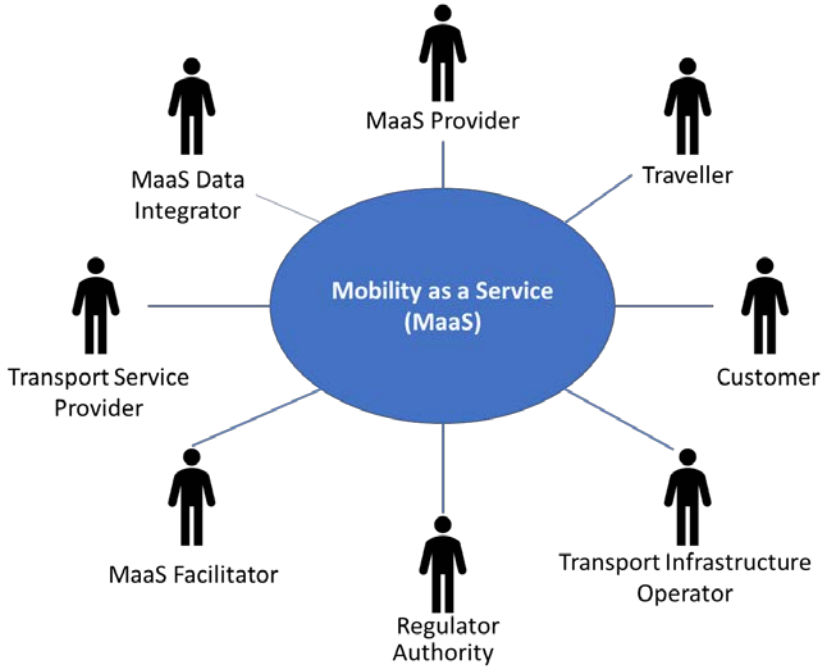

Report

Reference Architecture for Mobility as a Service (MaaS) - Stakeholder roles, motivations and use cases

A report from the project ReiseNavet

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SUMMARY
With Mobility as a Service (MaaS), a variety of transport services are offered to travellers as one integrated service via one App and with one payment. This report provides a reference architecture description for MaaS. It describes the generic stakeholder roles involved, their motivations for a change towards MaaS, and their use cases. The reference architecture aims to arrange for:

- Different types of MaaS. This includes MaaS provided by private and public actors, and MaaS with a variety of transport services.
- Modular and flexible composition of MaaS. The MaaS functionality can be provided by one or several stakeholders.
- Adaptation to new regulations and initiatives. These are addressing regulations and technical infrastructures for data sharing.

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Preface

This report has been prepared in the research project ReiseNavet, which has received funding from the Research Council of Norway (project number 296040).

Participants in the project have been Entur (project owner), Ruter, Kolumbus, Hertz, Hyre and Urban Sharing. The project owner (Entur) is established and owned by the Norwegian Ministry of Transport to manage transport related data. Entur also offers basic services like travel planning and ticketing on competition-neutral terms. The other project partners represent expertise within the provision of a variety transport services to the public, and some have also carried out trials of relevance to MaaS. The project has also taken advantage from good collaborated with MaaS expertise in ITS Norway and with relevant projects such as NOMAD (Nordic project on MaaS – see https://its-norway.no/prosjekter/nomad/), MaaS-Peer (international collaboration on data sharing and trust – see https://its-norway.no/maas-peer/), and MaaSeKOPP (national project on MaaS solutions and business models – see https://prosjektbanken.forskningsradet.no/en/project/FORISS/331961?Kilde=FORISS&distribution=Ar&chart=bar&calcType=funding&Sprak=no&sortBy=date&sortOrder=desc&resultCount=30&offset=0&TemaEmne.1=By&source=FORISS&projectId=329865).

This report describes the contextual parts of a reference architecture for a MaaS ecosystem. Project participants and others have contributed to the work through participation in workshops where relevant topics have been discussed, provision of input on stakeholder concerns and needs, and exchange of knowledge, experiences and relevant views related to MaaS. Some of the partners have also contributed with technical insight and expertise with respect to data formats, standardisation and services needed in MaaS.

1 Introduction

With Mobility as a Service (MaaS), a variety of transport services are offered to the traveller as one integrated service via one App and with one electronic payment paid via the App. The transport services provided may for example be public transport, on demand services like taxi, micro mobility, and shared cars. Travellers can use different combination of transport services on different journey, depending on needs.

MaaS can arrange for more sustainable transport, as the aim is to provide an easy and flexible mobility service that can replace private cars. With a successful implementation of MaaS, many people will not need private cars. This will reduce emissions, have positive effect on the urban environment (less traffic, less parking spaces, etc.), and be good for the public health through more use of active modes. MaaS can also reduce or remove car hold costs and troubles like parking problems, maintenance problems, etc. for citizens.

This report provides the contextual part of a reference architecture for the MaaS ecosystem. By reference architecture we mean an architecture description for MaaS in general and not for a particular MaaS system. A reference architecture is intended to work as a blueprint and a starting point for the system architecture description of individual MaaS systems.

The contextual part of the reference architecture described in this report aims to contribute to a common understanding of the MaaS ecosystem with respect to

- Who the stakeholders are and how they are involved
- What motivates the stakeholders for a participation in the MaaS ecosystem (drivers and goals), including the foreseen motivating effect of new European regulations and initiatives.
- Requirements from the perspective of the stakeholders derived from the above
- Use cases related to the stakeholders

2 Overall concerns

Mobility as a Service (MaaS) aims to provide a seamless integration of different transport services to travellers via one user interface and with one payment for the whole journey. The contextual part of the reference architecture must cover several concerns.

2.1 New regulations and initiatives

The MaaS reference architecture must adapt to existing and new regulations and initiatives that will influence the MaaS services and the related solutions. These regulations and initiatives are among others:

- **The ITS Directive (2010/40/EU) [1].** It identified data types to be shared as open data.
- **The Delegated Regulation (2017/1926/EU) [2].** It extends the ITS Directive and regulates mandatory and standardised data sharing via National Access Points (NAPs).
- **The approved Data Governance Act (DGA) [3].** It aims to increase trust related to data sharing, to strengthen the access to data both within and across sectors and countries, and to reduce the technical barriers towards data sharing and re-use of data. The sharing of governmental data that today are not shared as open data should be supported as well as the sharing of data from other sources (persons, businesses, etc.).
- **The Data Act proposal [4].** It aims for fair and interoperable data sharing of standardised data that makes data available to all and stimulates the data driven economy and data driven innovation. Data owners are obliged to share their data with authorities in case of emergencies, and system providers are obliged to provide data access to system owners and data owners. Furthermore, the regulation will prevent unconsented data transfer and ensure data portability when using cloud service providers.
- **The Multimodal Digital Mobility Services (MDMS) initiative [5].** This is about the de-regulation of products sales. Third parties should be allowed to re-sale public transport tickets. This will make it easier for commercial MaaS-providers to include public transport into their MaaS service.
- **The Mobility Data Spaces initiative.** The initiative is considered a strategic sector in the **Common European Data Spaces** initiative [6] defined in the European Strategy for Data. In parallel to the visions, strategies and measures proposed by EU, several private initiatives are now developing architectures and reference implementations of components in federated ICT infrastructure facilitating data discovery and sharing across sectors, regions, and countries. These initiatives include Gaia-X[1], International Data Spaces[2], the German Mobility Data Space[3] and Catena-X[4].

Appendix C describes a mapping between Data Governance and Data Acts and the MaaS stakeholder roles proposed in this report.

[1] https://gaia-x.eu/

[2] https://internationaldataspaces.org/

[3] https://mobility-dataspace.eu/

[4] https://catena-x.net/en/

2.2 Many perspectives

The MaaS reference architecture described in this report must take many perspectives into account:

- **Societal:** MaaS aims for more sustainable transport that takes the needs of travellers into account to that degree that the need for private cars is considerably reduced. Studies show potential effects of MaaS and that the car use can be reduced [7].
- **Business:** The search for viable business models is still an ongoing issue, especially for commercial MaaS providers.
- **Organisational/strategical:** The MaaS ecosystem includes many stakeholders, and national strategies, e.g. regarding the organisation of the data sharing, play an important role.
- **Technical:** The realisation of platforms for integration of data is emphasized. In addition, there is ongoing work on Mobility Data Spaces, a European technical infrastructure for fair and secure sharing of all types of data related to mobility.

2.3 Different MaaS service types

The MaaS reference architecture described in this report must support different types of MaaS services:

- **Different providers and content.** The MaaS may be provided by commercial and public actors and may include few or many types of transport services and modes. The business models may also differ between the different types of MaaS services (especially public and commercial).
- **Flexible organisation of MaaS.** The functionality needed (data integration, travel planner, booking, payment, etc.) can be provided by one or several actors. A MaaS provider may develop a complete system or build the MaaS service on top of generic, digital services provided by third parties.
- **Federated MaaS services.** All MaaS services have so far been non-federated - they cover just a limited geographical area, mainly cities. A federated MaaS services will facilitate roaming and can serve several geographical areas (e.g. cities, regions or countries) via the same App. Many prerequisites must be in place before federated MaaS services can be implemented, among others: Data on all MaaS services, transport services, transfer nodes, products, etc. must be harmonised and provided in standardised formats across all relevant geographical areas; the data must be shared as open data through a common ICT infrastructure, e.g. Mobility Data Spaces; and the contracts negotiations between MaaS Providers and Transport Service Providers must be established through automated procedures and standardised, electronic agreements.

3 Stakeholder roles

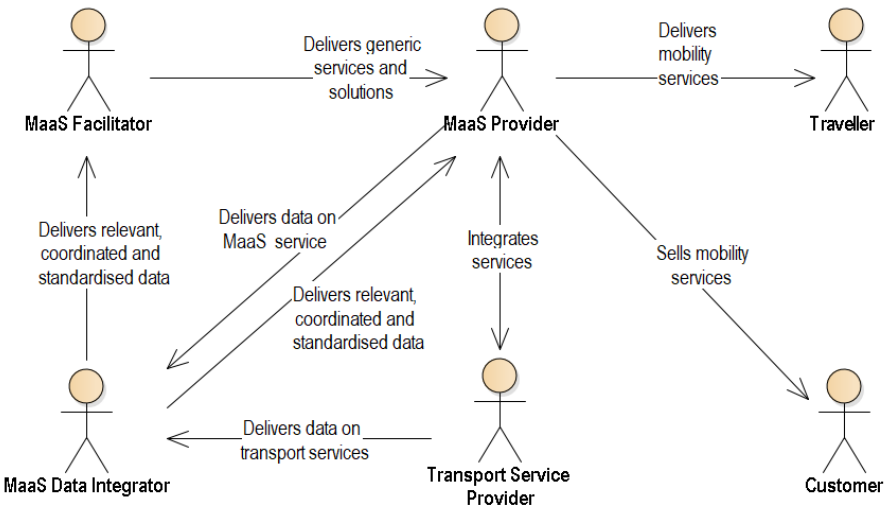

Figure 1 Relations between primary stakeholder roles

The MaaS ecosystem and the provision of MaaS services involve several actors. So far, there are no common definitions of these stakeholders, and the literature operates with different names and different definitions of the actors. ISO is working on standardised definitions, and ISO Technical Report 7878 [8] is used as input to the work described by this report. We have however identified a wider set of stakeholder roles needed in the MaaS ecosystem.

The roles defined in this report represent stakeholder archetypes with non-overlapping responsibilities. Figure 1 provides an overview of the main relations between the primary stakeholder roles. The roles are partly aligned with the ongoing work in ISO but are more detailed to arrange for modularity and flexibility. Annex B provides an overview of how the roles used in this report are related to the roles defined in ISO Technical Report 7878. Annex B also provides an example showing how the roles can be mapped to a selection of real actors in Norway. The roles are further defined in the sections below.

The use of generic, non-overlapping roles arranges for modularity and flexibility. The roles and the responsibilities represented by the roles can be fulfilled by different actors in the real world. One real actor may have one or more roles, and there may be several actors with the same role. Some examples (see definitions of the roles in the sections below):

- An actor with the MaaS Provider role may also have the Transport Service Provider role. This is for example the case if a public transport provider is a MaaS provider.
- Several actors may be MaaS Providers. They may cover different modes, areas, and regions, but the modes and geographical areas they cover may also partly or fully overlap.
- An actor with the MaaS Provider role may also be a MaaS Data integrator. This is the case if the actor collects and integrates data from one or more Transport Service Providers.
- Several actors may be MaaS Data Integrators, but there may also be just one, e.g. at a national level.
- Several actors may be MaaS Facilitators, and they may provide different types of solutions and services to MaaS Providers. A MaaS Facilitator may be a commercial service provider or a national entity providing national services, e.g. a national travel planner.
- An actor with the MaaS Provider role may also be a MaaS Facilitator if the actor develops its own solutions (travel planner, payment solutions, etc.).

- One actor may be both a MaaS Data Integrator and a MaaS Facilitator. Such actors may for example provide one or more generic services based on collected data.

