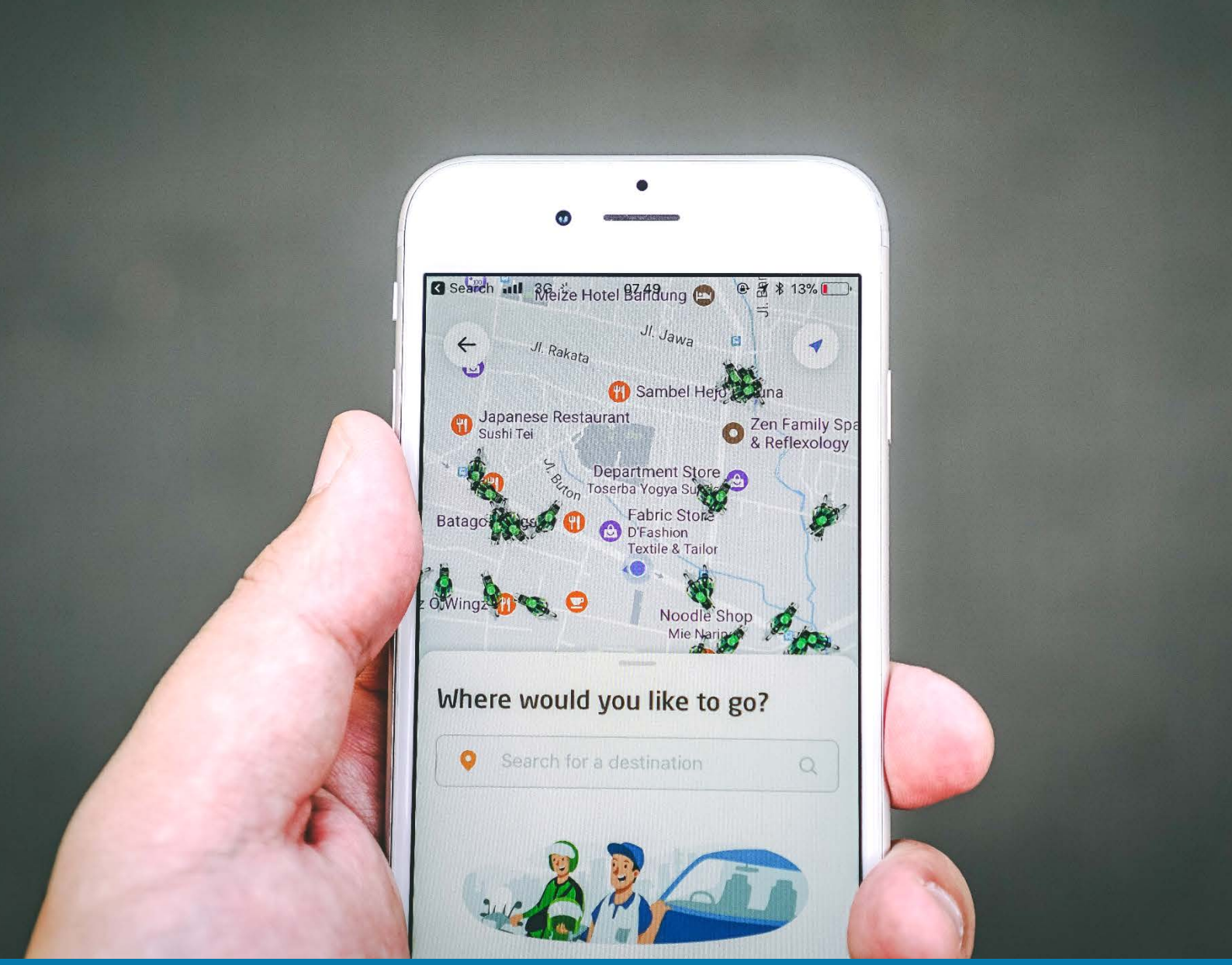

Multimodal travel planning

An analysis of ICT travel planning solutions in Baltic Sea Region cities

2019

cities. multimodal

Interreg Baltic Sea Region

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Project note

The EU co-funded project **cities.multimodal – urban transport systemin transition towards low carbon mobility** (2017–2020) brings together cities, NGOs, universities and other expert partners to facilitate the use of sustainable mobility solutions for citizens in the Baltic Sea Region.

Different activities and measures are implemented to promote walking, cycling, public transport and shared mobility services as more favourable alternatives to private car use.

Within cities.multimodal, partner cities develop and apply contemporary sustainable urban mobility approaches which are easily adoptable for follower cities. This includes a pilot area SUMP and multimodal mobility points where partner cities test and implement campaigns and innovative ways to involve citizens. Mobility management concepts are developed with different stakeholder groups.

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Introduction

This report has been created in the framework of the Interreg cities.multimodal project by the Institute of Baltic Studies[1] in cooperation with project partners. The focus of an activity in the cities.multimodal project was on web- and mobile-based individual travel planning applications (ICT solutions). These ICT solutions aim at providing different transport options and enabling individualised door-to-door travel for end users. This report will provide an overview of such applications and offer recommendations for the procurement process.

The goal is also to create a resource for civil servants, public transport providers, and project partners to help inform the planning and development process for multimodal solutions. The document covers the results of conducted market research, an analysis of partner cities' ICT solutions, and interviews, providing a helpful starting point for cities to educate themselves about the possibilities of multimodal ICT solutions.

In addition to interviews conducted with the project partners, there was also an opportunity to interview IT specialists from Berlin. Berlin hosts a robust IT cluster with several public and private mobility solutions already in place. As such, the interviewees provided valuable information that was used to broaden the knowledge of the report and support the analysis.

The **first chapter** introduces the relevance of multimodality and how travel planning ICT solutions can benefit multimodal transportation. **Chapter two** offers the results of the analysis that was conducted. The main value of the analysis is the comparison between the solutions currently available in the cities studied – by comparing them with each other and with the broader set of travel planning solutions also available elsewhere. One important outcome of the research is the **Criteria catalogue for ICT travel planning solutions' functionalities** which can be found in Annex 1. In **chapter three,** ownership, connection with mobility points and costs involved are dissected. The document ends with the **most relevant recommendations** to civil servants.

[1] The Institute of Baltic Studies is a non-governmental think-thank in Estonia, Tartu (www.ibs.ee/en). The authors of this report are analysts Mart Veliste, Richard Henahan, Maarja Käger and Merit Tatar. In case of questions regarding the report, please contact Merit Tatar (merit@ibs.ee).

1. Multimodality

1.1. Urban mobility – A turning point for transportation

The cornerstone of a liveable city is an efficient transportation network. Roads must be maintained to ensure the timely arrival of deliveries and people commuting to work, school, or places of leisure. Traffic lights, cameras, and sensors must work in unison to maintain the flows of traffic. Within this urban ecosystem, pedestrians, bicycles, scooters, motorcycles, automobiles, trams, and subways must coexist. If this movement falters, the dynamism of urban centres falter.

Key Trends
• 83.7% of Europeans will live in cities by 2050 • 75% of global primary energy consumed by cities • 60-80% of world's greenhouse gases emitted by cities • Congestion can cost as much as 2 - 4% of national GDP

Urban mobility is under pressure from multiple fronts. urbanisation trends indicate that by 2050, 83.7 percent of the European population will reside in urban areas[2]. In the context of mobility, this means current transportation infrastructures will be stressed; increasing congestion, commuter times, and pollution. This also raises environmental concerns as cities consume approximately 75 percent of global primary energy and emit between 60-80 percent of the world's greenhouse gases[3]. Further, there is a risk of exacerbating negative environmental externalities, which are often associated with urban areas. For example, road transport is responsible for up to 30% of particulate emissions (PM) in European cities. PM is associated with cardiovascular disease, heart disease, cancer, adverse birth outcomes, and higher death rates in general[4].

Paradoxically, the solution to some of these issues may lie with the cities themselves. People living in urban areas consume less energy per capita than those living in suburban or rural areas[5], suggesting that denser populations are more energy efficient. This can be partially attributed to the nature of densely built environments where it was found that reduced travel time and communication are advantageous towards better transportation[6]. Similarly, the implementation of novel and emerging technologies is more easily achieved in urban areas[7]. Given these trends, innovation driven by advancements in mobile technology may offer a solution.

1.2. Multimodal solutions - Changing the way we move

[2] European Commission. "Worldwide urban population growth". Accessed on: 7.10.2019. Retrieved from: https://ec.europa.eu/knowledge4policy/foresight/topic/continuing-urbanisation/worldwide-urban-population-growth_en

[3] United States Environmental Protection Agency. "Health and Environmental Effects of Particulate Matter". Accessed on: 7.10.2019. Retrieved from: https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm

[4] World Health Organization. "Air Pollution". Accessed on: 7.10.2019. Retrieved from: https://www.who.int/sustainable-development/transport/health-risks/air-pollution/en/

[5] Arbabi, Hadi. Mayfield, Martin. 2016. "Urban and Rural-Population and Energy Consumption Dynamics in Local Authorities within England and Wales". Buildings. Vol. 6(3), 34

[6] Hui, Sam C.M., 2001. "Low energy building in high density urban cities". Renewable Energy, 24(3-4), 627-640

[7] Ibid.

Technological innovation is paving the way for new transportation services, making it easier and safer for dwellers to get from point A to point B. The success of mobility applications can be observed in recent global statistics, which show that the use of mobile travel and navigation apps grew 50% between 2016 and 2018[8]. In a Google study[9], it was also found that Smartphone users in the USA aged 18-64 had an average of 2.3 travel applications installed on their phones. Taken together, we can see that not only are people using travel applications, but a growing number of people are adopting that technology. In other words, there is a market for mobility services, and this presents an opportunity for policy makers to address transportation challenges in their city.

The recent explosion of transportation services is seeing an array of new mobility options spring up in cities around the world. For example, in a snapshot of the top 5 ride sharing apps in the USA, it was shown that scooter and bike sharing apps grew 530% between 2017 and 2018[10]. To harness burgeoning transportation options, cities are looking to technology to provide simple, effective, and sustainable options for their citizens. One such solution is **multimodal transportation.**

Multimodal transportation is the combination and choice of sustainable modes of transportation - walking, cycling, public transportation, and carsharing - as an alternative to individual car use. The concept behind multimodal transport is that it combines the strongest points of different mobility options in terms of accessibility, mode of transport, and travel preferences, to accomplish an optimal level of efficiency[11].

Multimodal transportation is not a new concept, however, innovation in IT and web/mobile-based applications are increasing the availability and effectiveness of urban mobility. This yields several potential environmental, economic and social benefits including efficient transportation routes, reduced congestion, decreased air pollution, financial opportunities, and increased accessibility to transportation for low income users (See Figure 1).

Based on Haas[12], these benefits can be described as the following:

Economic benefits:

- **Increased system efficiency** – With accurate travel information and options for different routes, passengers can increase the overall efficiency of their travel.
- **Opening potential financial opportunities** - Broadening commuter routes and travel efficiency may increase the value of properties near these routes. This may open further investment into the development of areas that are located near these travel routes.

Environmental benefits:

[8] App Annie. 2019. "The State of Mobile". Accessed on 7.10.2019. Retrieved from: https://www.appannie.com/en/insights/market-data/the-state-of-mobile-2019/

[9] Google "How People use their phones for travel". Accessed on 7.10.2019. Retrieved from: https://www.thinkwithgoogle.com/data/average-number-of-travel-apps-installed/;

[10] App Annie. 2019.

[11] Haas, A. 2019. "Key considerations for integrated multimodal transport planning, policy paper." Retrieved from: https://www.theigc.org/wp-content/uploads/2019/02/Integrated-multi-modal-transport-planning-FINAL-Jan2019.pdf

[12] Ibid.

- **Decreasing air pollution** - Reduction of the use of private vehicles will lead to a decrease in air pollution.
- **Reduction in congestion** - By making multimodal options more competitive compared to cars, the usership of these options may increase, therefore decreasing congestion.

Societal benefits:

- **Improving affordability for low income users** - Maximizing the efficiency of multimodal options can make public transportation options more affordable for low income commuters. This will have a direct effect on their lifestyle and may increase access to job opportunities.
- **Enhancing social cohesion** - If multimodal systems are made more efficient, this may sway private commuters to switch to public options. Thereby creating a meeting space for different members of society and improving social cohesion.

