling – particularly around what options are available to meet their needs, and also what rules (Covid etiquette) they need to follow when travelling. During Sprint 2 people showed a willingness to embrace the opportunity to walk and cycle more but wanted to know where it is safe to do so. It was also expressed that it may be more important for people to make travel decisions based on finances as budgets tighten due to a recession (particularly for young people). Overall people felt that they may travel more sporadically (i.e. commuting less regularly), may plan their journeys more often, and be more nervous about using public transport. They also believed that a JPT that could help them to overcome many of these new challenges.

5. LESSONS LEARNED

The paper by Lyons, Hammond and Mackay (2019) is itself a product of combining insights from theory and practice. In this paper we have engaged in another iteration of concurrent advance in theory and practice. The JPT project has drawn upon conceptual insights for its delivery. In so doing, it has also revealed further insight of potential value to the ongoing development of theory, as well as practice. Lessons learned are set out here.

5.1 Policy underpins all layers of MaaS

Both in this JPT project and in work elsewhere, the simple user-centric 'hierarchy of need' depiction in Figure 1 of MaaS as the mobility system beyond the private car is proving to be an important representation. Lower layers must be in place and sufficiently developed for higher layers to deliver added value. Public policy can be assumed to have the needs of the electorate at its heart and in this sense is user oriented. Public policy also provides the vision for delivering the mobility system beyond the private car. In this project, public policy has combined with user requirements to frame the delivery of the information services layer in the form of the JPT. If it is assumed that policy and regulation are the governance structure within which MaaS should develop then these become foundational. Accordingly, in Figure 8 we suggest that this constitutes a further base layer to the 'hierarchy of need'. If this layer is poorly addressed, the course of MaaS evolution may deviate from delivering public benefit at a collective level for users, even if a purely market-led approach may benefit some users. If well addressed, it can strongly guide fruitful enhancement to the mobility system beyond the private car.