3.1 Primary stakeholders

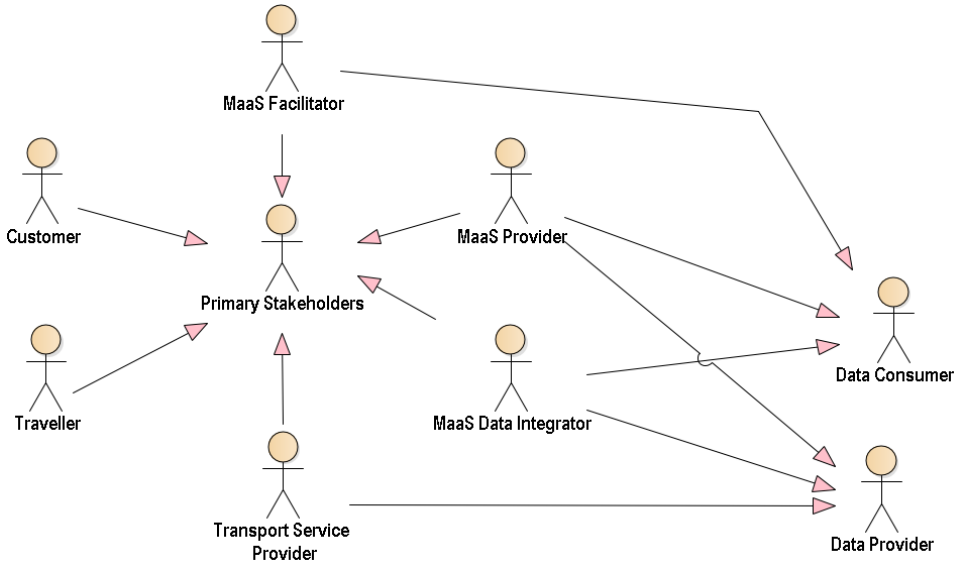

Figure 2 Primary stakeholders

Primary Stakeholders are depicted in Figure 2. They are directly involved in the MaaS solution, either as a user or as a provider of dedicated solutions or services targeting MaaS. The Primary Stakeholders are addressed by the motivation view in chapter 4 and the use cases in chapter 5. The overall relations between the roles are illustrated in Figure 1.

Traveller

A Traveller is a person with a mobility demand. Travellers need to travel from one location to another, and they may also have demands regarding the scheduling as well as preferences regarding price, quality, use of modes, etc.

Customer

A Customer pays for one or more Travellers' use of MaaS services.

MaaS Provider

A MaaS Provider delivers mobility services to Travellers, and should among others

- Package and deliver the transport services provided by Transport Service Providers as one service
- Allow Travellers to seamlessly select, pay for and use different types of transport services, through a single interface [9] [10]
- Offer Travellers an advanced travel experience and remove pain points related to travelling.

The MaaS Provider may deliver data on the MaaS service provided (e.g. to facilitate federated MaaS) to the MaaS Data Integrator and is a Data Provider (see 3.2).

The MaaS Provider depends on data from among others the MaaS Data Integrator/National Access Point (NAP) and is a Data Consumer (see details in these roles in section 3.2).

Transport Service Provider

A Transport Service Provider offers its transport capacity to the MaaS ecosystem, and the Travellers may choose to use the transport services they provide. By transport service we mean all types of transport

related services, such as transport with all types of modes as well as services like parking, and charging. The modes may for example be all types of public transport, on demand services like taxi, and new modes like micro mobility and car sharing. The Transport Service Providers of all modes should arrange for digital support for booking and payment, and for some modes there is also a need for digital verification of driver licences, keys-less access, digital insurance agreements, etc.

The MaaS Data Integrator provides data to the MaaS Data Integrator and is a Data Provider (see 3.2).

MaaS Data Integrator

A MaaS Data Integrator does technical integration of data and mediates data offerings from several Data Providers (see 3.2) to MaaS Providers and MaaS Facilitators (see below). The data integration must ensure the data quality and that the data are formatted according to standards. The data are provided via well defined (preferably standardised) interfaces.

The MaaS Data Integrator provides data to MaaS Provider and the MaaS Facilitator and metadata about the data to the National Access points (NAPs) (see 3.2) and/or ICT Infrastructure Providers (see 3.2) providing Mobility Data Spaces.

The MaaS Data Integrator uses data from Data Provider and is a Data Consumer (see 3.2).

MaaS Facilitator

A MaaS Facilitator provides services that support, facilitate and ease the establishment and provision of MaaS services. The MaaS Facilitator may provide generic services that can be used by several MaaS Providers, e.g. services supporting travel planning, booking and payment, and electronic business agreements.

The MaaS Facilitator may through the provision of services also generate or collect business related data, e.g. data on searches in travel planners, data on sales of products, data on the journeys accomplished, and data on the use of different transport services. Thus, the MaaS Facilitator may also provide data management services and value-added services to MaaS Providers, Transport Service Providers and Regulators (see section 3.3) based on these data, e.g. statistics, data on mobility patterns, etc.

The MaaS Facilitator depends on data from among others the MaaS Data Integrator and is a Data Consumer (see 3.2).

3.2 Secondary stakeholders

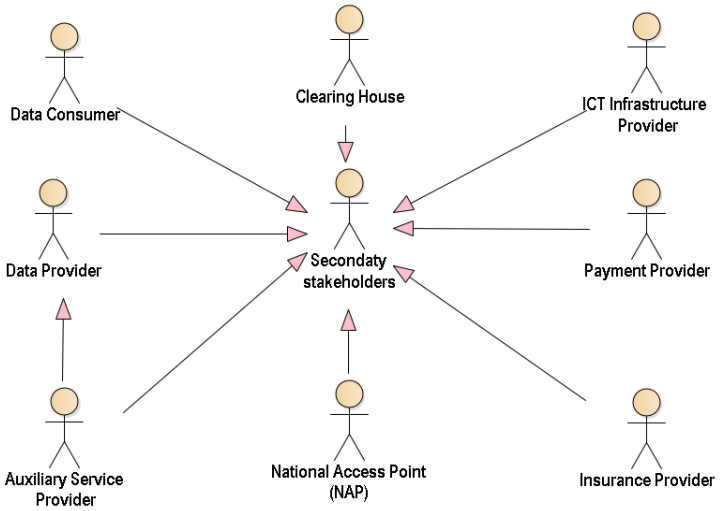

Figure 3 Secondary stakeholders

Secondary stakeholders are needed when MaaS is realised, but they provide generic services that are not adapted to MaaS. The secondary stakeholders are described to provide a more holistic picture of the MaaS ecosystem, but they are not further addressed by the architecture.

Data Provider

Data Providers deliver data of relevance to MaaS to the MaaS Data Integrator (see 3.1).

Data Providers may among others be

- Transport Service Providers – providing data about transport services.
- MaaS Providers – providing data about mobility services and products.
- MaaS Facilitator – providing business and/or mobility data and processed data) established from provided services. This may be data with or without access restrictions and commercial data for purchase.
- Auxiliary Service Providers - Providing data about offered services of different types of relevant to MaaS.
- Data providers in general providing data such as for example geographical data, meteorological data, and data on the transport infrastructure and traffic conditions.

Data Consumer

Data Consumers use the data provided by Data Providers and may discover the data through National Access Points (NAPs).

Clearing House

Clearing Houses support the financial clearing between actors involved in the MaaS ecosystem according to well defined settlement terms. The actors may for example be the MaaS Provider and Transport Service Providers.

Auxiliary Service Provider

Auxiliary Service Providers offer services via the MaaS ecosystem and may have a discount arrangement with the MaaS Provider. An Auxiliary Service Provider may for example provide

- Deliveries from for example libraries, grocery stores, restaurants and coffee shops.
- Discounts to events as a part of a MaaS product, e.g. for theatres and concerts.

Auxiliary Service Providers may share their data. Thus, they are a Data Providers (see above).

National Access Point (NAP)

A NAP is a portal facilitating access to *open data*. This is transport related data as described by the ITS Directive and the Delegated Regulation, as well as other open data. The NAP provides services for the discovery and information about the data as well as information about how the data can be accessed from Data Providers (see above).

Actors producing data may publish the data via NAP and provide the data (and thus be a Data Provider) via data repositories, or they may provide data via the MaaS Data Integrator (see 3.1). The latter might be the best solution to ensure the quality of the data and to ensure that the data comply with standardised formats.

ICT Infrastructure Provider

ICT Infrastructure Providers offer technical infrastructures and services needed in MaaS. This may for example be generic infrastructures and services such as communication infrastructures (e.g. Internet) and backend services (e.g. cloud services), as well as more specific services, for example:

- Mobility Data Spaces. Mobility Data Spaces is a European ICT infrastructure initiative providing access to *all types of mobility related data*, open data as well as commercial data and data owned by persons and entities and associated services aligned with a data use policy. At the moment, there is no commonly used Mobility Data Spaces in operation. Work on the design and implementation is however ongoing. Services for the discovery of and information about the data and how the data can be accessed from Data Providers will be provided (see above).
- Verification of driver licences. Transport authorities will provide services where the licences of Travellers can be verified. This is needed by some of the transport services provided via the MaaS service, e.g. car sharing.

Payment Provider

Payment Providers enable electronic payment transactions, e.g. when debit and credit cards are used, as defined by the Fare Management System (IFMSA) architecture [11].

Insurance Provider

Insurance Providers offer insurance services to Travellers (see 3.1) that choose to use a transport service where they operate shared or rented transport means (cars, city bikes, e-scooters, etc.). The Travellers may be obliged to enter digital insurance agreements via the MaaS interface when such transport services are used.

3.3 Tertiary stakeholders

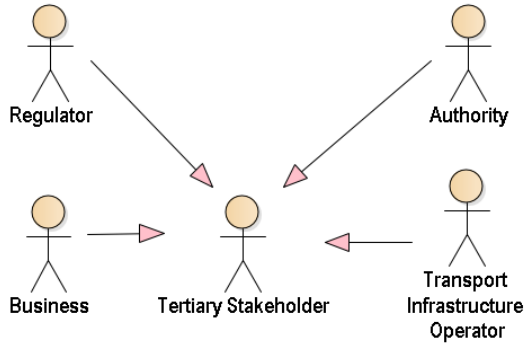

Figure 4 Tertiary stakeholders

Tertiary stakeholders influence MaaS through the definition of overall premises like political goals, conditions to be fulfilled, budget, etc., and through adaptation of transport infrastructure to MaaS. Infrastructures like transfer nodes (e.g. stations and stop pints) and parking areas for shared cars and micro mobility means may for example have an impact on MaaS. The tertiary stakeholders are not further addressed by the architecture as the interaction towards primary stakeholders in general is not digital.

Regulator

There may be several types of regulators. Regulators may be politicians and/or authorities at a local, regional and/or national level defining policies, strategies and goals and related regulations. Thus, Regulators will impact aspects of importance to MaaS such as for example the data sharing, the ability to re-sell products, priorities, economic issues, etc.

Authority

Authorities may be at local (city or municipality), regional (e.g. county) or national levels, and they are responsible for the implementation of the policies and strategies defined by the Regulator and also to some extent the enforcement and regulations. Depending on the governance structure, transport authorities are responsible for public transport and/or other transport services that may need a licence to

operate. Local or regional transport authorities may define the premises for public MaaS Providers and/or Transport Service Providers operating in their governance area (see 3.1).

Business

A Business may be the owner of a private MaaS Provider and may define the premises for the commercial operation (see 3.1).

Transport Infrastructure Operator

Transport Infrastructure Operators are responsible for the planning, establishment and/or operation of transport infrastructures needed in MaaS, e.g. mobility stations for integration of first/last mile transport services with other transport services (e.g. public transport), parking areas for micro mobility means, and infrastructures for soft modes (e.g. bike lanes and pedestrian areas). Depending on the type of infrastructure (e.g. public or private), Transport Infrastructure Operators may for example be local authorities or residential developers.

4 Motivation view

The motivation view provides an analyse of the main primary stakeholder archetypes with respect to

- Drivers motivating to a change towards MaaS
- Assessments of the current situation with respect to the drivers
- Goals with respect to MaaS.
- Requirements derived from the above.

ArchiMate motivation diagrams are used along with textual descriptions of the elements. Annex A.1 provides a description of the notation used.

4.1 Drivers

Drivers that are associated with a stakeholder are often called “concerns” and represent the interests of the stakeholder. A driver motivates the stakeholder to a change towards participation in the MaaS ecosystem.

Unique drivers per role were initially identified through workshops with relevant stakeholders. There are however similarities between the drivers across the roles, and a set of harmonised drivers were identified based on the input. Figure 5 provides an overview of these harmonised drivers/overall concerns for the primary stakeholder roles. Some drivers are common to all Primary stakeholders, others are more specific.

Table 1 provides a description of the details linked to the drivers for each stakeholder roles. The drivers for Traveller and Customer are combined into one column.