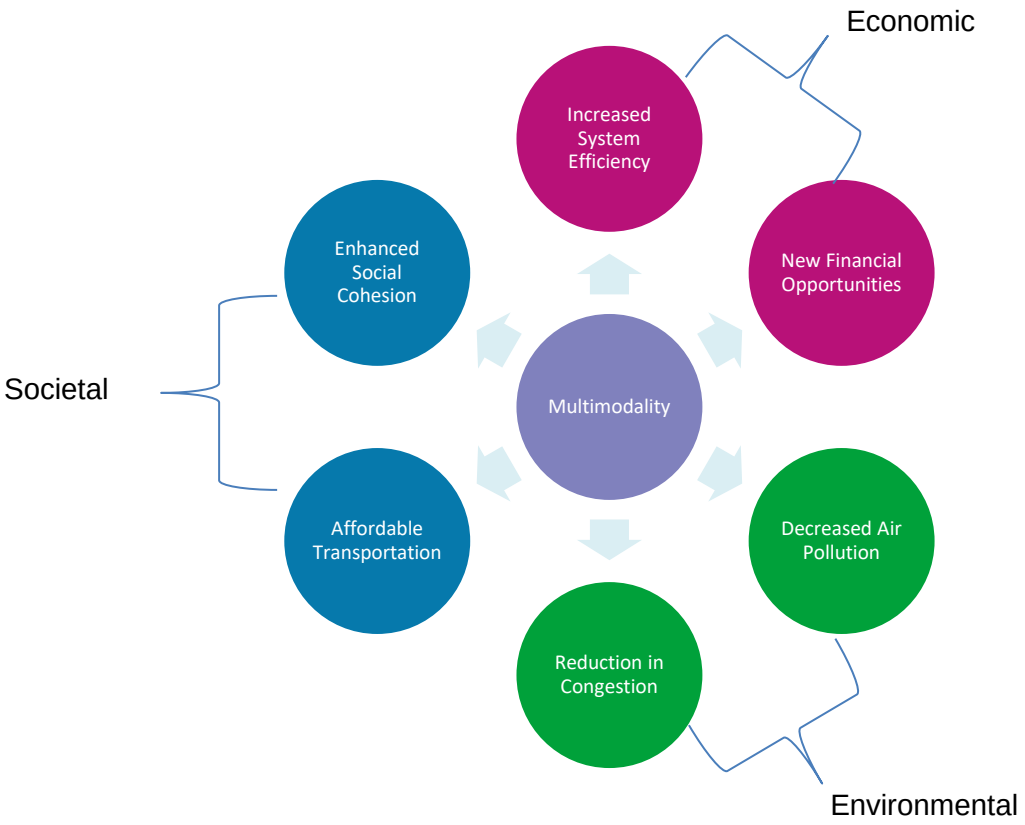

Figure 1. *Benefits of Multimodality. Source: Authors, based on Haas, A. 2019.*[13]

As is the case in most situations, **there is no "one size fits all" solution for implementing a multimodal transportation system**. There are several factors to consider like current and future population growth, budgetary constraints, political climate, existing transportation infrastructure and climate conditions to name a few. **Each city has individual needs that should be considered when developing a transportation solution**.

[13] Ibid.

2. Analysis

2.1. Method

Desk research

The research of cities.multimodal project started with desk and market research. To create an overview of ICT solutions used for individual travel planning, the following approaches were used:

- General web search and database search of academic journals to map positively/negatively mentioned ICT solutions
- City/solution specific web search and database search of academic journals
    - specifying information about solutions found in previous step
    - search for information about solutions used in the EU
- Collecting background information from partners through the project's Preparatory Analysis

The desk research helped to understand key aspects of ICT solutions, including potential functionalities, drivers and barriers of developing ICT solutions. The desk research had two outputs for the project. First, based on the initial desk research, **a template was developed for project cities to analyse their own current ICT solutions** in a more systematic way. These templates were then analysed for this report.

Secondly, as a result of the entire mapping process of this research (including desk research, template analysis, interviews and follow up desk research), a **criteria catalogue for ICT travel planning solutions' functionalities** was created. The criteria catalogue lists the functionalities available for promoting multimodality with ICT travel planning solutions[14]. It helps officials understand what kind of functionalities would be valuable to have in their city's or region's ICT solution to increase multimodality and guide the procurement of an ICT solution for cities. The catalogue can be found in Annex 1.

Template and interviews analysis

Based on the initial desk research, a template was created and distributed among the project partners (10 cities[15]) in April 2019. The purpose of the template was **to map the functionalities of travel planning ICT solutions available in project cities**. By having project partners fill in the templates, it was assured that there would be no language barriers and geographical obstacles (i.e. the interface looks different depending on where you access the solution from) in analysing the available solutions.

The template consisted mainly of a functionality checklist where partners had to tick boxes of the functionalities available in their solution. There were also open-ended questions regarding strengths, weaknesses, connection with info terminals, and other functionalities. See the full template in Annex 2.

[14] The research template and criteria catalogue are not identical regarding the functionalities listed. The criteria catalogue, as the main output of the research, was developed throughout the entire research. Existing information was clarified, and new information was added in the process. The template was just a research tool. Cities seeking to procure or develop their solutions should first and foremost consult the "Criteria catalogue for ICT travel planning solutions' functionalities."

[15] The 10 cities were: Aarhus, Berlin, Gdansk, Guldborgsund, Kalmar, Karlskrona, Pskov, Riga, Rostock, Tartu and Vilnius.

Altogether **15 templates** were filled in by project partners, i.e. 15 IT travel planning solutions formed the sample of the analysis[16]. In a few cases minor adjustments were made to the templates based on interviews conducted with the partners. When reading the results, one should be mindful of the small sample available. First and foremost, this section functions as a chance for the project cities to benchmark their solutions with others and create a space for sharing knowledge. It has been decided to present results based on full values and not percentages as with such a small sample it would only confuse the picture. Detailed results are available in Annex 3.

In addition to the templates one of the main sources of information for this analysis were **ten follow up interviews** with project partners regarding travel planning applications. In some cases, project partners were asked to forward specific questions to their ICT solution developers or other authorities. Additional data was also received from Technische Universität Berlin in the form of three interviews conducted with local IT experts regarding travel planning solutions available in Berlin.

The **main value of the analysis** is the comparison between the solutions currently available in the cites — comparing them with each other and with the broader set of travel planning solutions available elsewhere.

[16] In some cities more than one travel planning ICT solution is available and therefore more templates were completed. The cities with more than one template were: Gdansk (3), Karlskrona (2), Tartu (2) and Vilnius (2). Additionally, according to the interviews conducted, two cities out of ten are also in the development stages of new regional solutions, but it was too early to fill in templates on those.

2.2. Mapping cities.multimodal cities' solutions

Breakdown of the solutions

The cities in this study are at different stages in the development of travel planning applications, with some not considering further development, some that are in the process of setting up a new solution, and others with an application that is already in place (Table 1).

Table 1. Development phases of partners' ICT solutions.

No intention to develop	Currently developing			Mostly developed
Guldborgsund	Pskov	Karlskrona	Vilnius	Rostock
Gdansk	Aarhus	Kalmar	Tartu	Riga

Source: Authors

ICT solutions available vary in geographical scope – they can cover the nation, some specific regions or just the city level. Out of the 15 solutions, 6 are available nationally, 4 on the regional level and 5 on the city level (Table 2). In some partner cities, both a national and a regional solution are available. In situations like this, both can play a different role. For example, in Karlskrona, people would use *Blekingetrafiken* inside the region, but switch to *Resrobot* for travelling to neighbouring regions. In one of the interviews it was mentioned that the strength of a regional solution can be more accurate real time information and more convenient ticket purchasing functions compared to national solutions.

Table 2. Geographic scope of cities´ ICT solutions

National	Regional	City
Aarhus (MinRejseplan)[17]	**Rostock** (VVW Fahrplanauskunft)	**Pskov** (online.pskovbus.ru)
Gdansk (Jakdojade) **Gdansk** (MobileMPK)	**Gdansk** (Zdążuś)[18]	**Tartu** (Tartu bussiajad) **Tartu** (Ühistranspordi võrdlus)
Guldborgsund (MinRejseplan)	**Vilnius** (Trafi)[19]	**Vilnius** (mTicket)
Karlskrona (Resrobot)	**Karlskrona** (Blekingetrafiken)	**Riga** (Rīgas satiksme route planner)
Kalmar (MobiTime)		

Source: Authors

It is important to note that national solutions can still have regional differences. There is the obvious aspect of cities having different infrastructures, including transport modes (i.e. does the city have a tram or ferry service) or availability of electronic info terminals; but there are also cases where some new functions are piloted in certain areas. This became evident in the functionalities of *MinRejseplan* available in Aarhus and Guldborgsund.

[17] As of Spring 2019 Aarhus has the national Rejseplan solution. However, as the data collection for this report was carried out in Spring 2019, the report still refers to the MinRejseplan solution.
[18] Technically covers a tri-city metropolitan area.
[19] Trafi is available in many cities around the world, thus being somewhat global, but not all of Lithuania is included.

Having too many different regional solutions can be an obstacle. In many of the partner countries, the regional government is responsible for providing public transport services including setting up suitable ICT solutions (for example Karlskrona and Kalmar in Sweden). It is difficult to unify existing ICT solutions because there can be reluctance in giving up a solution that they have developed and spent money on. There is also the question of how to split the ticket money when you use cross county ticketing. This can lead to gaps in a travellers' journey where there is a period with no ticket.

ICT solution format

An ICT travel planning solution can be web-based (accessible through a browser), a mobile application, or it can function both ways. There is an equal distribution of the ICT solution formats among the solutions available in the project cities (Figure 2).

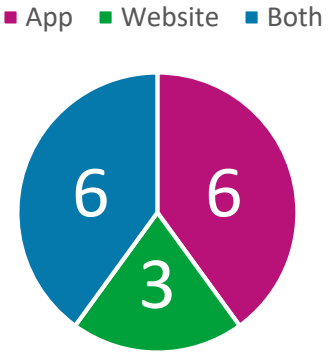

Figure 2. *ICT solution format*

It is hard to say which format is better. Some interviewees thought that only apps are reasonable nowadays by providing convenience in opening them up while walking on the street, whereas others did not see a problem with accessing the website with a browser on a phone. The thing to keep in mind is that websites are more reliant on having internet connection.

Covered infrastructure

One of the most interesting findings of this analysis was the breakdown of covered walking and cycling paths. Out of the 15 solutions analysed less than half had integrated walking paths and only four offered cycling paths (Figure 3). This indicates that of the current travel planning solutions quite a lot of emphasis is put on motorised transport, be it cars or public transport. Therefore, one of **the recommendations would be to work towards incorporating pedestrian routes and cycling paths in the ICT solutions** to encourage greener means of getting around. Multimodality is not only about connecting different forms of motorised transport.

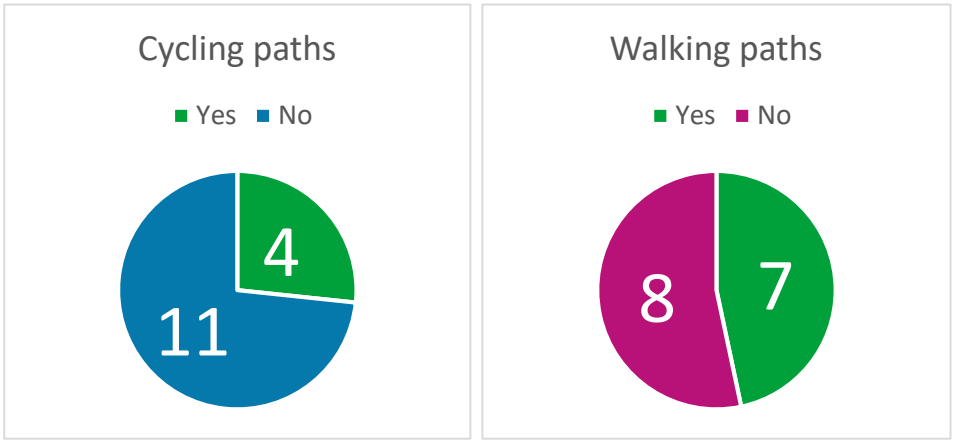

Figure 3. *Availability of cycling and walking paths (N=15)*

Multimodality

All the applications have information about local public transport and those with a larger regional or national scope also incorporate regional and national public transport. However, when it comes to other means of transport then there is room for improvement (Figure 4). Bike sharing stands out as the most common alternative means of transport included in the ICT solutions.