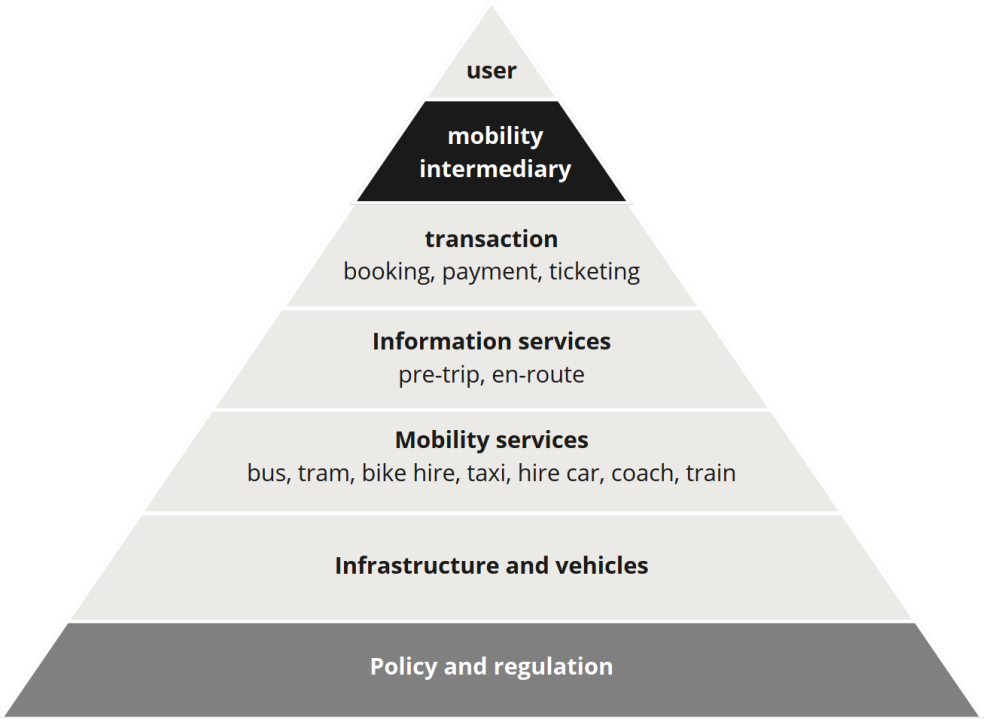


Figure 8: An extended hierarchy of need

5.2 An action-oriented collaborative approach is required to reach MaaS

Learning by doing, as well as learning from others is important. This has been the experience of this project. It may have been overwhelming to embark directly on a project to try and deliver 'MaaS' as aligned to its popularised representation. Instead, this project took advantage of some of the latest practice-informed theory to prioritise development of a likely key part of any MaaS offer, namely the information layer. In doing so learning emerges about the specific geographic location of application, its current state of 'MaaS maturity' and the priorities of both policymakers and users of the mobility system beyond the private car. It then becomes a stepping stone along a path towards later more advanced developed of that system. In the case of Aberdeen, ACC is now in a much better informed and developed position to consider its next steps. During the project it has also been apparent that a tripartite and open relationship between the public authority, private service developer and end users has been beneficial to learning together and to pursuing the most effective outcomes through co-design.

5.3 Not all layers on the LMI taxonomy are created equally

The LMI taxonomy in Figure 2 in isolation may imply that progressing to ever higher levels of achievement in advancing MaaS involves concurrently improving operational, informational and transactional integration. Figure 2 also leaves open to interpretation the relative improvements from the user perspective in advancing from one level of MaaS integration to the next. Notwithstanding that this project consciously chose to devote its attention to the information layer and its integration, it has nevertheless underscored the value of this layer. Figures 1 and 2 need to be considered together. We believe from experience with this project that the hierarchical nature of Figure 1 holds true in practice. Accordingly, operational integration and informational integration (Figure 2) are likely to be more important to users than transactional integration. In turn, the most important progression is from Level 0 to Level 2 in Figure 2, with any further progression arguably better targeted at further improving coverage of operational and informational integration rather than (over) prioritising transactional integration (something which (private sector) mobility intermediaries are likely to consider with greater interest). Although the transactional layer (Figure 1) provides added value to the user, it is not key in "bringing MaaS to the masses" in relation to the bottom three layers of the pyramid.

5.4 Co-design presents a way to gain unique insight into user needs

Few proponents of MaaS would contest that its key intention (perhaps also allied to profit motives) is to make the mobility system beyond the private car more attractive and more useable to travellers. User requirements should, therefore, be key. However, it is not always strongly

borne out in practice in terms of the nature and extent of engagement of users in the design process. Expert judgement is important, but it should not be seen as a substitute for direct engagement with users themselves. Recognising and accommodating the heterogeneity of users' needs is also important. People's individual needs differ and if a JPT or MaaS offer is to fulfil public policy objectives associated with inclusive mobility then co-design that engages with diversity is essential.

5.5 Travel behaviour dynamics as an enabler of MaaS effectiveness

Throughout this paper we have emphasised that MaaS is not only about information but about the mobility services available beyond the private car. It is also about, as depicted in Figure 3, individuals' circumstances. If people are satisfied with their current mobility choices, then a JPT alone may not bring about any change in behaviour (albeit that it may enhance the experience of fulfilling those mobility choices). If their circumstances change and/or they become aware of their choice set and the relative appeal of different travel options within their choice set changing, then the propensity to seek out information about travel options is likely to be greater.

Whether or not further shocks beyond the current pandemic await society remains to be seen. Nevertheless, the pandemic has amplified what is an ever-present feature of mobility – as people's circumstances change, so too may their travel requirements and their need to reassess what is available to them. Being able to target JPT and wider MaaS support to people at such times is likely to be beneficial in terms of society getting the most from the mobility system beyond the private car and recovering well from any future shocks. It should nevertheless be remembered that a good JPT is not a substitute for poor provision of mobility services themselves. Local authorities should beware of becoming part of the adrenal rush to 'MaaS utopia' and remain mindful of the user-oriented hierarchy of need when prioritising their investments and efforts.

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