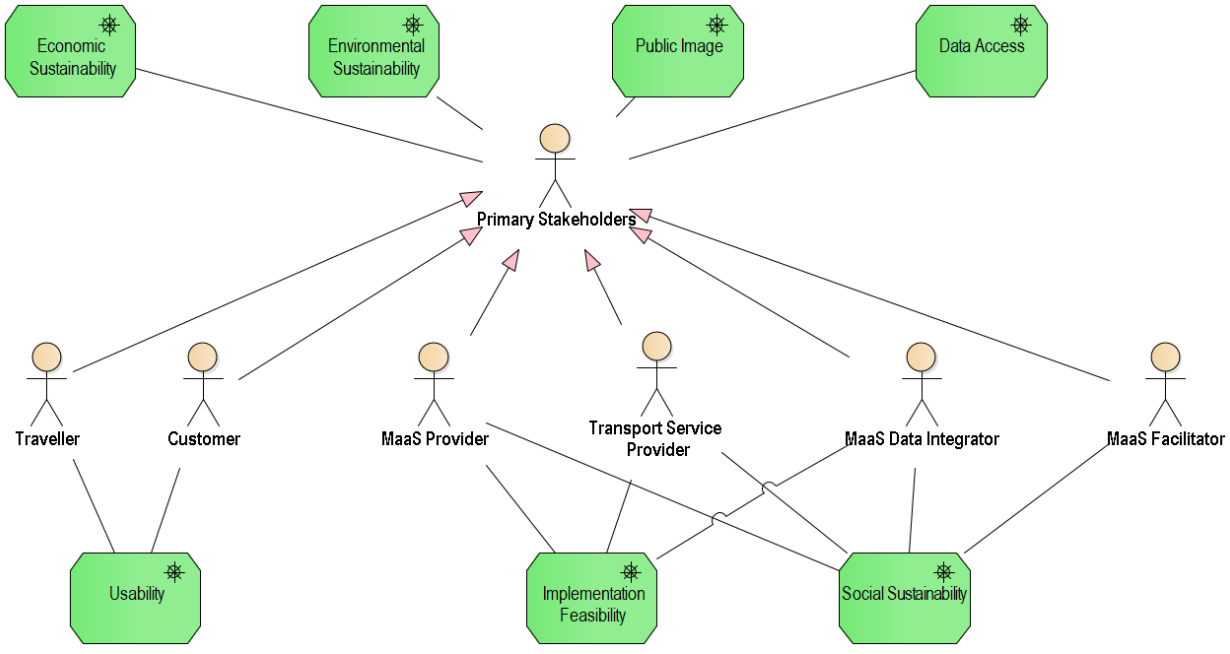

Figure 5 Drivers motivating for a participation in a MaaS ecosystem

Table 1 Drivers for stakeholder roles

Driver	Customer/Traveller	MaaS Provider	Transport Service Provider	MaaS Data Integrator	MaaS Facilitator
Economic sustainability	• Cost reduction due to no need for private car • Ability to avoid "lock-in" product. Not just public transport but a good price on a variety of modes.	• Commercial actors: Ability to get return of investment and cost coverage • Ability to reach new customer groups • Willingness to pay for the services offered • Ability to re-sell products provided by others	• Commercial actors: Profitability, return of investment and cost coverage included • Ability to reach bigger markets and new customer groups • Cost-efficiently integration into several MaaS • Ability to trust fairness when trips are assigned, and income is shared	• Cost-efficient integration of data • Commercial actors: Market/Willingness to pay for the services offered	• Commercial actors: Ability to get return of investment and cost coverage • Commercial actors: Market/Willingness to pay for the services offered • Ability to access data in a cost-efficient way
Social Sustainability	• NA	• Public actors: Fulfilment of transport policies • Ability to support mobility for all • Ability to support several areas (urban, rural, local, regional, …) • Ability to bridge transport silos	• Ability to be a part of something "bigger" than own services	• Ability to integrate data of relevance to MaaS and to the society • Ability to offer data needed by a variety of MaaS Providers and others	• Ability to offer services needed by a variety of MaaS Providers and others • Ability to offer generic services useful for several types of MaaS
Environmental sustainability	• Being green is a desire • Green image is a desire	• Reach customers through green service offerings	• Reach customers through green service offerings	• Ability to offer data promoting green transport	• Ability to offer services promoting green transport
Usability	• Ability to get support for easy and flexible mobility • Ability to easily find, book and pay for a variety of transport service options depending on needs • Less hassle with no private car				

Driver	Customer/Traveller	MaaS Provider	Transport Service Provider	MaaS Data Integrator	MaaS Facilitator
Implementation Feasibility		• Manageable to implement viable business models • Manageable to develop and offer attractive services • Manageable to build the competence needed	• Manageable data sharing • Manageable to implement digital integration into MaaS • Ability to integrate with federated MaaS solutions	• Ability to request the use of standards	
Data Access	• Private data must be protected and not misused • Ability to access own data	• Ability to access and use relevant data of sufficient amount, type and quality, suitable for MaaS • Willingness to share data	• Ability to deliver data in a cost-efficient way • Ability to trust that data is handled correctly and according to agreements	• Willingness to share data • Availability of standards for easy integration of data • Regulations ensuring data access • Ability to offer relevant data, new modes included	• Ability to get easy and cost-efficient access to data needed in solutions/services • Common formats bridging transport silos
Public image	• Being trendy - use of new and green modes	• Ability to maintain an image that generate more customers • Ability to offer green and trendy service • Positive appreciations due to reliability • Ability to measure and show effects of MaaS • To be trustworthy and fair • To be transparent regarding how potential conflicts are handled	• Ability to be a part of popular/trendy mobility services	• Positive appreciations due to provision of reliable data • To be trustworthy with respect to the data management and governance	• To be recognized as a provider of reliable and good services • To be trustworthy and fair with respect to the fairness of the services provided • To be transparent regarding how potential conflicts are handled

4.2 Assessments

This section provides supplementary descriptions for the motivation view, giving a more detailed assessment of the current status regarding the drivers in section 4.1. We also provide assessments of the architectural concern on new regulations and initiatives listed in section 2.1.

There is one sub-section for each stakeholder role. Some assessments are related to multiple drivers. In such cases, the full assessment description is provided only for the first driver, and brief references to the full description are given for the other drivers. The assessments are tagged to indicate the source for the information provided:

- WS - Workshops: The assessment is based in input from participants in internal workshops
- EX – Experts: The assessment is based on input from experts in the area of MaaS (dedicated through meetings and workshops). The input is mainly related to business models, regulations and technical solutions for the data integration.
- LI – Literature: The assessment is based on input from scientific literature. References are provided.
- PR – Related projects: The assessment is based on input received from collaboration with other projects and initiatives, mainly the international MaaS-Peer project on trust related to data sharing and the Nordic NOMAD project on international data sharing and federated solutions.
- GN – General knowledge: The assessment is based on facts.

4.2.1 Assessment for Customers and Travellers

Assessment of the current status

Drivers	Assessments (with relevant tags indicating the source – see above)
Economic sustainability	• **Expensive to be a car owner (GN):** The expenses related to car hold are high (purchase, engine, parking, insurance, taxes, etc.). In cities, there are also other types of cost, e.g. time use, and trouble related to parking of the car. • **Expensive to mix individual transport services (LI):** Flexibility is expensive if you do not have a car. When you pay for one product, e.g. public transport, you may be "locked-in" with that product for a period. If you want to use other products and modes in addition (e.g. car rental and micro mobility), you have to pay extra [7].
Usability	• **Need knowledge on how to travel in advance (WS, LI):** For many Travellers it is a barrier to find and use new travel options. Thus, they use the options they already know about, even though there might be better alternatives. It may not be easy to find the best option, and if they find new options, the Travellers must know how to pay, and perhaps also download and use new Apps. Trials may however contribute to a behavioural change towards use of MaaS [12]. • **Transport services are not coordinated (WS, GN):** If the use of several modes is required, and if you want to travel long distances, Travellers quite often have to search for, plan, book and pay for the individual legs of a journey. Some travel planners are multimodal and advanced, but new modes and modes like car sharing may not be included, and payment may not be supported for all modes. • **Deviations cause difficulties (WS, GN):** Deviations in one leg of a journey, may put extra burdens on the Travellers. They may have to figure out the consequences for the total journey, and when the possibility to reach succeeding legs is affected, Traveller may have to find alternative routes or new departures, and handle related tasks (cancellations, re-booking, payments, etc.). • **MaaS Apps are local (WS, GN):** Today, Travellers have to use a variety of Apps when they travel across countries, regions and cities. It would be a benefit if they could use the same App in the same way "everywhere".
Environmental sustainability	• **Easy to use private car (WS, LI):** Due to many of the barriers mentioned above (expensive to get flexibility through combinations of different services, lack of knowledge on new travel options and how they can be used, difficult to handle deviations, etc.) many people think they cannot manage without a car. Trials do however show that MaaS may reduce the use of private cars [7].

Drivers	Assessments (with relevant tags indicating the source – see above)
	• **Wish to cope without a private car, but this is not possible for many citizens (LI):** Many people wish to cope without their own car. They may for example be concerned about the environment, they may think it is too expensive, or they may think that it is trendy to not have a car. Despite of this, they really need or think they need the flexibility provided by a ca and do not realise that there are options that may work [7].
Data access	• **Extensive data sharing (GN):** Today, data is shared with individual Transport Service Providers via their Apps. In addition, data is also extensively shared with providers of social media and actors like Google, and these actors have probably a good overview of the mobility patterns.
Public image	• Wish to cope without a private car, but this is not possible for many citizens (LI) – see above.

Assessment regarding new regulations and initiatives

See references to the regulations and initiatives in section 2.1.

Multimodal Digital Mobility Services (MDMS) initiative and new regulations (WS, LI, EX): With a de-regulation of ticket sales, Travellers/Customers may get more channels where they can buy tickets for public transport.

Data Governance Act and Data Act and Mobility Data Spaces initiative (LI, WS): With extended data sharing via Mobility Data Spaces, Travellers may get access to federated MaaS services that makes it easier to travel across regions and boarders, and they may use their favourite App "everywhere".

MaaS Solutions may collect a lot of data about Customers and Travellers. The following measure in the Data Governance Act can be considered an enabler for this:

- Measures to facilitate data sharing, in particular to make it possible for data to be used across sectors and borders, and to enable the right data to be found for the right purpose.

With the realisation of mobility data spaces as envisioned by EU, it is important that the privacy of personal data associated with Customers and Travellers is protected, that the data intermediaries administering the data spaces can be trusted, that proper consent management is implemented, and that data sovereignty is ensured. These concerns are addressed by the following measures in the Data Governance Act and Data Act:

- Measures to ensure that data intermediaries will function as trustworthy organisers of data sharing or pooling within the common European data spaces (Data Governance Act)
- Measures to make it easier for citizens and businesses to make their data available for the benefit of society (Data Governance Act)
- Put in place safeguards against unlawful data transfer without notification by cloud service providers (Data Act).

4.2.2 Assessment for MaaS Providers

Assessment of the current status

Drivers	Assessments of current status (with relevant tags indicating the source – see above)
Economic sustainability	• **Economic vs social/environmental sustainability (WS, PR):** Public MaaS Providers aim to fulfil transport political goals, e.g. goals regarding the urban environment. It is a concern that commercial MaaS providers mainly may focus on economic gains and have less focus on environmental and social sustainability. **Regulations affects business models (PR, LI, EX):** Some countries, e.g. Finland, has already de-regulated ticket sales, and public Transport Service Providers are obliged to open for re-sales of a minimum set of products [13]. Other countries have hybrid solutions where products are sold via a central unit, and MaaS Providers