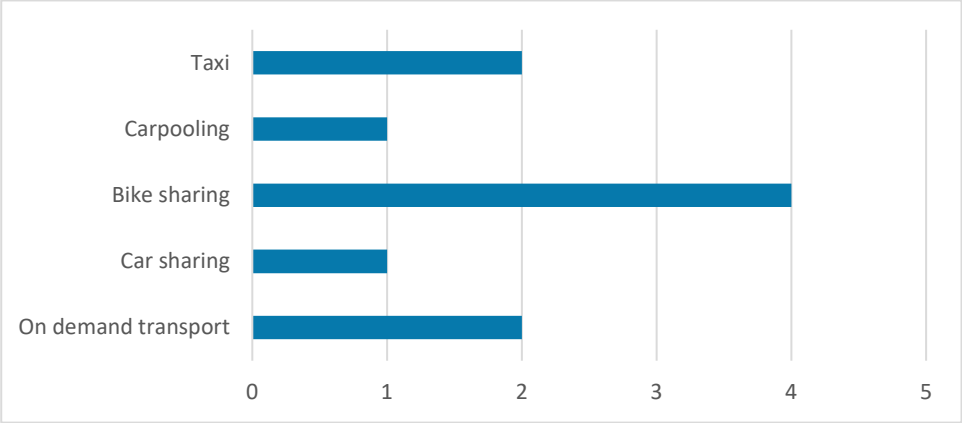

Figure 4. *Transport modes included in the ICT solutions (N=15)*

On demand transport, bike sharing, car sharing, carpooling and taxies were minimally represented among the project partners' applications and websites. There are many explanations as to why these other modes of transport have thus far not been incorporated. Such as obstacles related to stakeholders' motivation, data sharing, technological incompatibilities and costs involved. These and other challenges are elaborated in Table 5 **Partner Reference Guide for Challenges and Solutions** at the end of the chapter.

Real-time information

The availability of real-time or live information can be one of the **main strengths of a travel planning ICT solution** compared to the classical paper printouts of timetables. Indeed, real time data was also indicated as one of the main strengths of the available ICT solutions by project partners and it was cited as an "essential function" by IT experts in Berlin. Likewise, the importance of these functionalities was also seen during interviews of the preparatory analysis.

One of the main benefits of using private cars is the convenience of choosing when to leave and not relying on anybody else. Real time data on public transportation arrivals can make public transportation more reliable or trustworthy. **If ICT solutions can make the availability of other transport modes more reliable, it could potentially reduce car transport.** Furthermore, real time information can encourage better decision making for users planning their commute. Receiving real time data on congestions and road works, for example, can convince people to use a different mode of transport on that day.

It is positive to see that most of the ICT solutions available in partners´ cities already provide live information on arrivals and departures and many also have this information regarding changes and cancellations (Figure 5). However, the capabilities regarding real time data on congestion, accidents, roadwork and weather conditions are

less common. As technology and data sharing between devices becomes more advanced, one can expect that real time information in ICT travel planning solutions will become more common (see also Chapter 3).

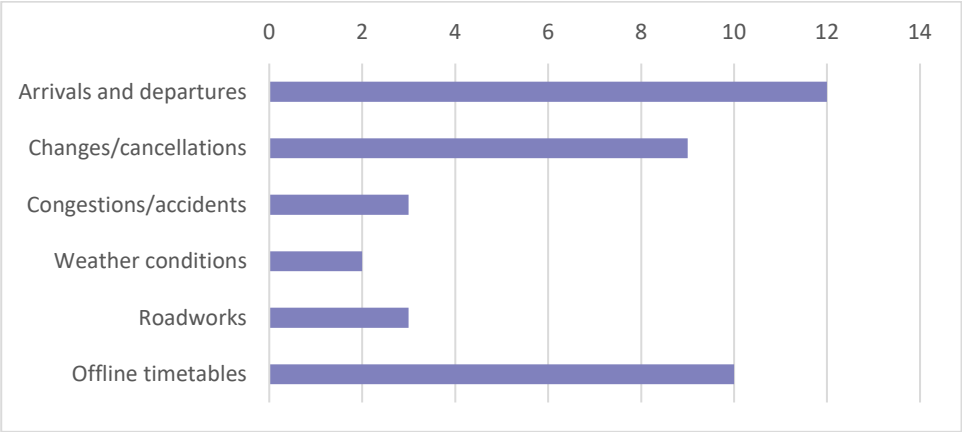

Figure 5. *Real-time information available in the ICT solutions (N=15)*

Booking and payment system

There are many ways a travel planning system can support the purchasing and booking of transportation tickets. These can be divided into features that inform and enable purchasing. For example, the ICT solution can inform the user about which payment methods are accepted on the given transport mode, so that one could be better prepared for getting their ticket. An alternative informative feature is one where the user can find the location of ticket sales points (e.g. ticket vending machines, ticket offices, other ticket distributors such as post offices). Some applications also show the general ticket prices or calculate the prize of the chosen journey. More advanced systems can allow the user to purchase a ticket through the system, either by linking or directing the user to the service provider or through in-App purchases. The booking and payment methods available in the ICT solutions are shown in Figure 6.

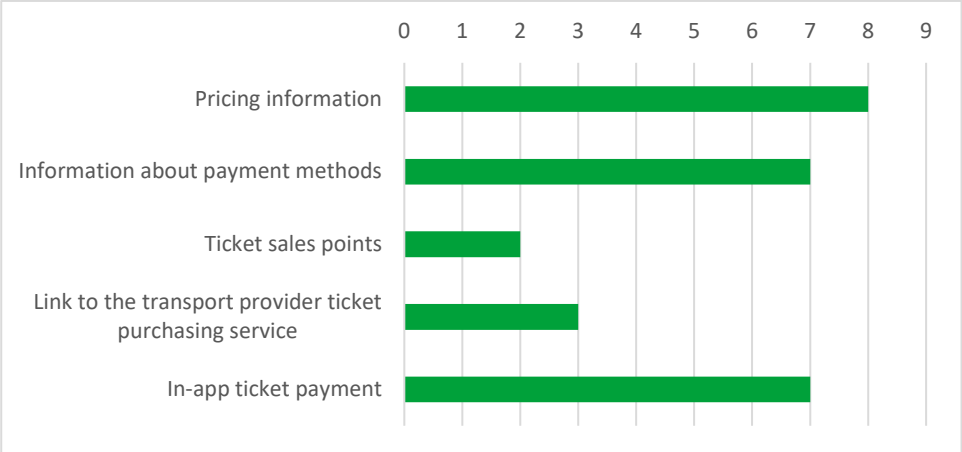

Figure 6. *Booking and payment systems incorporated in the ICT solutions (N=15)*

Through interviews with project partners and Berlin IT experts, it became evident that **the best option or a "must have feature" would be in-app ticket payments**. In Rostock, as a result of a survey conducted, the city found out that it is important for users to have an easy to use and safe ticket purchasing system that supports various payment channels. The users also preferred an option where a ticket could be bought without indicating a specific

destination. Also, in Kalmar, the current website had received criticism from users as the platform was not able to offer the option of buying tickets. A good example of convenient payment comes from a mobility application called *Whim* based in Helsinki, Finland, which offers the option to purchase a monthly subscription that gives access to private and public transportation as well as a pay as you go option.

Route and travel planning

Route planning functionalities that support the user in planning their journey were well represented among the analysed solutions (Figure 7). Travel planning functionalities, which are there to assist once the route has already been chosen, were less represented (Figure 8). One of the less frequently available functionalities are “reminders”. Some ICT solutions available elsewhere send users reminders of upcoming departures, how many stops to go until the destination or send out an alert when it is time to get off the public transportation. The most common function, however, was the information about the next buses, trains etc., that depart from a specific station.

Figure 7. *Route planning functionalities available in the ICT solutions (N=15)*

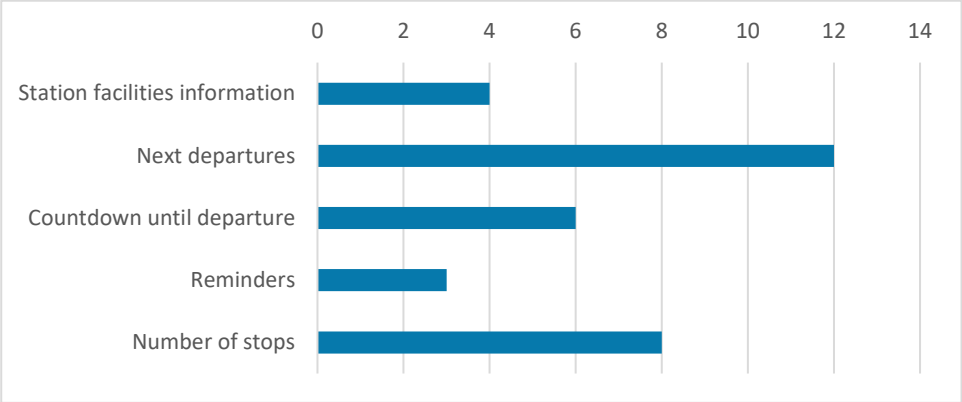

Figure 8. *Travel planning functionalities available in the ICT solutions (N=15)*

Less represented functionalities

As an outcome of the research it became evident that some functionalities mapped during the market research **were not readily available among the solutions from partner cities**. Table 3 offers a list of those less-common functionalities.

Table 3. Less frequently occurring functionalities

Functionality	Occurrence
Motivational statistics	0
Crowdsourcing	0
Special needs	0
Automatic planning	1
Parking assistance	1
Integration with your address book	1
Various cycling routes	2
Indoor navigation	2

Source: Authors

These functionalities are not necessary in all solutions, but will be introduced here to elaborate their content and potential benefits for cities:

Motivational statistics

One intriguing functionality that did not appear in any of the analysed cities was the simple idea of **using statistics that motivate multimodality**. For example, the application called *Citymapper* tracks how much money, and how many calories and trees the user has saved by planning their trip with public transportation instead of a private car. Such features, if accompanied by the ability to share personal results and progress on social media, could help people **publicly show their socially and environmentally responsible behaviour** to others. Integrating a social aspect to compare results with peers could also be useful. As healthy lifestyles and caring for the environment are becoming more popular life choices, functionalities like this could go a long way in promoting multimodality in local communities.

Essentially, this is about the gamification of the ICT solution. **Gamification**, i.e. the use of game design elements in non-game contexts, is known to incentivise application use. Gamification has also shown to promote behavioural change in the field of ICT travel planning solutions[20]. This could be a way to make public transportation and other means of getting around more popular compared to private car journeys. Therefore, when developing a travel planning ICT solution, it could be **wise to add a gamification element** so the user base will be more active in using the solution and sharing their results with others, which will hopefully cause behavioural change.

Crowdsourcing

Crowdsourcing means that the manager of the ICT solution and users get useful input from other users. By giving a chance for the ICT solution users to participate, a cumulative result is achieved. Enabling crowdsourcing in an ICT solution could help with user engagement and provide more reliable live information. For example, it might be useful if users could indicate congestion or traffic accidents. Such functionalities are readily available in applications such as *Waze,* which are first and foremost meant for car users, currently.