Drivers	Assessments of current status (with relevant tags indicating the source – see above)
	must have agreements with the central unit to be able to re-sell products. **Lack of viable MaaS business models (WS, LI, EX):** In general there are three business scenarios: Market-driven, public-controlled, and public-private, with advantages and disadvantages [9]. The value proposition varies between different types of MaaS (MaaS for urban areas, suburban areas, rural areas, and national/international MaaS) [14] and between public and commercial MaaS Providers. Public MaaS Providers must adapt to a budget, and they have to contribute to a fulfilment the transport policies. For commercial MaaS Providers, it has been a challenge to find viable business models. The Travellers' willingness to pay has not to a sufficient extend ensured sufficient return of investment and cost coverage. • **New possibilities in combining transport services (WS, EX):** MaaS providers that also provide a transport services, see opportunities in extending their own service, e.g. with services for first/last mile. Commercial MaaS providers not providing own transport services, see business opportunities in integrated services for Travellers.
Social Sustainability	• **Challenging to include all modes in MaaS (EX, GN):** As mentioned above, MaaS with a diversity of transport options offers flexibility to the Travellers. This may be beneficial to the society and the environment as it reduces the need for private cars. The establishment of such an ecosystem is however a challenge. Today, the use of different modes is usually supported by dedicated Apps, and not so often included in a good way in multimoded travel planning services of relevance to MaaS. • **Public transport and new modes may be regulated at different levels (WS):** Political and regulatory issues regarding transport services vary between countries, and MaaS providers have to adapt. Public transport may for example be managed at a regional level while micro mobility mainly is managed by cities/municipalities. • **MaaS has not replaced private cars (LI, WS):** Travellers think they need the flexibility provided by a private car. Trials do however show that MaaS with a diversity of transport options offers flexibility and may reduce the need for private cars [7] [15]. MaaS has however so far not succeeded with respect to this at a large scale.
Environmental Sustainability	• Challenging to include all modes in MaaS – see above • MaaS has not replaced private cars – see above.
Implementation feasibility	• **Challenging to establish MaaS (WS, EX, PR, LI):** MaaS is demanding for many reasons. More knowledge is needed regarding business models. The implementation of good MaaS services requires knowledge and skills: The integration of on-demand transport is for example not straight forward; it is challenging to support one payment for all transport services used; and it is challenging to meet political goals, and to convince citizens about that they do not need private cars. The MaaS community may benefit from more collaboration and knowledge sharing through both formal and informal networking activities [10]. • **A federated MaaS is not possible (EX, PR):** Today, MaaS Providers cover a specific area or a limited set of transport services. The MaaS App cannot be used for other areas or other transport services in general. A federated Maas will require access to standardised data across cities, regions and countries. The ITS Directive and the Delegated Regulation regulate the sharing of certain data types. Standards are also defined, data on new modes included (in an extension to Transmodel[5]). The regulations are however not completely implemented yet (should be in 2023). Data on on-demand transport are for example not commonly shared. The access to data is not sufficiently harmonised across regions and countries, and contractual issues are too demanding when they must be negotiated with and customized to different Transport Service Providers.
Data Access	• **Data are not available from all Transport Service Providers (EX):** The data sharing has traditionally targeted public transport. Transport Service Providers providing commercial on-demand services are to a little degree sharing data today. • **Mistrust in MaaS (PR, EX):** Some Transport Service Providers are not willing to share data due to a lack of trust regarding how the data can be used. They fear among others • Exposure of business secrets. • Misuse of data, e.g. that competing transport services are established based on insight provided by the data. • Unfair assignment of tours, e.g. that the MaaS Provider will prioritise use of their own transport services or greener modes. Transport Service Providers in traditional modes (e.g. taxi) are more reluctant to join MaaS than Transport Service Providers in new modes (e.g. micro mobility). Usually, MaaS ecosystems do not include competing

[5] https://www.transmodel-cen.eu/

Drivers	Assessments of current status (with relevant tags indicating the source – see above)
	Transport Service Providers. There is for example just one provider of city bikes, one provider of e-scooters, etc. • A federated MaaS is not possible – see above.
Public image	• **MaaS functionality is not yet perfect (WS, EX):** Travellers need the flexibility provided by private cars. Thus, MaaS Providers should combine different types of services. This is not the case for most MaaS-solutions today, and the solutions do not in general support one payment for all transport services. More knowledge is also needed on the price models to use. • **MaaS is considered to be an instrument for sustainable transport (GN, EX):** In general, MaaS is considered as beneficial to both the society and the environment. Thus, MaaS Providers will have a good public image as long as they deliver what they promise. • Mistrust in MaaS – see above.

Assessment regarding new regulations and initiatives

See references to the regulations and initiatives in section 2.1.

Multimodal Digital Mobility Services (MDMS) initiative and new regulations (WS, LI, EX): A de-regulation will make it possible for third parties to re-sell public transport products. This may pave the way for federated MaaS services as tickets from any transport service provider may be sold via the MaaS service.

From commercial MaaS Providers' point of view, a de-regulation has several advantages and may facilitate more viable business models, but there are also challenges. The following thoughts are addressed by the micro mobility provider TIER [16]:

- A re-sale public transport from the micro mobility Apps will be beneficial since 20-50 % of the trips and 67% of the tickets are combinations with public transport. The travellers can get more value.
- The choice regarding which App to use should be taken by the travellers.
- The sale of public transport tickets via third party Apps may increase the use of public transport and reduce the car use, and all parties may increase their revenue.
- There are technical challenges as many ticket solutions do not have open APIs.
- All sales must have identifiers to support the financial settlements between the actors.

For public MaaS Providers there are however many questions and challenges. They may get more competition and they may lose contact with travellers. Questions raised by VDV, the Association of German Transport Companies [17] are:

- Who should have access to the customers and to data on sales and use of transport services?
- Should actors that have not paid for investments also get a share of the revenue?
- Should public transport providers not be entitled to choose their sales channels, where to sell which tickets, conditions for sales, and the extend of B2B collaboration?
- Will commercial MaaS Providers arrange for sustainable transport to the same degree as public MaaS Providers?
- How deep should the integration be? Should third parties provide information and a link to a Web-side for ticket sales, should they provide information and booking via a link, or should they provide a complete platform where the tickets are sold?
- Who should have the responsibility for customer support in case of deviations?
- Which tickets should be sold where?
- How much should the sales channel (i.e. the third party) be paid?

Additional thoughts are also provided at workshops:

- A de-regulation may reduce the influence of the public transport providers and thereby also reduce the ability to use MaaS as an instrument for fulfilment of the transport policy. It might become more difficult to affect the mobility in a desired way.
- Due to the above, regulations that ensure sustainable transports must be established.
- A de-regulation may cause a reorganisation of the public transport sector. The need for regional public transport authorities might be reduced as their role will be reduced. They might be replaced by a national public transport authority. It will however still be a need for local knowledge on transport needs and local adaption.
- A de-regulation may not solve all problems, and there are still uncertainties about the business models. MaaS is very challenging, and small, commercial MaaS Providers might not have the capacity and knowledge needed.

ITS Directive and the Delegated Regulation (LI, WS): When the regulations are fully implemented (according to the plan this should be in 2023), more data and standardised data will be available from MaaS Data Integrators as Transport Service Providers and others will share more data in a standardised way. MaaS Providers may discover data via National Access Points (NAPs) or via a Mobility Data Spaces and thereby get access to a variety of data. However, there may for some time be data quality issues, and the data may not be completely harmonised across regions and countries, and all data needed for federated MaaS services will not be available, e.g. data on products and prices, and data supporting electronic agreements.

Data Governance Act and Data Act and the Mobility Data Spaces initiative (LI, WS): The implementation of the Data Governance and Data Acts, and the sharing of data via Mobility Data Spaces will increase the ability to find and get access to standardised and harmonised data on mobility issues across Europe. This may facilitate the provision of federated MaaS services. The Mobility Data Spaces initiative is however not yet sufficiently mature, and the technical infrastructure needed must be implemented.

MaaS Providers must also prepare for data sharing, e.g. the sharing of data on mobility patterns, use of product, etc. The following measure in the Data Governance Act can be considered an enabler for this:

- Measures to facilitate data sharing, in particular to make it possible for data to be used across sectors and borders, and to enable the right data to be found for the right purpose.

MaaS Providers will through the MaaS service they provide collect a lot of data about Customers and Travellers. It is important that the privacy of personal data is protected, as described in section 4.2.1.

4.2.3 Assessment for Transport Service Providers

Assessment of the current status

Drivers	Assessments (with relevant tags indicating the source – see above)
Economic sustainability	• **Costly to integrate in MaaS (WS, EX):** The integration into MaaS may put extra costs on the Transport Service Provider. They have to implement the required data sharing, and they have to negotiate and enter contracts with the MaaS Providers and/or public entities (e.g. city/municipality). If they will integrate into several MaaS ecosystems, it is beneficial if they can share data in a similar way for all. • **More competition if not in MaaS (WS, EX):** Transport Service Providers may fear that a MaaS (which they are not a part of) will increase the competition, especially if the MaaS includes transport services that are in direct competition with their own services. • **New possibilities in combination with other services (WS, EX):** Transport Service Providers, especially those representing new modes, may see MaaS as a business opportunity. In combination with other transport services they may reach new customers, e.g. by providing first/last mile services. They may also become more visible as a contributor to sustainable transport.

Drivers	Assessments (with relevant tags indicating the source – see above)
	• **Marketing is a challenge (WS, EX):** Marketing might be a costly and challenging task. By joining MaaS, Transport Service Providers will get access to a new market channel.
Social Sustainability/ Environmental sustainability	• New possibilities in combination with other services - see above.
Implementation Feasibility	• Costly to integrate in MaaS - see above
Data Access	• **Concerns about data access (WS, EX, PR):** By joining MaaS, the distance to the users might become longer, and some Transport Service Providers fear less direct contact with the users (Travellers), and thus reduced access to data on user needs, market opportunities, and changes in trends. This might reduce their capability for adaptation to new possibilities and trends. • **Concerns about data sharing (WS, EX, PR):** Data sharing has a cost, but due to regulations many Transport Service Providers have to share their data. Among those that do not share data today, e.g. many providers of traditional on-demand services like taxi, there is a fear that the data sharing may expose business secrets and reduce the competitional power. Data is considered as a valuable asset that should not be shared. There is a lack of trust regarding how the data will be used.
Public image	• New possibilities in combination with other services – see above • **Brands might be less visible (WS. EX):** By entering MaaS, the visibility of the brands of the Transport Service Providers might be reduced. The Travellers will know the MaaS Provider and be less informed about the Transport Service Providers. Providers of micro mobility services are less concerned as they also intend to operate in parallel with the MaaS service, and their brands will be visible on their micro mobility means.

Assessment regarding new regulations and initiatives

See references to the regulations and initiatives in section 2.1.

Multimodal Digital Mobility Services (MDMS) initiative and new regulations (WS, LI, EX): The transport service providers must open up their sales channels to arrange for bookings from third parties. This also applies for public transport providers. According to TIER [16], this might be challenging for among other some public transport providers. Their ticket solutions are not sufficiently open. Collaboration is needed on APIs, product types, and solutions.

ITS Directive and the Delegated Regulation (LI, WS): More transport service providers than today will have to share their data, and the data must be formatted according to standards defined in the regulations.

Data Governance Act and Data Act (LI, WS): The Transport Service Providers may share more data than today, and they may also benefit from data shared by others, e.g. MaaS Providers.

4.2.4 Assessment for MaaS Data Integrators

Assessment of the current status

Drivers	Assessments (with relevant tags indicating the source – see above)
Environmental sustainability	• **Data on greenness are not provided (EX):** Data on the greenness of transport services are not provided.
Social sustainability	• **Data sharing is regulated (EX):** In some countries, e.g. Norway, there is one, national MaaS Data Integrator that ensures the publication of quality assured and harmonised data in a standardised way.
Economic Sustainability	• **Cost efficient data sharing is challenging (EX):** The integration of data on all types of transport services as well as other related data is a challenge. Different approaches can be followed, it is however recognised

Drivers	Assessments (with relevant tags indicating the source – see above)
	that data preferably should be delivered according to standards. Several standards are available. The quality of the data must also be ensured.
Data Access	• **Many different Data Providers (EX):** Data on public transport may be delivered in a professional way by public transport entities in regions or cities. Other Data Providers may have varying qualifications. The Data Providers may for example be small or large Transport Service Providers. • **National access points and data repositories (EX):** Some countries, e.g. Norway, have a central data repository where the data are managed in a professional way and represented in accordance with common/standardised formats. • **Shared data are partly standardised (EX):** The ITS Directive and the Delegated Regulation regulate the sharing of certain data types. The standards and the data sharing has traditionally targeted public transport, but standards are now also defined for new modes (in an extension to Transmodel), and the Delegated Regulation defines requirements regarding the use of standards. The data and the standards may however not cover all aspects needed, and the data quality may vary. Schedules for on-demand transport may for example be estimated based on an assumed routes and not aligned with actual routes, and the availability of resources (e.g. cars) ahead in time may not be available. The regulations are not completely implemented in all countries (to be done by 2023). Data on new modes and on-demand transport are for example not commonly shared, and data are shared in different ways. The data integration strategy and availability vary between countries. Some countries requires that all data are harmonised and delivered according to well defined standards. In other countries, transformations of data might be required. Access to the following data types is for example needed or desired: • Data on transfer nodes (stations, stop points, terminals, etc.). Such data are in some countries harmonized to provide a common reference for all transport services. Duplicates must also be removed. • Planned routes and schedules for scheduled transport services. Such data is to a large extend harmonized and standardised within countries. • Data on on-demand services (micro mobility and shared cars included). • Real-time data from transport services. Such data is to a large extend harmonized and standardised within countries. • Product data, including prices. The prices are quite often missing. • Capacity utilisation • **Concerns about data sharing (WS, EX, PR):** As described in 4.2.3, the Data Providers may have concerns regarding data sharing, and that might affect the access to data. • **A federated MaaS is not possible (EX, PR):** As mentioned in 4.2.2, MaaS providers cannot offer a federated MaaS that covers several areas/countries and transport services in general. The data provided by MaaS Data Integrators are today not sufficiently harmonised across regions and countries, and contractual issues are too demanding when they must be customized to different Transport Service Providers.
Public image	• **MaaS Data Integrator may not be trusted (EX, PR):** As mentioned above, some Data Providers have concerns regarding the sharing of data. Thus, the MaaS Data Integrator must clearly define the purpose and use of the data, and the data must be shared with well-defined conditions. The Data Provider must not be responsible for any unintended use of the data.