[20] In a study measuring gamification of mobility apps in the Italian city, Rovereto, it was found that car trips decreased, bike trips and bike sharing, train use, and walking all increased after the introduction of gamification. Source: Kazhamiakin, Raman., Marconi, Annapaola., Perillo, Mirko., Pistore, Giuseppe., Kessler, Fondazione B., Piras, Lucas, Avesani, Francesco., Perri, Nicola. 2017. "Using Gamification to incentivize Sustainable Urban Mobility". Retrieved from: https://cris.fbk.eu/retrieve/handle/11582/301779/8482/SmartCities_cameraReadyPDFExpress.pdf

The above scenario describes what is called **active crowdsourcing,** where users interact with an application to provide information. **Passive crowdsourcing** is data that is shared automatically, such as location data if you are using a navigation app. This type of information can provide information on where and when congestion occurs so journeys can be rerouted. Passive information can also be collected for studying the individual travel patterns of users, which will be valuable to cities for optimising existing transportation routes. For example, in 2019, Tartu used mobile data for optimising and re-organising the entire bus network in the city as the data provides the most accurate information about real practices[21].

Special needs

The handicapped or the elderly are minority groups that private companies might ignore due to a small market size. This is where the public sector could step up to provide ICT solutions with functionalities considering this target group. Functionalities particularly aimed at people with special needs (e.g. people with disabilities, people in wheelchairs, mothers with baby strollers, and the elderly) were not present among project partners[22].

However, through interviews it became evident that **such functionalities might not be necessarily needed** if all busses are wheelchair accessible (Rostock, Kalmar) or if people know which lines have access and which do not (e.g. fast or slow regional buses in Karlskrona). However, many partners emphasised that a city cannot go fully digital or "smart" with city transport solutions as the elderly might not be able or willing to adapt to new solutions such as electronic timetables or ICT travel planning solutions.

> *"You also need to consider your target group. A large portion of public bus users are retired people who likely do not use travel planning apps. You need to keep and develop traditional systems for these people."* (interviewee from Tartu)

Nonetheless, there are ICT solutions available in other cities that indicate whether the bus is wheelchair accessible. Some applications, such as *FUTAR* in Budapest, also assist people with sight impediments by providing spoken directions or by having integrated a built-in screen reader function.

Parking assistance

Only one solution offered **parking assistance**, which means that the app/website presents a list of nearby parking lots and garages. The relatively rare occurrence of this feature could stem from the existence of ICT solutions that are meant to facilitate parking. Furthermore, it is up for discussion whether a multimodality ICT solution should integrate a feature that makes it easier for private car users to manage their daily routines.

Personalisation: automatic planning, integration with address book, various cycling routes

While **personalisation functionalities** such as setting preferred stops or saving trips were represented relatively well (in 10/15 and 5/15 ICT solutions respectfully) some other personalisation features were less common. Both

[21] In addition to the quantitative data the city also asked people about their preferences. The main challenge was to combine hard mobile data and qualitative data from preferences as they did not match very well.

[22] As a side note, an interesting ICT solution comes from Germany. The App *VBB jump* is a routing app designed especially for children. Source: VBB. 2019. "VBB jump – the app for children". Accessed on 11.10.2019. Retrieved from: https://www.vbb.de/fahrplan/vbb-app/vbb-jump-die-app-fr-kinder

automatic planning and **integration with your address book** appeared only once. Automatic planning means that the solution can automatically generate trips between your favourite locations, for example home and work, or it can automatically suggest trips to go to the events in your calendar. Integration with your address book means that if you have saved addresses to your phones contact list, then the solution can for example automatically plan a trip to your friend's house. Both are nice to have extras that can make the ICT solution an integral part of everyday routines. Their rarer occurrence likely stems from the more complicated technologies involved. These features also require giving access to more data than with simpler travel planners.

Personalisation is also related to route and travel planning options such as being able to choose between **various cycling routes**. Earlier it was mentioned that out of 15 applications only 4 offered cycling paths. Some applications go further than just providing cycling routes by allowing the user to choose which sort of cycling they would like to do, for example the fastest journey or the quietest route. Including alternative versions of cycling, or also walking routes such as most scenic or least exhausting paths, can really promote non-motorised mobility and add a **recreational value** to the travel planning application. The ability for users to customise their journeys was also emphasised in interviews.

> *"The user should be able to select or limit specific parameters – such as the number of connections, distance to be travelled, travel time, travel speed, possibility to choose specific transport modes, routes, etc."* (interviewee from Riga)

Indoor navigation

Most travel planning solutions can help the user to get to the airport or train station, while not many are detailed enough to assist the user from there onwards. **Indoor navigation** can help users navigate large infrastructures like airports and train stations, allowing the traveller to have "door to gate" convenience. This solution makes the most sense in larger cities with large mobility hubs that are difficult to navigate.

However, it was mentioned by IT experts from Berlin, where this functionality has been available, that indoor routing had not caught on with their users. As will be elaborated at end of the chapter, whenever a city decides to procure or develop a travel planning ICT solution, a special notice should always be given to user trends to see if such features would really interest end users.

Other insights and observations

Ownership

One obstacle regarding the development of multimodality applications not explicitly mentioned in the interviews, is that the form of ownership can limit the functionalities available. For example, if the Website/App is owned by a public transport provider, they might lack the interest or incentives to include other forms of mobility. For example, in Rostock´s experience, becoming an integral mobility provider is not the first aim for a public company tasked with organising the local bus transport. In Riga, the city was first and foremost interested in supporting municipal transport and green bus transport, which makes them less inclined to include carsharing or taxi services[23].

[23] However, Riga is aware that shared public transport needs to be introduced in near future, therefore the city plans to develop a legislative framework aimed to support car sharing and bike sharing.

Depending on the owner of the solution, the aims and intended userbase can also differ. For example, in the case of Aarhus, the city is developing their own solution to be able to focus on car drivers instead of public transport users, which is the aim of the national solution *MinRejseplan*.

Ownership is also a question of having control. For example, *Trafi* already provides a travel planning service in Vilnius (and other cities around the world), but the city government is interested in developing their own solution (*mTicket*) in order to be independent from a private company and guarantee a public service even in case the private company would suddenly decide to leave or raise prices.

> *"If they disappear or raise the price, we want citizens to have a functional service."* (interviewee from Vilnius)

Having control also seems to be relevant in the case of procurement procedures. In the case of Pskov, the development of their travel planning website has stalled somewhat until it has become clear who has won the next procurement round of public transport. Although these procurement mechanisms occur every 5 or more years, it does seem to hinder the stability of offering a transport planning solution to citizens and makes it difficult to add new features as technology changes.

Connecting information on applications with terminals and mobility points

One of the aims of the cities.multimodal project is to address the challenges related to connecting ICT solutions with information terminals at mobility sites like bus or train stations or integrated mobility points. Cities with some connected screens include Tartu, Kalmar, Vilnius and partially Rostock. All the cities mentioned that there are **occasional technological challenges** in running such a system. IT experts from Berlin mentioned that connecting an application with mobility points would require the synchronisation of frequencies between the applications and sensors monitoring the information that will be displayed at mobility points. In the Tartu case it was mentioned that as the system runs on mobile data there are issues of connectivity where uneven transmission affects system accuracy. It was also stated by Berlin experts that it is essential that information is **displayed in the exact same way on different devices and systems**.

These answers indicate that solution integration with information terminals at mobility points requires a certain level of synchronisation. Further, they underline a potentially greater challenge of making sure that all forms of transportation are communicating with mobility points on the same frequency to make features like route planning with multiple forms of transport possible. Therefore, it is important to make sure the IT infrastructure for mobility terminals and mobile/web-based devices are synchronised. If the IT requirements for full synchronisation are not in place, then policy makers should consider the resources necessary (cost, time, people) for updating their IT systems to make this feature feasible. One recommendation from Tartu regarding procuring such systems **is to clearly define the required competencies in the procurement process** as they have had problems with a provider who did not have enough prior experience with large scale real-time systems.

An interesting practice in linking devices and bus stops comes from Helsinki where bus stops and public transport vehicles were equipped with Bluetooth "boxes" in summer 2019. These seem to have a similar role to mobility point info terminals: people who are near the bus stop may receive information about delays, etc. Also, this system

enables sending feedback questionnaires to people in a bus stop or public vehicle.[24] Furthermore, with the advancement of 5G technologies (see also Chapter 3), it is most likely that data transmission between ICT travel planning solutions and physical hardware on the streets will become more reliable.

Costs involved in developing and maintaining ICT solutions

Limited resources and financial restrictions were often cited as a challenge to cities when developing multimodal solutions. Further, information on the breakdown of costs associated with developing and procuring an ICT solution was also cited as a barrier. Unfortunately, costs for developing a mobility application and limited financial resources is often a reality for municipalities. However, some solutions were highlighted in our research.
Different payment schemes and partnerships may help alleviate the cost burden of procuring and developing a mobile solution. For example, Aarhus has a joint payment scheme with a private company where they pay for the license to use a platform and a third party covers the maintenance of the application. For larger scale mobility projects where transportation crosses lines of jurisdiction, it may be possible to secure the help of other regions or cities. For instance, in Kalmar, Sweden, they are developing a mobility solution with three other counties to integrate different forms of transportation into one application. Also, partnerships with private companies may be an option for some cities, like Vilnius who uses a private company to help distribute public tickets.

Also mentioned in the partner interviews as a challenge was a **lack of knowledge about the specific breakdown of costs associated with an ICT mobility solution**. Particularly with ICT solutions, there seems to be an added air of mystery involved as many policy makers may not be aware of the costs associated with the development and maintenance of a web/mobile based application. For example, in Rostock, a large share of the costs goes to licenses i.e. to maintain the rights of the mobile ticketing solution. Interviews with IT experts in Berlin helped clarify some of the itemised costs of developing a mobility solution which are outlined in Table 4.

Table 4. Breakdown of expenses involved

Capital Expenses	Operational Expenses
• Developing application	• Web hosting & secure systems (licenses)
• Initialising costs for tender agreement	• Maintenance of site & uploading content
• Costs for integrating travel systems	• Maintaining service hotlines
• Website design	• Operating CRM system
• Installation of hardware. E.g. street sensors, GPS trackers on busses	• Staff costs for programmers & operators
	• Costs for data providers
	• Marketing
	• Billing

Source: Authors

The capital expenses and operational expenses above are not an exhaustive list of all the costs associated with a mobility application. Concrete costs will always depend on the local context (average salaries, how many providers are competing for procurement, etc.) and the functionalities of the ICT solution needed. For example, it was emphasised in the Tartu interviews that in order to provide real time data through the solution it is most likely that hardware in the form of sensors and GPS trackers need to be installed, which increases costs.

[24] HSL. 2019. "HSL asentaa majakoita matkan varrelle." Accessed on 11.10.2019. Retrieved from: https://www.hsl.fi/uutiset/2019/hsl-asentaa-majakoita-matkan-varrelle-18078

2.3. Partners' challenges and solutions

The aim of this section is to highlight the common challenges that were identified by partner cities and match them with a potential solution. Therefore, this reference guide will serve as **a tool for officials to leverage the collective experience of project cities and promote a mutually beneficial exchange of information on best practices and solutions**.

Partner Reference Guide for Challenges and Solutions is a table (Table 5) that includes two columns, which are:

1. **"Challenge":** Refers to specific challenges faced by city officials at any stage of the procurement or development process.
2. **"Solutions and where they come from":** Solutions offered by interviewees and desk research that could potentially help solve a challenge.

In addition, each challenge was assigned a sub-category, labelled as:

1. **"Accessibility":** Refers to challenges related to the accessibility of transportation services in their city.
2. **"Information":** Refers to challenges related to the access to, quantity, and quality of information regarding transportation.
3. **"Integration":** Refers to the incorporation of new or existing transportation services, including travel routes, into new applications.
4. **"Limited Resources"**: Refers to challenges related to limited financial resources or the complications that can arise from limited resources.
5. **"Market Considerations"**: Refers to challenges related to market forces or public sentiment like demand for new mobility services and competing against existing mobility options like private cars.
6. **"Other"**: Refers to challenges that cannot be neatly placed into the above categories.

The information for the reference guide was collected from interviews conducted with officials and IT experts from 10 different cities. It is important to note that the solutions primarily came from the partner cities and where applicable, "Other recommendations" were added with additional research. This was done to supplement partner responses with relevant research to provide a more comprehensive list of solutions. The table serves as a tool for open dialogue and collaboration between partners to create sustainable solutions in their cities.