Assessment regarding new regulations and initiatives

See references to the regulations and initiatives in section 2.1.

Multimodal Digital Mobility Services (MDMS) initiative and new regulations (WS, LI, EX): Information on products and prices will have to be shared.

ITS Directive and the Delegated Regulation (LI, WS): More data will be available by 2023. Data Provider may provide the data directly to a National Access Point (NAP) or via a MaaS Data Integrator, and the MaaS Data Integrator can publishe the data.

Probably there will be data quality issues, and the data may not be completely harmonised across cities, regions and countries. The data must also be coordinated. Data on the transport services must for example

link to a common dataset defining all transfer nodes (stations, stops, etc.) in an area, probably a country, to cover long distance transport services.

It is very demanding to arrange for quality assured and harmonised data, and some countries (e.g. Norway) have a national MaaS Data Integrator with the dedication and expertise are needed.

Data Governance Act and Data Act and Mobility Data Spaces(LI, WS): The Mobility Data Spaces initiative may in the future provide a Europe-wide infrastructure for data sharing, and the Data Governance and Data Acts may lead to the sharing of new types of data. The MaaS Data Integrator may play an important role regarding the preparation of data before the sharing (cleaning, formatting, quality checking, etc.). The MaaS Data Integrator may provide metadata input to Mobility Data Spaces, and may also manage and provide access to the data content. The enhanced data sharing through Mobility Data Spaces will arrange for federated MaaS services.

4.2.5 Assessment for MaaS Facilitators

Assessment of the current status

Drivers	Assessments (with relevant tags indicating the source – see above)
Economic sustainability	• **Lack of knowledge and resources among potential MaaS Providers (WS, EX):** MaaS Providers may come in many shapes, and they may not have the resources and expertise needed for the development of the complete MaaS functionality. Thus, they may want to use generic software products and services supporting travel planning, booking, payment, financial settlements, et. provided by third parties – MaaS Facilitator. In this way, MaaS Providers can focus on how to support to the Travellers. Some countries have developed core functionality/services at a national level, e.g. national travel planners, but MaaS building blocks can also be delivered by commercial actors. This approach may make the establishment of MaaS feasible for more MaaS Providers.
Social Sustainability	• Lack of knowledge and resources among potential MaaS Providers – see above. • **Lack of standards expressing policies and strategies (EX, PR):** Generic services and solutions developed for re-use must be able to support a variety of policies and strategies. Thus, it must be possible to configure the services/solutions, for example with respect to rules regarding priorities. The expression of such rules is mot standardised today.
Environmental sustainability	• Lack of knowledge and resources among potential MaaS Providers – see above. • Lack of standards expressing policies and strategies – see above.
Data Access	• **Data are not available from all Transport Service Providers (EX):** The ITS Directive and the Delegated Regulation regulate the sharing of certain data types. Standards are also defined for the sharing of data, data on new modes included (in an extension to Transmodel). The regulations are however not completely implemented yet, data on new modes and on-demand transport are for example not commonly shared. Data are shared in different ways. The data sharing has traditionally targeted public transport. Transport Service Providers providing commercial on-demand services are to a little degree sharing data today.
Public image	• **Some common services are highly appreciated (WS, EX):** National travel planners are commonly used, and payment solutions are requested.

Assessment regarding new regulations and initiatives

See references to the regulations and initiatives in section 2.1.

Multimodal Digital Mobility Services (MDMS) initiative and new regulations (WS, LI, EX): MaaS Facilitator may play a role in the provision of generic services for third party sales of tickets, public transport tickets included.

ITS Directive and the Delegated Regulation (LI, WS): More data will be available, and this may open for the provision of new services and products. The MaaS Facilitator may make it easier for MaaS providers to provide value added services based on new data.

Data Governance Act and Data Act (LI, WS): The MaaS Facilitator may provide services and solutions that makes it easier to implement federated MaaS services based on available data and to provide services that fulfil new data sharing requirements.

4.3 Goals and Requirements

Section 4.1 provides and overview of the drivers for a change towards MaaS for the main stakeholder roles, and section 4.2 makes assessments of the current state with respect to the drivers and also with respect to new regulations and initiatives. Based on analysis of drivers and the assessments, this section provides

- Goals regarding how to fill gaps and meet the drivers. A goal represents achievements that are essential for the MaaS ecosystem, as seen from the perspective of the different stakeholder roles.
- Requirements stating needs that must be fulfilled.

Below, there is one sub-section describing the goals and requirements for each stakeholder role. ArchiMate motivation diagrams are used along with textual descriptions, and Annex A.1 provides a description of the notation used.

4.3.1 Goals and requirements for Travellers/ Customers

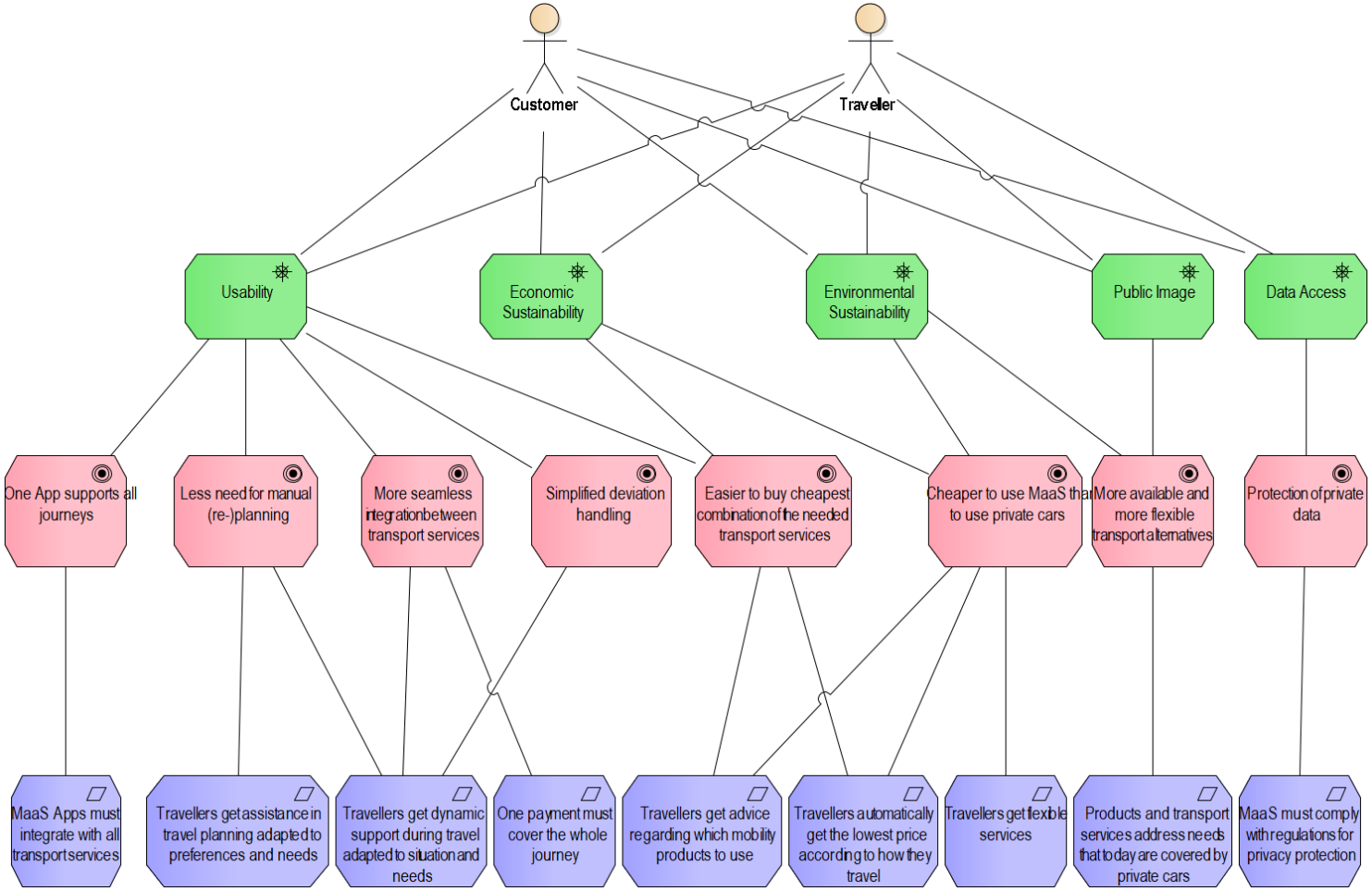

Figure 6 Goals and requirements for Travellers/ Customers

One App supports all journeys

- **MaaS Apps must integrate with all transport services.** MaaS Apps should be able to find the relevant transport alternatives and to support the Traveller on "all" journeys in Europe.

Less need for manual (re-)planning:

- **Travellers get assistance in travel planning adapted to preferences and needs.** When the mobility demand Is explained, the system should suggest transport alternatives that are aligned with the preferences.
- **Travellers get dynamic support during travel adapted to situation and needs.** In case of deviations, the Traveller must be notified, and alternative ways to cope with the deviations should be presented, and the use of the selected transport alternative should be supported.

More seamless integration between transport services:

- **One payment must cover the whole journey.** The Traveller should be able to pay for the whole journey (and all the transport services used) in one payment transaction via the MaaS App. It should not be necessary to have the individual Apps for each transport service.
- **Travellers get dynamic support during travel adapted to situation and needs**. See above.

Simplified deviation handling:

- **Travellers get dynamic support during travel adapted to situation and needs**. See above.

Easier to buy cheapest combination of the needed transport services:

- **Travellers get advice regarding which mobility products to use.** The products must be adapted to the mobility needs, and it must be easy to understand the price models, and the prices of the different transport services must be shared and easy to take into consideration.
- **Travellers automatically get the lowest price according to how they travel.** It must be easy to get the lowest price and the price model must facilitate flexibility .
    - Travellers should not have to know how and to which degree they will use of different transport services in advance to be able to buy the best product. The system should switch to a more advantageous product if this is the best option based on the use pattern.
    - Products should not cause a "lock-in" where the Travellers pays for the use of just one services over time (e.g. public transport) and where it is too expensive to extend the use to other services.
    - For normal citizens/families, it must be considerably cheaper to use MaaS than to own a private car. Less use of parking spaces, reductions in emissions, and a contribution to a better urban environment should be compensated.

Cheaper to use MaaS than to use private cars:

- **Travellers get flexible services.** Several alternative transport services should be offered to provide flexibility. Products should not restrict the Traveller to use of just one or a few modes.
- **Travellers get advice regarding which mobility products to use.** See above.
- **Travellers automatically get the lowest price according to how they travel.** See above.

More available and flexible transport alternatives:

- **Products and transport services address needs that today are covered by private cars.** MaaS should integrate a variety of transport services to arrange for the same flexibility that can be achieved through the ownership of private cars. Products must also arrange for flexibility and not

limit the Traveller to the use of just one or a few transport service types. Products must also support families and other groups of Travellers.

Protection of private data:

- **MaaS must comply with regulations for privacy protection:** MaaS must comply with legal frameworks such as GDPR on privacy issues, the Data Governance Act on the sharing of data, and (if approved) the Data Act which will ensure everyone access to their own data.