Table 5. Partner Reference Guide for Challenges and Solutions

No.	Challenge	Solutions and where they come from
Accessibility		
1	Increasing access to mobility options in rural areas.	• **Aarhus:** Carpooling services to connect rural areas • **Karlskrona:** IT solution that brings in a bus company or taxi services to underserved areas • **Other recommendations:** Modality options like cycling, electric bicycles, feeder buses, ride sharing services, and park and ride systems have been found to be effective in connecting rural areas with urban areas[25]
2	Inclusivity of elderly and handicapped	• **Aarhus, Riga, Tartu:** Mobility project called "GreenSAM[26]" that proposes different methods for inclusive mobility • **Riga:** Innovative solutions for elderly and handicapped people
Information		
3	Lack of information on individual travel patterns and customer feedback on mobility applications.	• **Kalmar:** Compiling user statistics from the ICT solution website • **Riga:** Send out general public transportation surveys to their citizens every two years • **Tartu:** Combined the use of surveys and mobile data to map commuter travel patterns and optimise bus routes • **Other recommendations:** Consider using cell-phone data (mobile roaming data) as a way to collect information on travel patterns. Free wifi-hotspots at transport hubs and in vehicles can provide feedback on travel patterns[27]
4	Lack of information regarding costs and benefits of mobility solution	• **Rostock and Kalmar:** Have detailed breakdown of IT development costs, including initial investment, annual costs, etc.
5	GDPR and data sharing complications between platforms	• **Other Recommendations:** Make sure data collection systems are GDPR compliant. This improves data security, identifies redundancies in old data, and updates the cities data catalogue, which can be used to drive innovation, and improve decision making processes and services[28]
Integration		
6	Integrating new modality pilots	• **Tartu**: Recently initiated bike sharing platform as a stand-alone app. • **Aarhus**: Currently testing carsharing pilot • **Other recommendations**: City policies may be dated and unprepared for new types of mobility options. Cities should make sure local policies are

[25] UN report that creates an outline for planning eco-friendly mobility options to connect rural areas with urban areas. Source: Yi, Ch'ng Sin, Prescott, Itzel Obregon., Kodukula, Santhosh. 2017. "Ecomobility in the Context of Rural-Urban Connectivity". Retrieved from: http://www.uncrd.or.jp/content/documents/5128Eco-Mobility%20in%20the%20Context%20of%20Rural-Urban%20Connectivity.pdf

[26] GreenSAM is a project in the Baltic region that is introducing green urban mobility solutions and finding ways to make them available to senior citizens. Source: GreenSAM, 2019. "Green Silver Age Mobility". Accessed on: 30.09.2019. Retrieved from: http://greensam.eu/

[27] Wang, Zhenzhen; He, Sylvia. 2018. "Applying mobile phone data to travel behavior: A literature review". Travel Behaviour and Society. Vol. 11, 141-155

[28] Andrews, Jonathan., 2018. "How the EU's new data laws will affect Smart City development". Accessed on 8.10.2019. Retrieved from: https://news.itu.int/eu-gdpr-smart-cities/

		conducive for testing pilot programs to encourage the use of different mobility options[29]
7	Integrating local mobility options with nationwide options	• **Kalmar**: Is cooperating with 3 other counties on integrating different travel options
Limited Resources		
8	Financial limitations	• **Aarhus:** Joint payment scheme with private company. Ex: Aarhus pays license for platform & maintenance of platform covered by another group • **Vilnius:** Use private provider to help distribute public tickets • **Kalmar**: Cooperating with different counties for mobility solutions
Market Considerations		
9	Lack of interest or critical mass to offer new mobility services Ex: Carpooling	• **Aarhus:** Incentivise different modalities through schemes (e.g. cheaper petrol, cheaper insurance) • **Other recommendations:** Gamification of mobility apps has been shown to incentivise the use of eco-friendly transport options[30]
10	Providing a more convenient mobility option than private car ownership	• Most cities have integrated some type of multimodal transport. Integrating more modalities will expand the transportation options of dwellers, potentially making those other choices more convenient than private car use. • Mobility ICT solutions can be made more reliable through real-time information, payment abilities, and other features to make the use of eco-friendly transportation a more attractive option.
11	Mobility application not competitive enough to change travel behaviours	• **Other recommendations:** City marketing initiatives to educate people about the safety and environmental benefits of public transport can encourage shift away from car use[31]
Other		
12	Lack of ownership or control over popular application	• **Other recommendations:** Cities and private companies could collaborate on mobility solutions, merging public and private interests for the benefit of dwellers[32]
13	IT issues – difficult to change built-in functionalities, lack of skilled personnel, etc.	• Unsure, because each solution has its own specific IT challenges.

Source: Authors

[29] Bannon, Eric. 2018. "Integrating new mobility services in urban transport". Accessed on 7.10.2019. Retrieved from: https://www.transportenvironment.org/publications/integrating-new-mobility-services-urban-transport

[30] Kazhamiakin, Raman., Marconi, Annapaola., Perillo, Mirko., Pistore, Giuseppe., Kessler, Fondazione B., Piras, Lucas, Avesani, Francesco., Perri, Nicola. 2017. "Using Gamification to incentivize Sustainable Urban Mobility". Accessed on 10.10.2019. Retrieved from: https://cris.fbk.eu/retrieve/handle/11582/301779/8482/SmartCities_cameraReadyPDFExpress.pdf

[31] Waqas, Muhammad., et al. 2018. "Understanding Acceptability towards Sustainable Transportation Behavior, A Case Study of China". MDPI, Vol. 10(10), 1-24

[32] Monaya, Jaanaki. 2019. "Better public-private collaboration key to urban mobility". Accessed on 8.10.2010. Retrieved from: https://www.smartcitiesworld.net/opinions/better-public-private-collaboration-key-to-urban-mobility

2.4. Cities' needs regarding ICT solutions

Balancing essential functions with local needs

The conducted interviews also mapped partner cities needs regarding ICT travel planning solutions. Figure 9 displays specific needs that were identified from the interviews which **highlight what cities in the project would like to have addressed through an ICT solution**. Like the reference guide, the goal for the **needs table** is to encourage collaboration between partners by identifying common needs which may help procurement and development of mobility applications. In addition, partners may find useful information they may have been unaware of.

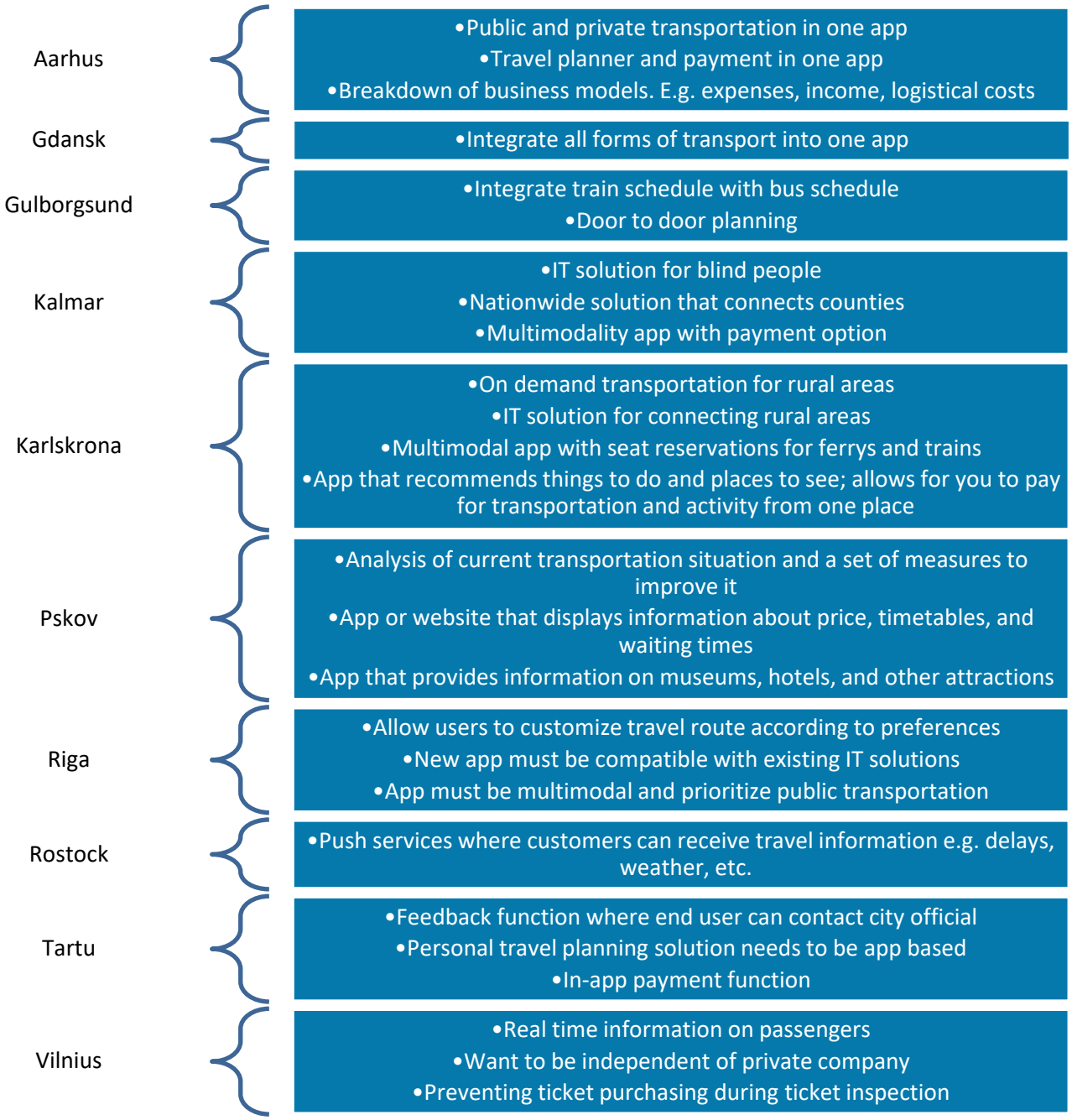

Figure 9. *Partners' needs and wishes (as of April 2019)*

Many of the needs that the partner cities have indicated represent a "wish list" of features of an ideal ICT travel planning solution. Many partners indicated that they would like one, fully integrated application with travel options, payment options, real-time information, and information on hotels and attractions. However, an ICT travel planning solution **does not necessarily have to be a swiss-army knife like solution** with all the bells and whistles. While it may be perceived that a "one-stop shop" application would be a positive thing, having too many functions can make an application difficult to use.

The functionalities of a local ICT solution should be guided by local needs and the aims of the city. Is the application just a travel planner or should it go beyond that by promoting greener lifestyles, recreational activities or even local tourism? For example, out of the 15 analysed solutions, only one had information on hotels and restaurants and two had information on attractions or landmarks. If the city seeks to enhance tourism services, it might make sense to connect it with the development of a regional ICT travel planning solution. However, from a costs perspective, it might **make more sense to leave some tasks for the private sector**. Coming back to the tourism example, it is likely that there are already well working global platforms for finding hotels, restaurants and getting sightseeing recommendations.

Likewise, instead of developing a separate map system, it might make sense to base the solution on Google, Apple or some other large providers´ map system to guarantee a high-level accuracy and reliability. For example, Riga had difficulties in adding pedestrian routes to the system because the company providing the ICT solution did not have the relevant map GIS layer[33]. However, the limitations of these systems should also be kept in mind. For example, although Google Maps is readily available in Tartu, it lacks bicycle routes. This is one of the reasons why Tartu is also considering integrating bike routes in their own ICT solution. Further, it may be very time consuming or difficult, even impossible, to change information in Google Maps (e.g. addresses, new walking paths) whereby in a city's own ICT solution changes can be made more easily.

In smaller cities with less financial funds available and a smaller userbase, a cutting-edge solution might be too much. This highlights the **importance of researching what the user needs are**, be it through surveys, consumer feedback or other methods, before investing time and resources into the development of a new feature. An example of conducting user surveys can be observed in Aarhus, where in autumn 2017 small investigations were conducted with people using car sharing. As a result, it was identified that users wanted smooth payment transactions without negotiating with the driver, fixed guidelines of social behaviour, and guaranteed trips to avoid interruptions in their daily schedule. Similarly, a survey was conducted in Rostock that showed that commuters valued safe payment options, real time information on travel connections and a fully integrated mobility option, not a pilot project.