4.3.2 Goals and requirements for MaaS Providers

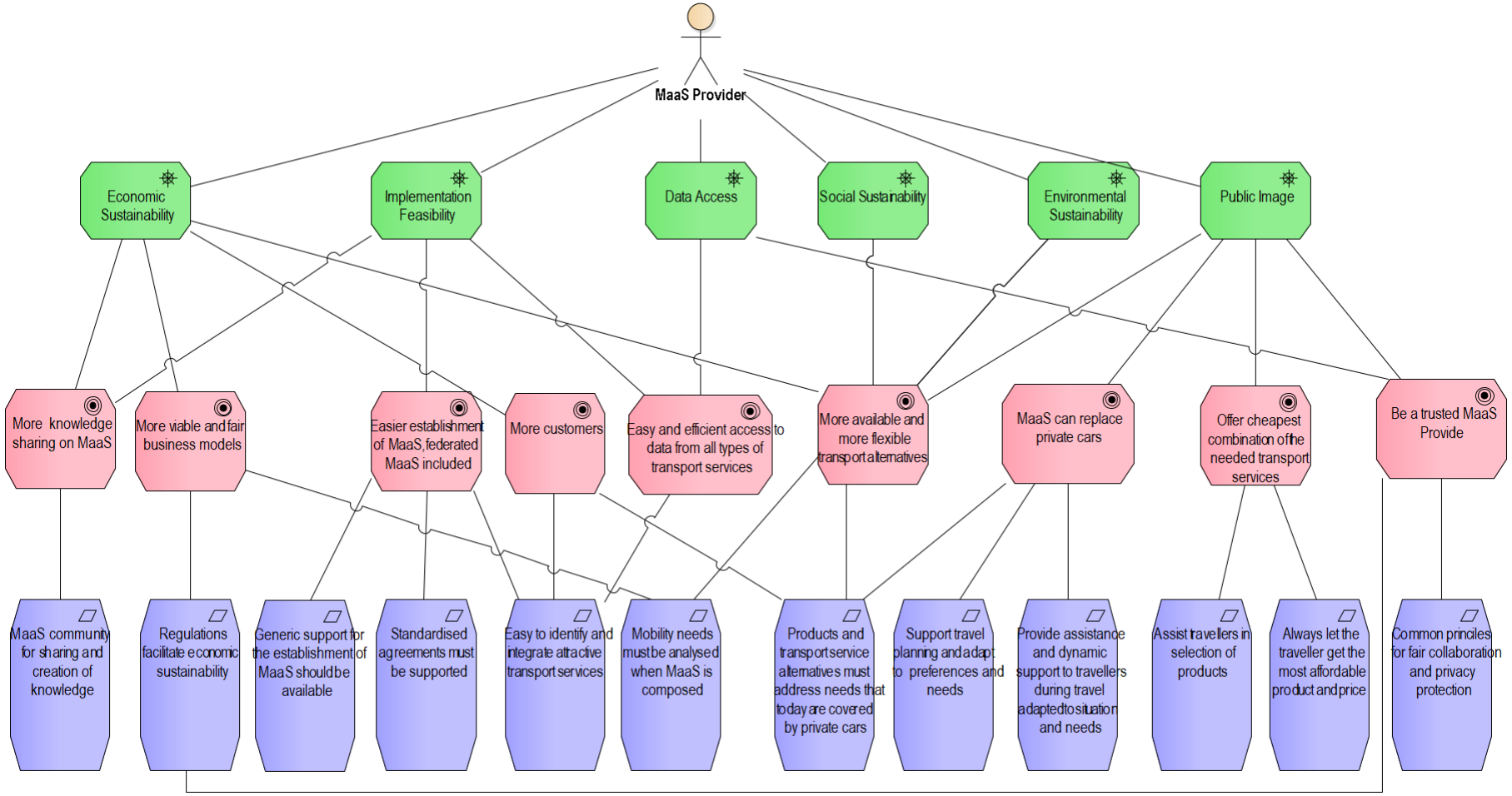

Figure 7 Goals and requirements for MaaS Providers

More viable and fair business models

- **Regulations facilitate economic sustainability:** Regulations must be used as an instrument to promote environmental and social sustainable transport as well as economic sustainability for all parties involved. Transport Service Providers must see benefits in MaaS integration, and the ability for commercial MaaS Providers to re-sale products from third parties must be considered. Re-sellers of public transport might however have to comply with local/regional/national regulations and policies to ensure that commercial MaaS providers also take environmental and social sustainability into account.
- **Mobility needs must be analysed when MaaS is composed:** To make MaaS an attractive service, data on current and historical use of transport services, mobility patterns and the market must be analysed carefully when MaaS is planned to guide the selection of transport services, products and prices. Such data might in the future be available through Mobility Data Spaces.

More knowledge sharing on MaaS

- **MaaS community for sharing and creation of knowledge:** Transport authorities, MaaS providers and potential MaaS providers, transport service providers and researchers should meet and share knowledge on MaaS and how MaaS can contribute to all types of sustainability.

Easier to establish MaaS, federated MaaS included:

- **Generic support for the establishment of MaaS should be available:** Digital services and software from third party experts providing core functionality needed in MaaS should be available to potential MaaS Providers. This will ease the establishment of MaaS and ensure technical solutions of high quality. Such services/solutions can be provided by commercial and/or public actors to fuel the MaaS establishment processes.
- **Standardised agreements must be supported:** It must be possible to offer transport services from "everywhere". It is however not possible for the MaaS Provider to negotiate contracts in traditional ways with all Transport Service Providers. Thus, it must be possible to define and share standardised information from the Transport Service Providers on conditions, products, prices and economic settlements, and to enter online agreements on the re-selling of transport services
- **Easy to identify and integrate attractive transport services:** Federated MaaS must be supported. Data on "all" available transport services (scheduled, on demand, micro mobility, charging, parking, etc.) in "all" regions and countries must be available via NAP and shared via mobility data spaces in standardised ways through standardised APIs. This includes data on:
    - Transport services details. This includes planned routes and schedules for scheduled transport services, real-time data, data on products and prices, and data on related services (charging, parking, etc.)
    - Transfer nodes (stations, terminals, stop points, etc.), cleaned and harmonised across modes and service types. The data on the transport services must link to the common data on transfer nodes.

  In addition, it must be possible to book these services. If regulations allow re-sales, it must also be easy to integrate and re-sale public transport.

More customers

- **Easy to identify and integrate attractive transport services:** See above.
- **Products and transport service alternatives must address needs that today are covered by private cars:** MaaS Providers must be obliged to contribute to a fulfilment of transport policies. Their contributions to sustainable transport must be regulated. They must provide flexibility to the Travellers through the integration of different types of transport services, and it must be easy to

use (book, pay for, get support in case of deviations, etc.) the service. The products must also arrange for flexibility. The use of several services must not cause disproportionate prices.

Easy and efficient access to data from all types of transport services

- **Easy to identify and integrate attractive transport services**. See above.

More available and more flexible transport alternatives

- **Products and transport service alternatives must address needs that today are covered by private cars.** See above
- **Mobility needs must be analysed when MaaS is composed.** See above.

MaaS can replace private cars

- **Products and transport service alternatives must address needs that today are covered by private cars.** See above.
- **Support travel planning and adapt to preferences and needs:** The MaaS system should suggest transport alternatives that are aligned with the preferences and needs.
- **Provide assistance and dynamic support to travellers during travel adapted to situation and needs:** The MaaS system should notify the Traveller in case of deviations, and alternative ways to cope with the deviations should be presented, and the use of the selected transport alternatives should be supported.

Offer cheapest combination of the needed transport services

- **Assist travellers in selection of products:** It must be easy to understand the price model and it must be easy for the traveller to select the most affordable product.
- **Always let the traveller get the most affordable product and price:** The price must be fair, and the price product must be defined by the transport services actually used by the Travellers. If another product than the one selected is more affordable, the system should automatically switch to the most affordable product.

Be a trusted MaaS provider

- **Regulations facilitate economic sustainability.** See above.
- **Common principles for fair collaboration and privacy protection.** The MaaS Provider must have strategies for and be transparent about the protection of data about the travellers.
  The MaaS Provider must also have strategies for and be transparent about fair collaboration with Transport Service Providers, including
    - The presentation of transport alternatives to the Travellers (which alternative is listed first, which alternatives are included/not included, etc.)
    - Assignment of tours if there are several competing Transport Service Providers in the MaaS (e.g. several providers of e-scooters).
    - Strategies for the sharing of revenue and income.

4.3.3 Goals and requirements for Transport Service Providers

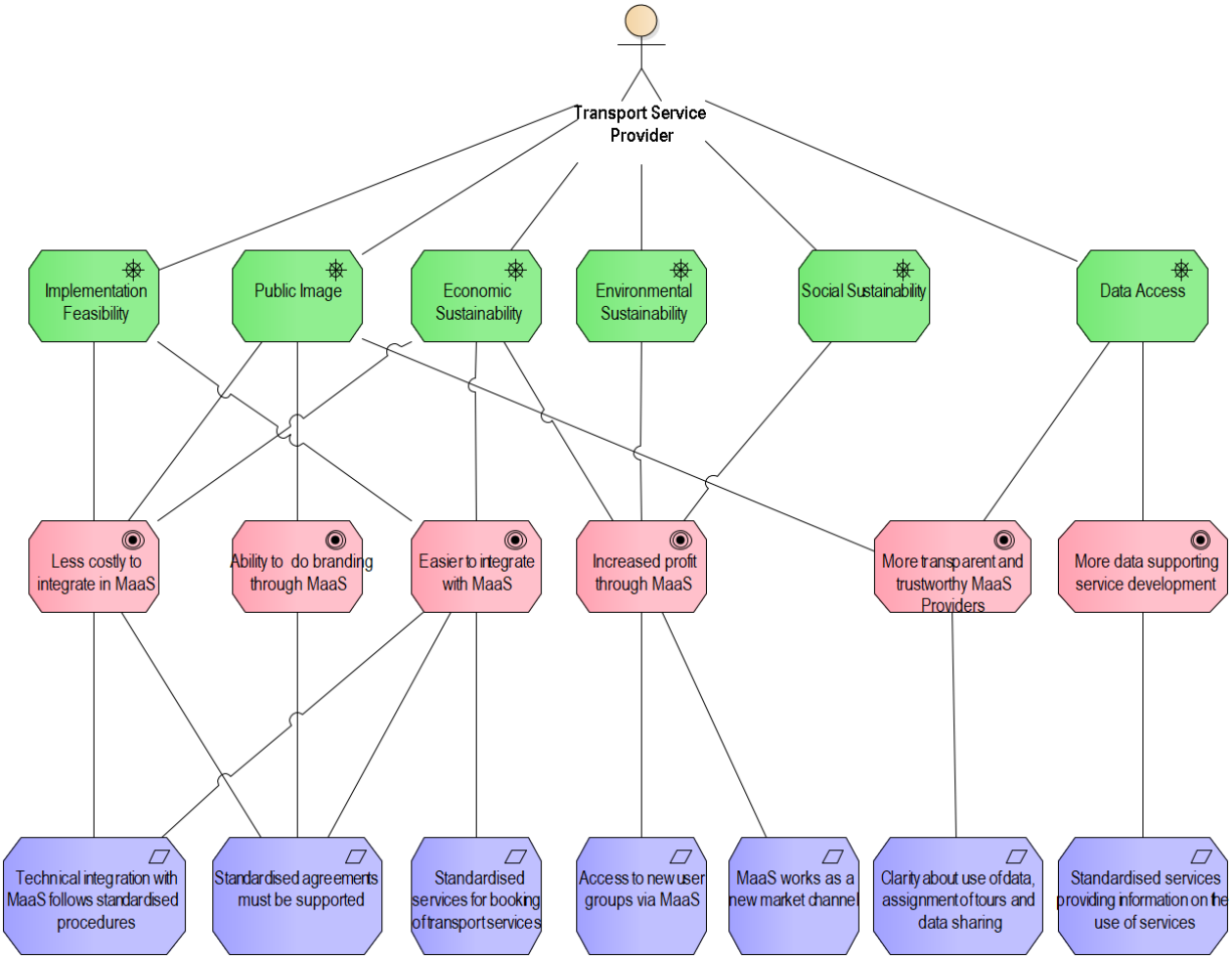

Figure 8 Goals and requirements for Transport Service Providers

Less costly to integrate in MaaS

- **Technical integration with MaaS follows standardised procedure:** It is easy to integrate with MaaS, and the integration with all MaaS Providers can be done in the same way. When integrated in one MaaS, a Transport Service Providers can easily integrate with another MaaS. Thus, the costs are reduced.
  The required data must be published via the NAP and made available to the MaaS Data Integrator using standard data formats. If the MaaS Data Integrator is a centralised unit used by all MaaS Providers, this can be done one time for all.
- **Standardised agreements must be supported:** To facilitate easy and efficient business agreements, the Transport Service Provider should prepare for the use of standardised and electronic agreements with MaaS Providers, providers of federated MaaS included. The Transport Service Provider may for example pre-define the conditions to be used for the collaboration in federated MaaS in a standardised way, e.g.
  - The price to be paid from the MaaS Provider to the Transport Service provider for use of the transport service (e.g. price per tour, per time unit, or per meter).
  - Payment details (when to pay, where to pay, advance payment, etc.)

- Branding conditions
- Contact information

Ability to do branding through MaaS

- **Standardised agreements must be supported.** See above.

Easier to integrate with MaaS

- **Technical integration with MaaS follows standardised procedures.** See above.
- **Standardised agreements must be supported.** See above.
- **Standardised services for booking of transport services:** The booking of transport services must be supported in a standardised way when this is relevant. The standardised booking must support booking information such as location (station, stop point, etc.), time (departure or time slot for shared use of transport means), documentation needed for verification of certificates (driver licence, etc.), and confirmations (e.g. regarding acceptance of condition and insurance).

Increased profit through MaaS

- **Access to new user groups via MaaS:** MaaS should help the Transport Service Provider to get access to new user groups, e.g. users that today are using private cars and users that need first/last mile services in combination with other services. The MaaS Provider should discuss such opportunities with the Transport Service Providers.
- **MaaS works as a new market channel:** MaaS should work as a market channel for attractive transport services. When transport alternatives are presented, attractive services should get users.