In the case that an application is already available, it would make sense to analyse **which features are being used and which have been irrelevant**. For example, in interviews with IT experts in Berlin, many functions were not being used like indoor routing, augmented reality, and a "bookmark" function, among others. Unfortunately, additional information on less used functionalities was either not collected or was not made available for the current research. The exception was *MobiTime* from Kalmar where website statistics had been used to map the most relevant features:

[33] "Geographic information system or GIS": Is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. It is a spatial data set, showing maps, points of interests, routes, or perimeters of neighborhoods. Accessed on 7.10.2019. Source: Retrieved from: https://researchguides.library.wisc.edu/GIS

> *"Our website statistics of what the visitors look for and use shows a resounding dominance of "travel planner" and "pricing" functions."* (Interviewee from Kalmar)

Furthermore, **customer support** should be readily available. Out of the 15 applications analysed, only 1/3rd offered customer support to the user.

All these examples illustrate how finding out what your local needs are can help guide the development process in a meaningful way. In some interviews it was mentioned that the city conducts regular surveys about public transport, however, questions related to ICT solutions were not incorporated. The main recommendation here is to **conduct surveys or incorporate some questions into other public transport surveys** that are already taking place**.**

Transferability

Although many solutions available in other cities are replicable elsewhere, one should always consider the local situation. Do all functionalities make sense in the new setting or is something crucial missing or is something unnecessary? This largely depends on the **modal split** of cities. In the preliminary research conducted for the cities.multimodal project it became evident that cities have very different profiles when it comes to modal split and, therefore, their multimodality challenges vary. This directly influences which travel planning ICT solutions are needed.

Another important thing to consider is the local context of transportation providers. For example, in Karlskrona one company owns all the city busses, ferries and regional trains. This makes incorporation of different travel modes onto one ICT platform much easier than in cities where there are multiple transportation providers.

Finally, one should not forget the local geography. If the city territory is large or in a stretched-out shape, then developing ICT solutions for public buses and car sharing might make more sense compared to cities such as Tartu where most people live in a 1.5 km radius from the city center, hence giving more relevance to ICT solutions that provide walking and biking paths. Indeed, geography can even determine whether a travel planning ICT solution is needed to begin with.

> *"As the city is relatively small and distances are short, people tend to develop their own concrete travel patterns and assistance of a travel app is not as crucial as in larger cities."* (interviewee from Tartu)

All in all, either when procuring or developing a new solution or when transferring an existing service over to a new context, it needs to be considered as to whether the additional investments for more functionalities are worth it in the local setting.

3. The Future of Mobility

3.1. Mobility as a service (MaaS)

In the interviews, many of the partners stated that their ideal mobility app would combine multiple forms of transportation, include real time travel information, booking and payment on app, and route planning based on your preferences. **The hope is to combine these features into one app, making it a singular solution for their user's mobility needs**. This solution that best matches this description is an emerging technology called **Mobility as a service or MaaS**.

MaaS is a concept that provides several on-demand transportation options in a single mobility service. This "one-stop shop" travel solution allows users to curate their commute based on a number of factors including price, mode of transportation, time of arrival or departure, and distance to their destination.
At a singular level, this provides benefits to the end user including:

1. Travel planning – Users are able to compare different travel options based on time, price, and mode of transportation to fit their needs.
2. Price comparing – Users are able to compare different prices, find an option that is best for them and pay for it through a mobile or web-based application.
3. Real-time information – Real-time information on departure and arrival times. Also, location data that allows you to track the distance of transportation options to your location.

Like the benefits of multimodality, a MaaS solution has economic, environmental, and societal benefits:

1. Economic: The data from a MaaS solution, including the most used transport options, customer feedback, and preferred routes, could help optimise investments into transportation infrastructure[34]. Further, it would help foster financial transactions through an application and therefore contribute to the wealth of the city[35]. Lastly, the introduction of a MaaS solution could reduce traffic congestion, saving the city costs on time lost, wasted fuel, and increased costs of doing business[36].
2. Environmental: MaaS solutions could potentially reduce the need for the use of personal cars, thereby alleviating pollution in urban areas[37].
3. Societal: MaaS solutions could create a more inclusive transportation network for low income families and people with special needs[38]. Further, lack of access to reliable transportation has been found to contribute to unemployment for individuals in low income communities, MaaS could be an affordable solution for those who cannot afford a personal vehicle[39].

[34] Hazan, Joel., Lang, Nikolaus., Chraibi, Hind El Abassi. 2019. "Motion with Mobility as a Service." Accessed on: 8.10.2019 Retrieved from: https://www.bcg.com/publications/2019/seeking-perpetual-motion-mobility-as-service.aspx
[35] Ibid.
[36] Congestion can cost as much as 2 to 4 percent of national GDP, by measures such as lost time, wasted fuel, and increased cost of doing business. Source: Bouton, Shannon., Knupfer, Stefan., Mihov, Iva., Swartz, Steven. 2015. "Urban Mobility at a tipping point". Accessed on 7.10.2019. Retrieved from: https://www.mckinsey.com/business-functions/sustainability/our-insights/urban-mobility-at-a-tipping-point
[37] Hazan, Joel., Lang, Nikolaus., Chraibi, Hind El Abassi. 2019. "Motion with Mobility as a Service. Accessed on: 7.10.2019 Retrieved from: https://www.bcg.com/publications/2019/seeking-perpetual-motion-mobility-as-service.aspx
[38] Ibid.
[39] McGregor, Alan., & McConnachie, Margaret. (1995). "Social Exclusion, Urban Regeneration and Economic Reintegration". Urban Studies, 32(10), 1587–1600

Therefore, as discussed in Chapter 1, MaaS solutions promote multimodality and can support the positive effects of multimodality regarding system efficiency and potential financial opportunities, reducing congestion and air pollution, affordability for low income users and social cohesion.

In theory, the potential benefits of MaaS are clear for both cities and their commuters, but as it is an emerging technology, there have been limited opportunities to observe MaaS in practice. Most of these services seem to come from private parties with a few public supported MaaS solutions, like *MaaS Madrid* which was developed by the local transportation authority, EMT Madrid[40]. Unfortunately, success indicators for these solutions are not yet available. However, a MaaS application called *Whim* based out of Helsinki, Finland can shed light on the benefits and challenges of MaaS.

Whim and the City of Helsinki have managed to bring together different service providers and modes of transportation into one application. As an element of convenience, *Whim* offers the possibility to purchase single journeys or an in-app subscription that covers the cost of all forms of transportation within a city. Success indicators have been limited, however in one study, it was found that people who used the app were 25% more likely to use public transportation and three times more likely to combine multiple forms of transportation in a single trip[41]. It was also reported that in its first year of operation, Whim supported 2.5 million trips, 120,000 of those being city bike trips[42]. This data is consistent with the benefits mentioned of increasing the use of public transportation that is known to be more environmentally friendly and reduce congestion.

However, there are some doubts about convincing users that public transportation is more convenient than private car use in urban environments. If users pay the unlimited subscription and can take any form of transport, there is a chance they still take a taxi because it is more convenient[43]. If enough users feel the same way, then the appeal of public transportation will fade. Additionally, transportation agencies are wary of third party MaaS services because they may erode the relationship they have with their riders[44]. Having spent decades building a reputation, transportation authorities are worried that having a third-party selling tickets may hurt their brand.

MaaS is an oft touted solution for urban transportation of the future. With the potential environmental, societal, and economic benefits, it is an option worth exploring. However, there is still much to learn from MaaS solutions, with no definitive data supporting its effectiveness. In the meantime, multimodal solutions are growing everyday with more transportation options entering the market. Given recent trends in urbanisation, mobility challenges will have to be met and having more sustainable transportation options stands out as a promising solution for cities across the world.

[40] Vergnani, Raffaele. 2018. "MaaS Madrid, a new mobile application for shared mobility". Accessed on: 11.10.2019. Retrieved from: https://www.eltis.org/discover/news/maas-madrid-new-mobile-application-shared-mobility
[41] Combs, Veronica. 2019. "Mobility as a Service could convert car drivers to bus riders". Accessed on: 9.10.2019. Retrieved from: https://www.techrepublic.com/article/mobility-as-a-service-could-convert-car-drivers-to-bus-riders/
[42] Clementi, Alyssa. 2018. "Whim looks to expand after 2.5m trips in year one". Accessed on: 7.10.2019. Retrieved from: https://mobilemarketingmagazine.com/whim-transportation-app-debuts-with-25-million-trips-taken-
[43] Zipper, David. 2018. "Helsinki's MaaS App, Whim: Is It Really Mobilt's Great Hope?". Accessed on: 7.10.2019. Retrieved from: https://www.citylab.com/perspective/2018/10/helsinkis-maas-app-whim-is-it-really-mobilitys-great-hope/573841/
[44] Ibid.

3.2. 5G and travel planning ICT solutions

5G is the revolutionary next standard of mobile communication. As its name would suggest, it is the 5th generation of mobile communication, following 1G, 2G, 3G, and 4G. The mobile wireless generation ("G" standards) are standards of mobile communication, which generally refer to the speed, latency, technology, and frequency of the network. Currently, we are in the 4th iteration (4G) of mobile standards, with 5G still considered an emerging technology. However, with 5G rolling out in cities across the world, it is expected that within the next decade 5G will be globally available.

It is expected that 5G will be between 10x-100x times faster than 4G. This has immense implications on how much and how fast data can be transferred between devices, particularly in transportation technology. The potential impact on cities is best observed through *Autonomous Transport Systems,* an umbrella term for an array of applications like driverless vehicles, unmanned aerial drones, flying cars, automated parking systems, and even automated driving techniques like platooning[45]. **This also has implications for ICT mobility solutions such as providing real-time travel data to users.** Internal sensors, on phones and busses, and external sensors (lamp posts, streetlights, etc.) will be able to communicate almost instantaneously, giving real-time travel information to commuters, traffic controllers, and eventually, autonomous vehicles.

Autonomous transport systems will require the download speed and latency that only 5G is capable of. For example, for autonomous driving to be viable, vehicles must obey municipal, regional, and national laws, be able to independently operate and refuel on their own. This requires an array of internal and external sensors to communicate with each other in real time to make it possible for vehicles to safely operate in the built environment. A few of the autonomous services possible with 5G are listed in Table 6.

[45] Platooning is when automated vehicles drive in a line with little space between them. This reduces the drag from the air and improves fuel consumption, significantly reducing the costs associated operating a vehicle. Source: Alliance for the Internet of Things Innovation. 2018. "IoT Relation and Impact on 5G. Accessed on: 7.10.2019. Retrieved from: https://aioti.eu/wp-content/uploads/2018/06/AIOTI-IoT-relation-and-impact-on-5G_v1a-1.pdf

Table 6. Autonomous services facilitated by 5G

Autonomous Vehicle	Description
Autonomous Shuttle	Autonomous Shuttle that can drive passengers to and from locations. Can fit between 12-15 people. Are ideal for less travelled routes or for first and last routes of a person's commute (For example: From home to Metro line)
Robo-Taxi	Robo-Taxis fit 4-5 people. Ideal for individualised routes within an Urban Centre; similar to taxis of today, except driverless. Could also be ideal for increasing access to business parks outside of dense urban areas where public mass transit does not normally connect to.
Municipal Services	Municipal services requiring trucks, like water disposal, would be the ideal application for automation. Automated vehicles in this sector could dramatically decrease CO2 emissions and triple the productivity of their services.
Delivery Robots	In early stage of development, delivery robots could take the place of standard delivery trucks. The general concept is an unmanned mobile hub twill carry the items to be delivered. Once in location, a robot would descend from the vehicle and deliver the item to the receiver.
Air Taxi	Air Taxis are made possible by the introduction of UAV's or unmanned aerial vehicles. Drones will be able to fly a certain number of passengers from one destination to another. Can travel short distances, generally 50 miles maximum at a time, ideal for urban transit in dense areas.

Source: Authors based on table information retrieved from: https://www.apur.org/fr

With the introduction of 5G technology, there are many exciting potential applications in urban mobility. While these solutions may seem futuristic, some autonomous vehicles are already in operation. For example, The Sohjoa Baltic Project[46] is already planning, studying, and implementing driverless bus pilots in Germany, Finland, Estonia, Sweden, Latvia, Poland, Norway, and Denmark. In fact, Tallinn, Estonia, recently opened an autonomous bus route connecting a local tram stop with the Kumu Art Museum[47]. Further, **the rate of data consumption facilitated by 5G will make ICT solutions, like real-time travel information, more accurate**. Given the rapid rate of innovation, it is important for cities to be open to new ideas and technology that could make a significant impact on the health and well-being of their citizens.

[46] SohJoa Baltic. 2019. Accessed on: 7.10.2019. Retrieved from: http://www.sohjoabaltic.eu/en/

[47] E-estonia. 2019. "Driverless public bus route now open in Tallinn". Accessed on 7.10.2019. Retrieved from: https://e-estonia.com/driverless-public-bus-tallinn/

4. Recommendations

The main objective of this report is to create a resource for cities who are interested in developing a multimodal ICT solution for their city. To this point, the benefits of multimodality, useful features of mobility applications, common challenges and solutions, and future trends for mobility solutions have been covered. To round out the analysis, this section will discuss recommendations for cities based on the findings of the report.

The recommendations are informed and supported by the information in the report. Based on findings, 5 areas have been identified that would be beneficial for cities to address when starting the ICT solution development process. These areas include:

1. Antiquated policies and data systems
2. Information gathering
3. Incentivising the use of multimodal options
4. Expanding mobility routes
5. Transparency and collaboration

Antiquated policies and data systems

Among the challenges listed, issues related to the General Data Protection Regulation (GDPR) and outdated city policies were not frequently mentioned. However, both these issues have broad applicability to cities across Europe and are, therefore, important to mention.

Recommendation: City data collection systems should be made GDPR compliant

GDPR is often seen as a hinderance to collecting and sharing information, which has been noted in the interviews with city partners. Regardless of the opinions on GDPR, it is a fact of life that policy makers and city officials must be aware of in an information driven world.

GDPR compliant information systems can have several benefits that include, establishing trust between city dwellers and city officials; decreased storage and maintenance costs by identifying outdated data, redundancies, and inconsistencies and removing them. This will also lead to a more up to date catalogue of data, which can be used to drive innovation and improve decision making processes[48]. Further, information gathering processes can be optimised, which increases the reliability of data, better informing the development of an ICT mobility solution.

Recommendation: City officials must review and identify policies that are unnecessarily hindering the development of ICT mobility solutions and remove them.

City policies can restrict access to the mobility market because of outdated operational requirements (limits on licenses for new mobility services; varying regulations in different neighbourhoods) or pricing regulations like

[48] Andreas, Jonathan. 2019. "How the EU's new data laws will affect Smart City development". Accessed on 9.10.2019. Retrieved from: https://news.itu.int/eu-gdpr-smart-cities/

hindering dynamic pricing[49]. Such policies can slow or even prevent the introduction of new mobility solutions into a city like bike sharing, e-scooters, or car share schemes to name a few. Reviewing outdated laws and policies that unnecessarily hinder the rollout of new mobility solutions will make it easier for cities to develop, test, and implement innovative ICT solutions.

Information gathering

Gathering relevant and accurate data on travel patterns, user preferences and needs will be crucial in the development of an ICT solution. As previously mentioned, city partners have identified gathering information for developing an ICT solution as a challenge. A few recommendations have been identified that will help guide cities information gathering initiatives.

Recommendation: Conduct surveys or incorporate questions related to an ICT solution into other public transport surveys

Creating surveys for gathering information on user preferences, needs, and travel patterns will be helpful in creating a functional application. As previously mentioned, too many features may clutter an application and render it unusable. As a solution to this problem, surveys can help identify features that mobility users would like to use; in turn, this will help cities avoid unnecessary costs by developing features that are undesirable or not necessary. Further, existing transportation surveys can be updated with new questions regarding ICT solutions, therefore saving time and energy on creating a completely new survey.

Recommendation: Use cell-phone data to collect information on travel patterns and user feedback

Mentioned in the section on crowdsourcing information, cell phones can provide passive or active crowd sourced data revealing information that may be beneficial to cities, like identifying travel patterns or user preferences. As most people use smart-phones, it would be a good opportunity to gather active crowd sourced information like mobile surveys or customer feedback or passive data provided by cell-phone carriers, which can include location data revealing travel patterns. Like surveys, this will increase the quality of data used in developing an ICT solution.

Incentivizing the use of multimodal solutions

One of the main challenges faced by cities around the world is finding ways to incentivise the use of multimodal transportation options as an alternative to private car use. To compete with private cars, mobility applications supporting multimodality must be convenient, cost effective, and enjoyable to use. Given the convenience that comes with owning a car, providing a competitive alternative can be a challenging task. Therefore, this section focuses on recommendations that can be used to incentivise the use of mobility options.

Recommendation: Consider using a "gamification" feature to incentivise good travel behaviour

As previously mentioned, gamification is a feature being used by application developers to encourage the use of an application by rewarding "good" behaviour. For example, a mobile ICT solution could display a statistical breakdown

[49] Bannon, Eoin. 2018. "Integrating new mobility services in urban transport". Accessed on 9.10.2019. Retrieved from: https://www.transportenvironment.org/publications/integrating-new-mobility-services-urban-transport

showing the environmental impact of a users' travel patterns, highlighting areas where they can improve their transportation habits. Another example would be if a user chooses cycling or public transportation, then they can be rewarded with a point scheme for cheaper transportation fares. A social element could also be included that compares a user's environmental impact with a community of people, therefore encouraging environmentally friendly travel behaviour.

Recommendation: Consider initiating a marketing campaign to support alternative transportation methods

City marketing initiatives have been found to be effective methods to inform citizens about alternative forms of transportation. For example, in the Bay Area located in the United States, they have a "Spare the Air" day which provides city commuters a free day of public transportation to raise awareness about the harmful effects of private transportation[50]. There were two "Spare the Air" days in the Bay area one year, and it was found that public transport ridership increased 8.2% on those days, which amounts to an additional 40,000 riders[51]. Similarly, On September 22nd, cities across Europe participate in "Car Free Day", an event tied to Urban Mobility Week that raises awareness for urban mobility issues and encourages the use of sustainable transport options[52]. With mobile technology and the wide reach of social media marketing, such campaigns may be an effective way to encourage the use of an ICT solution.

Expanding Mobility Routes

Based on partner responses, route planning overwhelmingly favoured motorised transport routes. These routes include main roads, highways, or other means that allow for motorised transport. Even Google Maps, which can be argued as being one of the most accurate route planners, plans routes according to established roads. This leaves other routes like walking and cycling paths unused.

Recommendation: Cities should include cycling paths and pedestrian walkways in an ICT solution

The report found that pedestrian and cycling paths were underrepresented in route planning for ICT solutions. Adding such routes may increase the convenience of alternative transportation methods such as walking and cycling. Further, having cost free transportation routes may entice travellers to choose an eco-friendly option rather than private car travel.

Transparency and Collaboration

The report finds that several partner cities have some sort of private mobility service that is being used. Private companies are also being used in parts of the application development process including payment processing or integrating private mobility options into the public application itself. Cities need the technology developed in the private sector to help with the development of a mobility solution. Further, community members who will be using the application must be consulted and informed about the process. Therefore, the following recommendations focus on creating a transparent environment that encourages collaboration between all the stakeholders involved.

[50] Sorell, Miriam, L., June 2005. "Transportation Choices: Can Social Marketing make a difference?". Retrieved from: https://core.ac.uk/download/pdf/4398445.pdf
[51] Ibid.
[52] European Mobility Week. 2019. Accessed on: 14.10.2019. Retrieved from: http://www.mobilityweek.eu/

Recommendation: Cities should identify stakeholders involved in developing an ICT solution

Several different stakeholders have been identified through the report. Stakeholders can include public entities like local, regional or national officials; private companies and corporations; city dwellers and interest groups. In order to formulate a comprehensive plan, it would be beneficial for cities to identify relevant stakeholders in the development process and engage with them throughout the process to ensure that the end solution is meeting the needs of those involved.

Recommendation: Engage with private companies and collaborate on the development of an ICT solution

The report has identified several companies that are developing innovative solutions in the mobility market. Some companies may be developing new transportation options that could be integrated into a city. Further, it was mentioned that cities may have to partner with private companies and outsource services that they may not be capable of developing themselves, like payment processing or application maintenance. Therefore, it would be in the cities best interest to engage with these companies and openly discuss how they can work together to safely integrate mobility solutions into their city.

Annexes

Annex 1. Criteria catalogue for ICT travel planning solutions' functionalities

The criteria catalogue for functionalities **lists technological solutions available for promoting multimodality with ICT travel planning solutions**. The list seeks to inform about the different solutions used around the world[53]. It **helps officials to get ideas what kind of functionalities would be valuable to have in their city's or region's ICT solution to increase multimodality.** The document can be used to get ideas for creating a new ICT solution and for improving existing solutions.

It should be pointed out that the compiled list is not to demonstrate the "best-of". Value judgements to these functionalities are not given. Rather, different sorts of functionalities have been listed. Some are more thorough and technically complex than others. **It is important to remember that one size does not fit all** – officials should consider what are the real needs of a travel planning solution in their region and what is doable with the funds available. Sometimes less is more.

The catalogue for functionalities has been compiled based on data collected throughout the project. First, market research based on desktop review were conducted that mapped the state-of-the art ICT solutions globally. Second, cities.multimodal project partners were asked to fill in templates about their own regional travel planning solutions and needs related to such applications. 15 such templates were filled in and analyzed. Third, ten follow up interviews were conducted with project partners regarding travel planning applications. Additional data was also received from Technische Universität Berlin in the form of three interviews conducted with local experts regarding travel planning solutions available in Berlin. In total around 40 ICT solutions were identified while developing the criteria catalogue.

The catalogue for functionalities is a table containing three columns:

- **"Functionality"** is a general name given to a certain function. The functions have been categorized under specific themes: route planning, travel information, navigation, maps, travel planning, personalization, booking and payment, and other.
- **"Explanation"** contains the description of the function.
- **"Offered by"** lists some exemplary applications or websites that use/offer the functionality.[54]

[53] The list does not cover all apps used in every country but the ones that were brought out on the Internet and different documents as (good) examples. Also, apps used or noticed (e.g. during other projects, visits of other cities) by partners were mapped.

[54] As new solution providers might appear and old ones might change or be closed, it must be noted that the functionalities in the application might have changed over time. The main period of the desk research was between February 2018 and April 2019. The applications from project partners were gathered in March 2019. Some later additions were made in September and October 2019.

Table of functionalities that support multimodality

No.	Functionality	Explanation	Offered by[55]
Route planning			
1	**Route optimization**	Suggests the most favorable (fastest) routes to the selected destination.	CombiTrip, Citymapper, INRIX Traffic
2	**Price optimization**	Suggests the cheapest routes to the selected destination.	CombiTrip, Trafi, MinRejseplan
3	**Door-to-door planning**	Provides the user with all the door-to-door details and connections, e.g. maps with walking/cycling/driving/public transportation routes. The user can compare all travel options based on the entire itinerary from door-to-door.	*Various*
4	**Door-to-door planning with *via* points**	The user can add stops between the start and destination locations and mark how much time they would need at these points.	Reittiopas
5	**Separate to-and-from planning**	Searches for relevant itineraries based on the user´s preferences and any outbound and inbound journey can be combined, e.g. the user can depart by plane and return by train.	CombiTrip
6	**Automatic planning**	Enables automatic planning of trips between home, work or events in the calendar.	TripGo, MobiTime
7	**Timing filters**	Enables looking at routes through timing filters: leave now, leave by, arrive at.	*Various*
Travel information			
8	**Live travel information**	Real-time information on departures, schedule/platform changes, cancellations, congestions, accidents, weather conditions, roadworks etc.	*Various*
9	**Real-time arrivals**	Real-time arrivals taken directly from GPS devices positioned on buses and trains.	Moovit, Tartu bussiajad
10	**Traffic webcams**	User can see real time traffic camera footage.	MapQuest
11	**Detailed public transport information**	Offers detailed information about public transportation, e.g. which train to take, which platform, which direction and how to connect with other modes of transport.	*Various*
12	**Station facilities information**	Detailed information on which facilities each of the stations have.	PTV
13	**Offline timetables**	All timetable data is stored on the phone, so it can be used offline.	TripView
14	**Sends a timetable**	Sends a timetable list to the user´s email.	Resrobot
15	**Next departures**	Information on the next buses, trains etc. that depart from a specific station.	*Various*
16	**Countdown until departure**	Countdown mode until departure.	PTV, Tartu bussiajad

[55] The list is not exhaustive, these are just a few examples of applications that have such functionalities. *Various* indicates that it is a common feature. Mentioned application may not have all the functionalities described in column „explanations“, but just some of these.