More transparent and trustworthy MaaS Providers

- **Clarity about use of data, assignment of tours and data sharing:** MaaS Providers should offer agreements where the following is made clear:
  - Rules regarding how the data provided by the Transport Service Provider will be used
  - Rules regarding how the data provided by the Transport Service Provider will not be used.
  - Rules for the financial settlements (how much the Transport Service provider will be paid, how the payment will be calculated, minimum payments, etc.).
  - Rules regarding how a growth/reduction in the number of travellers will benefit/disadvantage the MaaS Provider and the Transport Service Providers.
  - Rules for the presentation of transport alternatives to the Travellers (which alternative is listed first, which alternatives are listed/not listed, etc.)
  - Rules for assignment of tours if there are several competing Transport Service Providers in the MaaS (e.g. if there are several providers of e-scooters and the travellers want an e-scooter).

More data supporting service development

- **Standardised services providing information on the use of services:** The Transport Service Provider will in MaaS loose some of the contact with the Travellers as the bookings are handled by the MaaS Provider. Thus, The Transport Service Provider must get data on the use of transport from the MaaS Provider, preferably more data than they can get today, e.g. data on the previous and succeeding leg, data on the popularity of the service compared to other services, and user categories.

4.3.4 Goals and requirements for MaaS Data Integrators

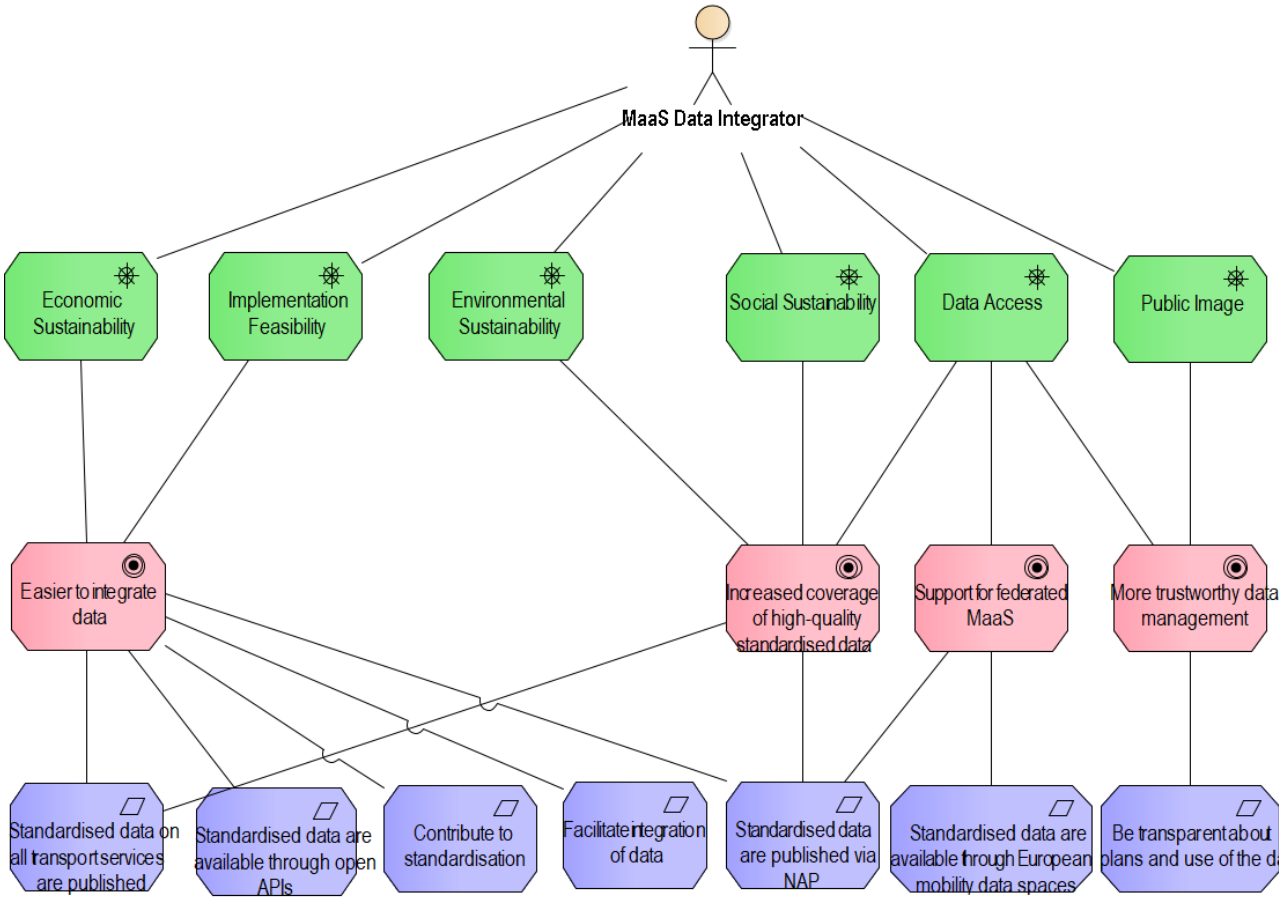

Figure 9 Goals and requirements for MaaS Data Integrators

Easier to integrate data

- **Standardised data on all transport services are published:** Data on all types of transport services (scheduled, on-demand, micro mobility, car sharing, etc.) should be published. Both planned schedules and real-time data should be published. The data must be:
    - Published in a standardised way.
    - Washed. Duplicated data must be avoided. Responsibilities must be defined to ensure that the same data are not publish by several MaaS Data Integrators.
    - Harmonised. A common set of transfer nodes (stations, stop points, terminals, etc.) must be defined, and data about these transfer nodes must be published in a common and standardised way, without duplicates. The data about the transport services should whenever this is relevant be linked to the transfer nodes.
- **Standardised data are available through open APIs:** The data should be published via well-defined APIs supporting the needs of the data users.
- **Contribute to standardisation:** Some MaaS Data Integrators may contribute to standardisation activities related to the data needed in MaaS.
- **Facilitate integration of data:** Transport Service Providers and other providers of data must be supported to ensure that data of good quality are delivered according to standards.
- **Standardised data are published via NAP:** Metadata describing the published data should be published via the NAP.

Increased coverage of high-quality data

- **Standardised data on all transport services are published.** See above.
- **Standardised data are published via NAP.** See above.

Support for federated MaaS

- **Standardised data are published via NAP.** See above.
- **Standardised data are available through European mobility data spaces:** In the future, European mobility data spaces may be implemented and offered as an infrastructure for data sharing.

More trustworthy data management

- **Be transparent about plans and use of the data:** The MaaS Data Integrator must manage the data in a fair and transparent way. All data must be handled equally with respect to quality assurance and publication. APIs must also support access to all types of data. Transport Service Providers must get the support they need to deliver data of good quality.

4.3.5 Goals and requirements for MaaS Facilitators

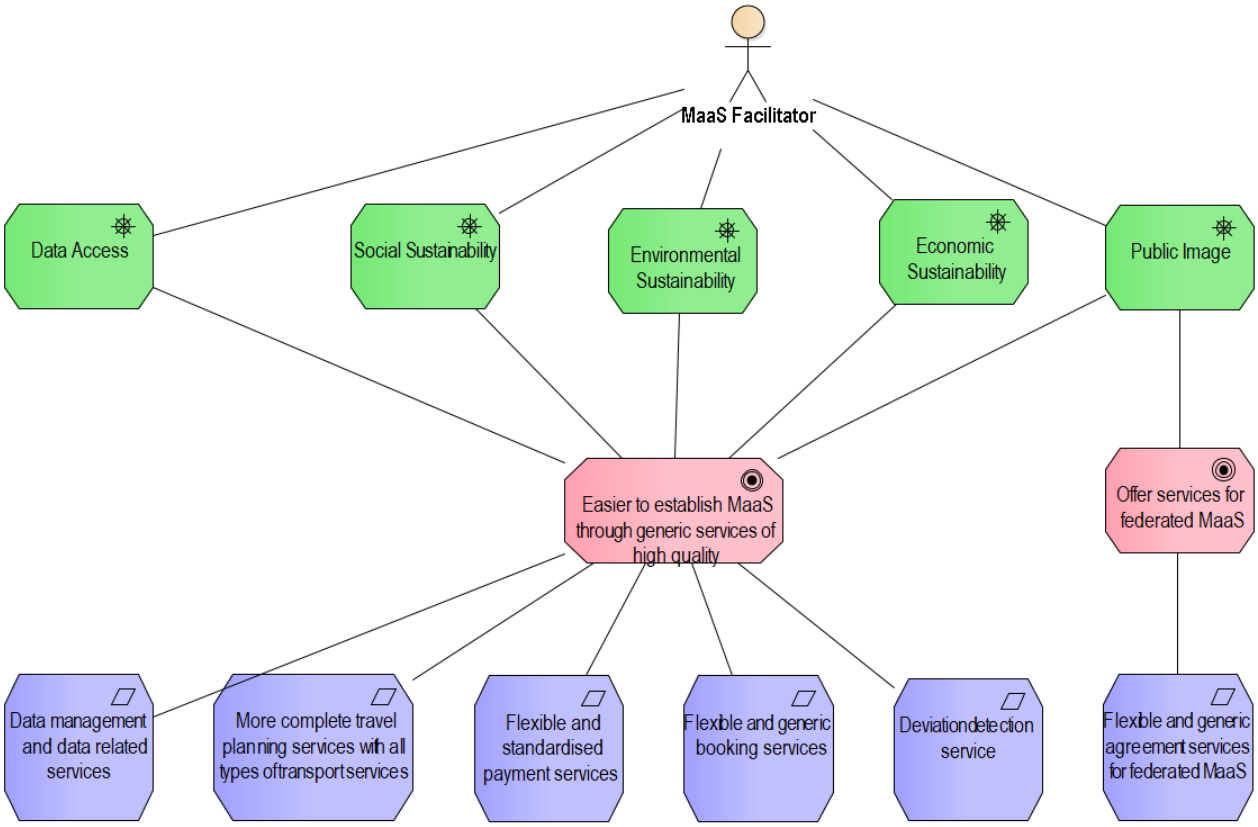

Figure 10 Goals and requirements for MaaS Facilitators

Easier to establish MaaS through generic services of high quality
MaaS Providers may not have the expertise to develop or manage the development of the software solutions they need. The MaaS facilitator should offer best practice services of relevance to MaaS Providers and maintain the services to simplify the establishment and provision of MaaS.

- **Data management and data related services:** The MaaS Facilitator may through the provision of different services get access to data of relevance to MaaS Providers and Transport Service

Providers and may offer data management services. Business sensitive data must be protected. The data may for example be data on sales/payments, preferences, search data regarding tours, executed tours, and travel patterns. The MaaS Facilitator may also offer value added services based on the data e.g.
    - Statistics regarding sales, number of tours, travel patterns, etc.
    - Analyses based on data
- **More complete travel planning services with all types of transport services:** Travel planners with complete functionality should be offered to MaaS Providers.
- **Flexible and generic booking services:** Booking services should be offered to MaaS Providers, e.g. as a part of the travel planner.
- **Flexible and standardised payment services:** Payment services should be offered to MaaS Providers, e.g. as a part of the travel planner and the booking service. The payment service should support electronic payments by means of different media.
- **Deviation detection service:** The Travellers journey execution must be supported. Deviations and possible consequences for the next leg on the journey must be detected.

Offer services for federated MaaS

- **Flexible and generic agreement services for federated MaaS:** In federated MaaS, The MaaS Provider may have to offer services from any Transport Service Providers. Thus, it is necessary to enter agreements in a standardised and automatic way, based on well-defined conditions.

5 Mobility as a Service use cases

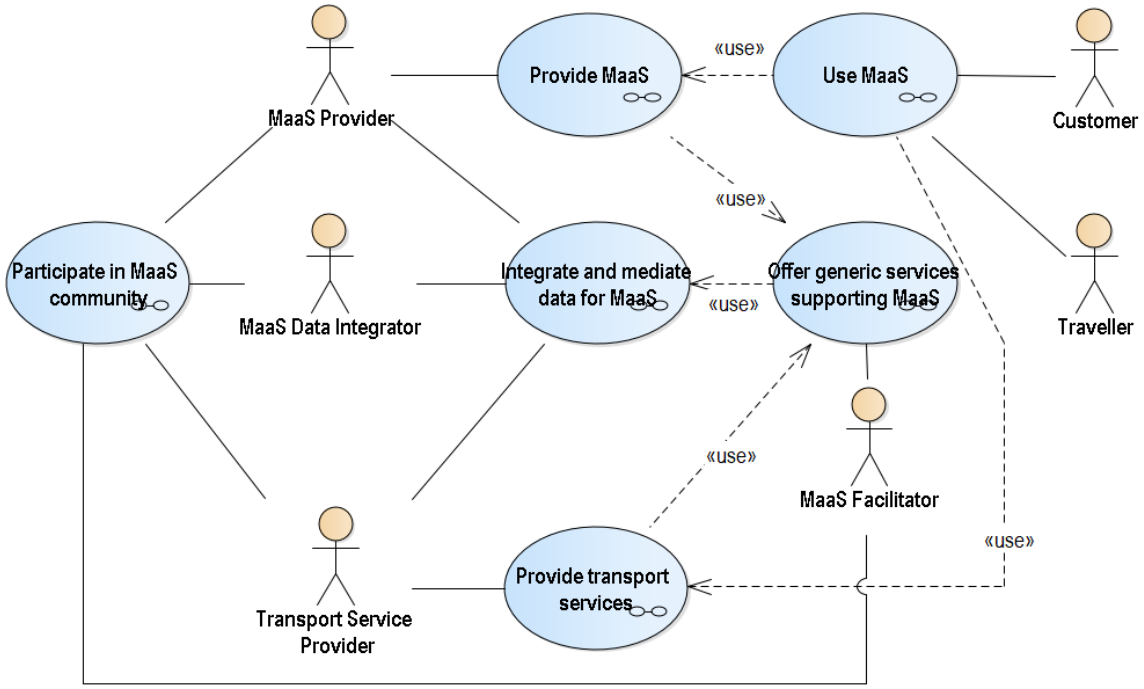

Figure 11 Overall use cases linked to stakeholder roles

UML 2.0 is used to describe the use cases related to the primary stakeholders. A UML use case captures requirements to the systems by describing the functionality to be provided.