17	**Reminders**	Reminders on the journey (including reminders of departure, stops, get-off alerts).	*Various*
18	**Number of stops**	Along with the name or number of the bus the app also tells you the number of stops along with where you need to get off.	*Various*
Navigation			
19	**Location finder**	GPS is used to pin-point the user's location after which a list of the nearest stations, sorted in order of increasing distance, is provided. This list will update as the user walks around.	TripView
20	**Using sensors**	Using sensors inside the user's phone, the system knows and shows which direction the user is facing, with the map turning as the user does.	Google Maps, HERE, Blekingetrafiken
21	**Indoor navigation**	The indoor localization system of the airport can be accessed through a smartphone. Generates optimal indoor paths and navigates users to security checks, boarding gates, points of interest, etc.	Dora
22	**Step-by-step directions**	Directions continually presented to the user in the form of spoken and visual instructions.	Google Maps, HERE, Trafi
Maps			
21	**Offline maps**	Maps are available when the user is offline or underground on the subway.	*Various*
22	**Interactive maps**	The user can create their own trip by clicking on a station/stop and customize exact change locations.	TripView, Jakdojade
23	**Vehicle position**	Click on a route to see the position of a public transport vehicle live on the map.	TripGo, FUTAR, Nysse, MobiTime
24	**Compatibility with Google/Apple maps**	The system is connected with Google Maps/OpenStreetMap/Apple Maps so that GPS navigation routes can be offered based on the user's location.	Traveline, FUTAR
Travel planning			
25	**Points of interest**	Displays a map of the surroundings, including points of interest, businesses etc.	Citymapper
26	**Information about destinations**	Displays information about hotels, restaurants, attractions, landmarks, etc.	Google Maps, MapsWithMe
27	**Sight-seeing route planner**	Depending on the selected timeframe the system generates various sightseeing routes, including how to get from one location to another by walking or public transportation.	Visitacity
28	**Parking assistance**	Presents a list of nearby parking lots and garages on the map. Some solutions also allow reserving, paying and adding more time for the parking through the system.	Google Maps, Rīgas satiksme, ParkChicago
Personalization			
29	**Movement preferences**	Enables the user to customize their travel, e.g. by selecting the maximum walking distance, walking speed, amount of transfers, etc.	Reittiopas, Nysse, Google Maps, VBB jump
30	**Setting preferred stops**	The system allows selecting favorite stops throughout the city instead of automatic optimization for a quick access to the user's favorite stops and stations.	PTV, Transit App, Moovit

31	**Integration with address book**	Integrates with the address book to enable quick travel planning to contacts.	PTV
32	**Calendar compatibility**	Connects with the user' s personal calendar and provides automatic trips, leave alerts and best connections.	TripGo
33	**Various cycling routes**	Presents different cycling routes, e.g. quiet, regular and fast.	Citymapper
34	**Save a trip**	Allows viewing the times for any trip saved beforehand with a single tap.	TripView, MobileMPK, MobiTime
Booking and payment			
35	**Pricing info**	Displays pricing information for public transport, taxis, tolls or car parks.	TripGo, Reittiopas, Google Maps, URBI
36	**Information about payment methods**	Informs the user about which payment methods are accepted on the given transport mode, so that the user could be better prepared for the trip.	MinRejseplan, Blekingetrafiken, Rīgas satiksme
37	**Ticket sales points**	Displays the locations (on a map) and working hours of ticket vending machines, ticket offices, customer service centers and other ticket distributors.	FUTAR, Rīgas satiksme, MobiTime
38	**Book tickets through provider**	Enables booking and purchasing of tickets by being redirected to the provider.	Qixxit, MinRejseplan
39	**In-app ticket payment**	Enables purchasing all tickets through one platform without being redirected.	Trafi, Reittiopas, Whim
Other			
40	**Open data services**	The system's data can be used to develop new services. The dataset is updated each week and it can be downloaded for free once subscribed.	Traveline, Blekingetrafiken
41	**Crowdsourcing**	Real-time traffic data is collected from users via crowdsourcing.	Moovit, Waze, INRIX Traffic
42	**Motivational statistics**	Shows the number of calories used, as well as trees and money a user has saved through planning the trip by more eco-friendly means of transport.	Citymapper
43	**Special needs**	Offers a wider set of functions to fully assist blind and visually impaired customers.	FUTAR
44	**Customer support**	Ability to contact with app provider/operator directly from the system or includes a direct link to customer support.	PTV, Reittiopas
45	**Accessibility**	The ICT solution can be accessed conveniently both from web browsers and mobile devices (Android, iOS).	*Various*

Annex 2. Template for individual travel planner IT solutions

The digital focus of the cities.multimodal project is on web- and mobile-based individual travel planner applications. Part of the task involves clarifying which solutions for individual travel planning already exist on the market. The main aim of this task is to compile model tender documents for individual travel planning applications (IT solutions) that cities can use while developing respective IT solutions. Additionally, it helps you to see whether and in which direction solutions used in your city/country could and should be developed to support multimodal transport.

We now ask you to use your local know-how and fill in the table below with information about **travel planner IT solutions used (or currently in development) in your city.**

Name of the IT solution	
Owner of the solution (Company name)	
Contacts (main contact person with e-mail, phone no, if possible or general contacts to get more specific information about the solution)	
Is it web- or APP-based or both?	
Website link (if available)	
Name of the app and link (if available)	

Please mark all options that are available in the travel planning solution (tick the box) and add any other functionalities or comments if needed.
Please also highlight if the functionality differs between the web-based solution and in the app (if applicable).

Route planning functions	☐ Route optimization ☐ Price optimization ☐ Door-to-door ☐ Separate to-and-from planning ☐ Automatic planning (*automatically plans trips between home, work and events in your calendar*)
Travel information	Live/real-time travel information on: ☐ arrivals and departures ☐ schedule/platform changes and/or cancellations ☐ congestions and/or accidents ☐ weather conditions ☐ roadworks ☐ Detailed public transport information ☐ Offline timetables ☐ Station facilities information ☐ Next departures (*Information on the next buses, trains etc. that depart from a specific station.)* ☐ Countdown until departure ☐ Reminders (*e.g. get-off alerts*) ☐ Number of stops

Navigation functions	☐ Location finder ☐ Indoor navigation (*e.g. in airports, trainstations*) ☐ Step-by-step directions (*continuous directions in the form of spoken or visual instructions*) ☐ Parking assistance (*list of nearby parking lots and garages*)
Map functions	☐ Offline maps ☐ Interactive maps (*create your own trip by clicking on a station/stop on a map*) ☐ Sensors turning the map (*the app knows which direction you are facing, with the map turning as you do*) ☐ Vehicle position
Travel planning functions	☐ Hotel information ☐ Restaurant information ☐ Attractions, landmarks information
Personalization functions	☐ Setting preferred stops ☐ Integration with your address book to plan a journey to your contacts ☐ Leave alerts based on calendar appointments ☐ Various cycling routes (*presents different cycling routes, e.g. quiet, regular and fast or based on altitudes*) ☐ Save a trip
Booking and paying system	☐ Pricing information ☐ Information about payment methods ☐ Ticket sales points ☐ Link to the transport provider ticket purchasing service ☐ In-app ticket payment
Geographical coverage	☐ Global ☐ Entire country ☐ Regional ☐ City ☐ District
Covered infrastructure	☐ Public roads ☐ Private roads ☐ Cycling paths ☐ Walking paths
Transport modes	☐ National public transport ☐ Regional public transport ☐ Local public transport ☐ Train ☐ Bus ☐ Trolleybus ☐ Tram ☐ Boat/ship/ferry ☐ On demand transport ☐ Car sharing ☐ Bike sharing ☐ Carpooling ☐ Taxi

Other noteworthy functions	☐ Open data services (*system's data is downloadable*) ☐ Facts that motivate multimodality (*e. g shows the number of calories used and trees and money a user has saved through multimodality and by planning the trip with the app.*) ☐ Crowdsourcing (*real-time data collected from users*) ☐ Special needs (*wider set of functions to fully assist blind and visually impaired customers*) ☐ Customer support
Are there any other functions not listed above?	
Is the IT solution connected with info terminals at mobility points/bus or train stations? How? *E.g. the same information is duplicated in the app and at an info terminal*	
Stakeholders *(please describe which parties have been involved in the development and maintenance of the system)*	
Costs for the owner *(please give the (estimate) figure of the costs related to maintenance of the system, like data update, maintaining the function, development of the system; initial investment, operation costs)*	
Costs for the user	
Potential for transferability/replicability in other cities *Please indicate the replicability of the solution in other cities and explain briefly your selection (consider technical issues, social, legal, economic etc.)*	
Weaknesses of the system	
Strengths of the system	
Cooperation demands *(i.e. in case where application owner is not the same as public transport organizer or different modes of transport are operated by different organisations and need to be integrated into one platform)*	
Related documents, graphs, pictures – **please provide links or as attachments** *Incl. studies about system requirements*	

Bring out some remarkable IT solutions that are used in **other** cities/ countries for travel planning. Why would you like to bring these out (functionality, etc…)? You can describe it shortly or fill table above about these IT solutions as well. *These examples can be used also during interviews to generate new ideas, validate the need for this kind of functionalities, etc.*

Annex 3. Template analysis overview

Functionalities	Available	Not available
ROUTE PLANNING FUNCTIONS		
Route optimization	11	4
Price optimization	8	7
Door to door	10	5
Separate to-and-from planning	9	6
Automatic planning	1	14
TRAVEL INFORMATION		
Live info on arrivals and departures	12	3
Live info on schedule/platform changes and/or cancellations	9	6
Live info on congestions and/or accidents	3	12
Live info on weather conditions	2	13
Live info on roadworks	3	12
Detailed public transport information	12	3
Offline timetables	10	5
Station facilities information	4	11
Next departures	12	3
Countdown until departure	6	9
Reminders	3	12
Number of stops	8	7
NAVIGATION FUNCTIONS		
Location finder	11	4
Indoor navigation	2	13
Step-by-step directions	4	11
Parking assistance	1	14
MAP FUNCTIONS		
Offline maps	5	10
Interactive maps	7	8
Sensors turning the map	4	11
Vehicle position	5	10
TRAVEL PLANNING FUNCTIONS		
Hotel information	1	14
Restaurant information	1	14
Attraction, landmark information	2	13
PERSONALIZATION FUNCTIONS		
Setting preferred stops	10	5
Integration with your address book	1	14
Leave alerts based on calendar appointments	0	15
Various cycling routes	2	13
Save a trip	5	10
BOOKING AND PAYING SYSTEM		
Pricing information	8	7
Information about payment methods	7	8
Ticket sales points	2	13
Link to the transport provider ticket purchasing service	3	12

In-app ticket payment	7	8
COVERED INFRASTRUCTURE		
Public roads	15	0
Private roads	10	5
Cycling paths	4	11
Walking paths	7	8
TRANSPORT MODES		
National public transport	7	8
Regional public transport	10	5
Local public transport	15	0
Train	9	6
Bus	15	0
Trolleybus	7	8
Tram	7	8
Boat/ship/ferry	7	8
On demand transport	2	13
Car sharing	1	14
Bike sharing	4	11
Carpooling	1	14
Taxi	2	13
OTHER FUNCTIONS		
Open data service	4	11
Facts that motivate multimodality	0	15
Crowdsourcing	0	15
Special needs	0	15
Customer support	5	10
GEOGRAPHICAL COVERAGE		
Global	0	-
Entire country	5	-
Regional	5	-
City	5	-
District	0	-