Figure 11 shows the overall use cases linked to the primary stakeholders defined in section 3.1, and the overall relations between the use cases. The use cases are further described in the sections below where they are decomposed into more detailed use case diagrams. The detailed diagrams also trace back to the requirements identified in section 4.3. The notation used in the diagrams is described in Annex A.2.

The descriptions of the use cases are based on input from the literature, and from input from experts at workshop.

5.1 Use MaaS

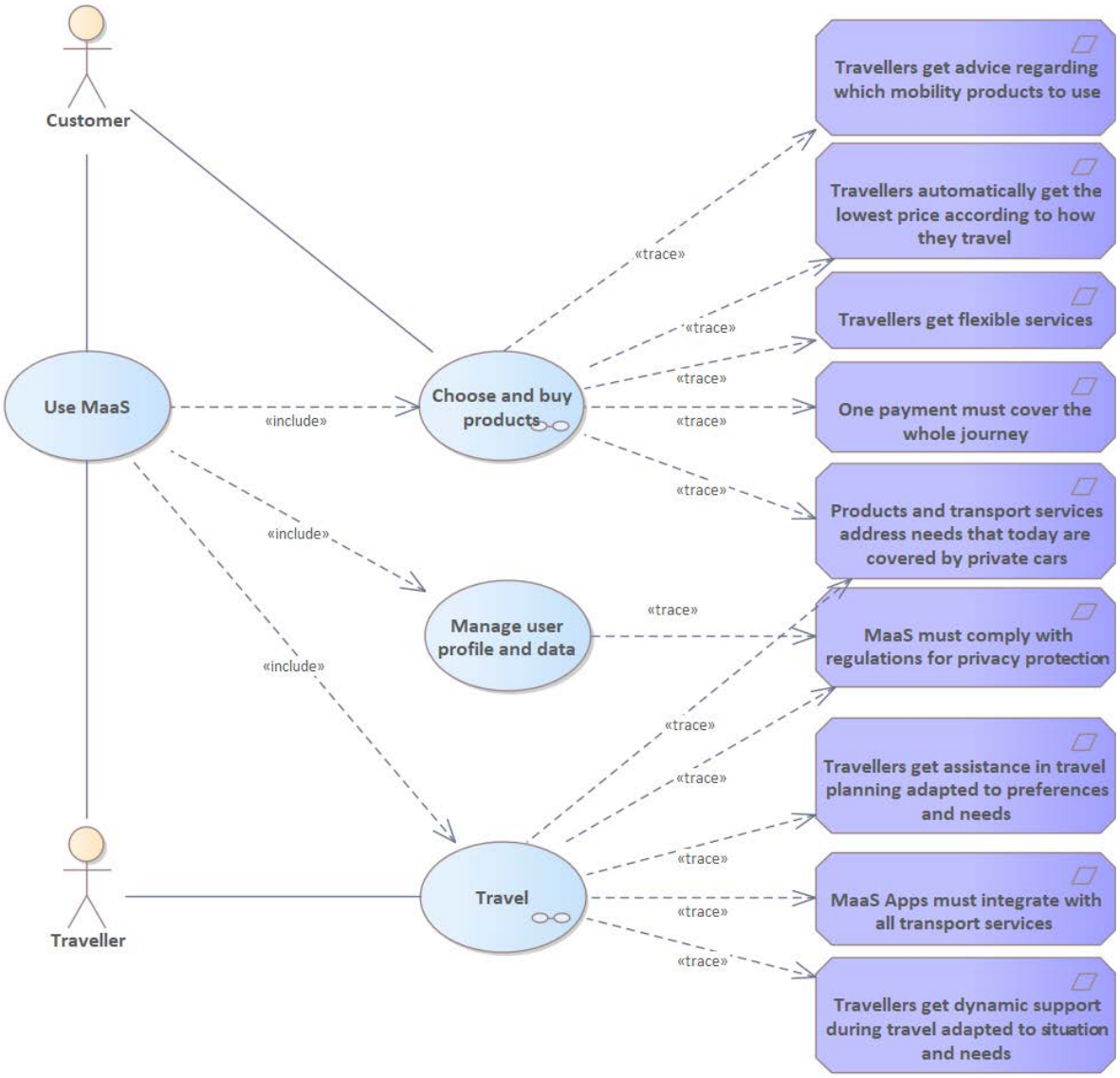

Figure 12 Use case: Use MaaS

The detailed use cases included in Use MaaS are depicted in Figure 12, and they are further described below. In general, MaaS Apps may provide the functionality addressed by the Use MaaS use case. MaaS Apps may however provide a large variety of functionality. The detailed use cases described below are however limited to address the core functionality.

5.1.1 Manage user profile and data

Customers/Travellers must be offered functionality supporting

- Management of user profiles for the MaaS service where the following can be defined:
  - Special needs
  - Preferences regarding for example transport services and modes
  - Payment information
- Control of personal data, among others:

- Management of consents: The Customer/Traveller must get an overview of consents provided and be able to update consents.
- Access to personal data: The Customer/Traveller must be able to access and see personal data hold by the system.
- Control of personal data: The Customer/Traveller must be able to request deletion of personal data.

- Access to information about the use of the MaaS service, for example
  - Active products
  - Information/statistics on use of the service.

5.1.2 Choose and buy products

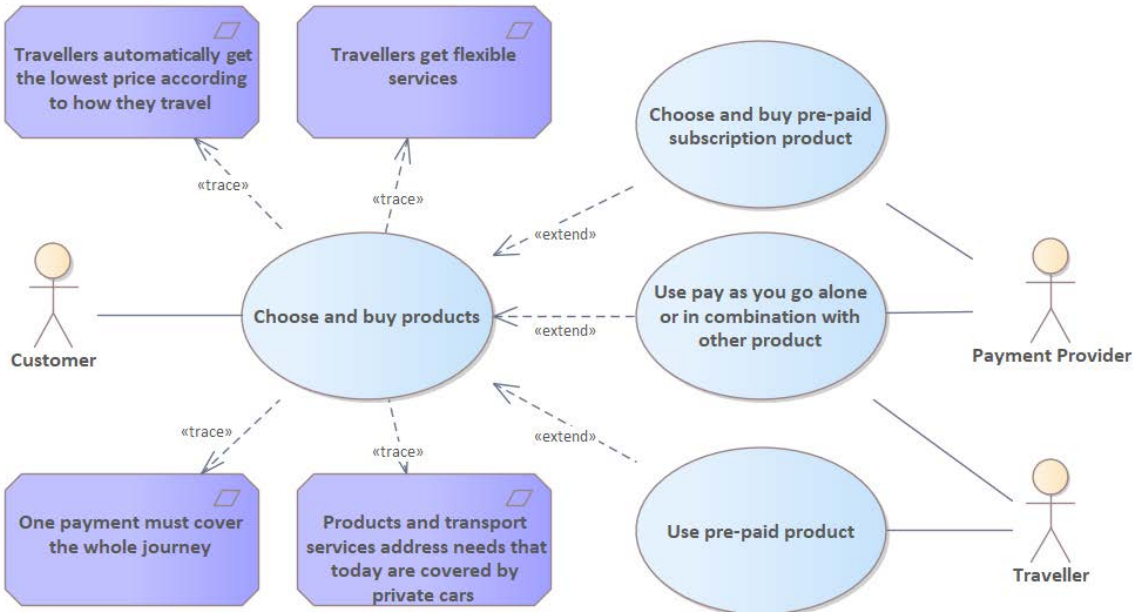

Figure 13 Use case: Choose and buy products

MaaS Providers sell **products** to the Customers. There are three main types of products:

- ***Pre-paid subscription products*** giving the Traveller the right to use the MaaS service in a certain way (e.g. selected transport services, within certain zones, etc.) for a time period.
- ***Pay as you go products*** where the price will vary depending on the individual journey, e.g. the transport services used and/or the distance travelled.
- ***Combination products*** where pre-paid products are combined with pay as you go products with or without a discount.

For all types, there may be separate products for different user groups, e.g. adults, children, families, students, and elderly. All MaaS Providers may not provide all types of products.

When a product is bought, an electronic ***travel document*** is issued. The travel document proves the right to use selected parts of the MaaS service. The Customer will use the travel document (as a Traveller) or share the travel document with one or more other Travellers (e.g. a family member or the whole family depending on the rules applied to the product). Travellers with active travel documents have the right to use the offered MaaS service as defined by the travel document.

Customers must be supported in the selection of the right product.

Choose and buy pre-paid subscription product

Customers must get an overview of available pre-paid subscription products and prices and related rules to support the choice of products.

Customers may fear that they do not select the best possible product. The MaaS service should try to eliminate such concerns. If the travel pattern over time shows that another subscription product or a combination of pay as you go products would have been more affordable, the Customer should retroactively and automatically get the most affordable product(s), and when relevant, a repayment should be manged.

Use pay as you go alone or in combination with other product

Pay as you go products must be provided, and the MaaS service should integrate the selection of such products in the travel planning to ensure that the selected product matches and covers the planned journey.

If the Traveller has a travel document confirming an active pre-paid subscription, but the travel plan exceeds the coverage of this product, the Customer should be offered combination product where the pre-paid subscription is combined with a pay as you go product with or without a discount.

If the travel pattern over time shows that a subscription product is more affordable than the pay as you go products used, the Customer should retroactively and automatically get the subscription product, and when relevant, repayments should be manged.

Use pre-paid product

The Traveller must get an electronic travel document from the Customer, and the travel document will confirm that there is an active product.

5.1.3 Travel

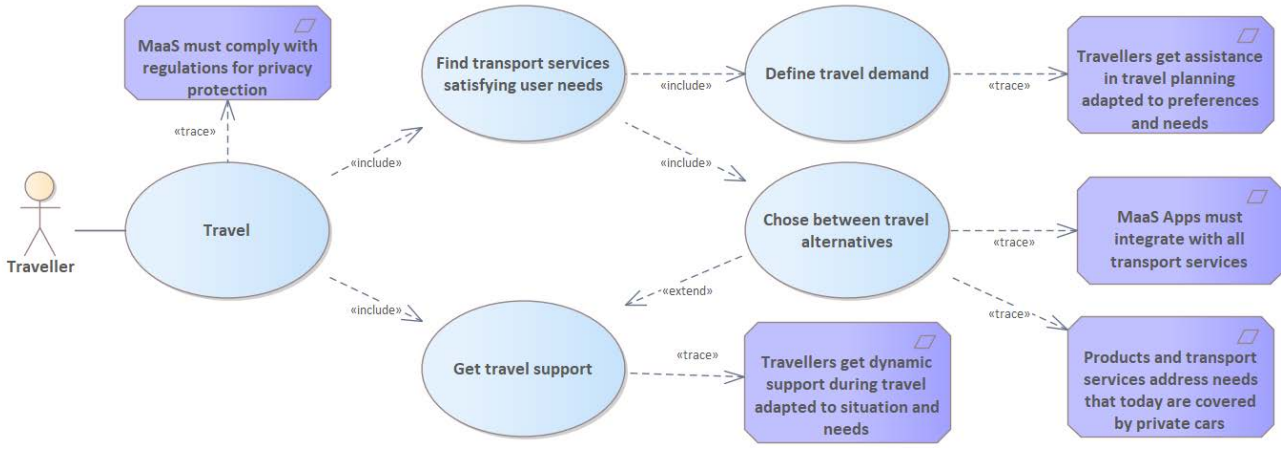

Figure 14 Use case: Travel

The Travellers must be supported both before and during the travel.

Find transport services satisfying user needs

Define transport demand:

The Traveller will before the travel use a travel planner to define the transport demand. The to and from locations must be defined as well as timing constraints. The Traveller should get support for

- Door-to-door planning and not just planning between transfer nodes as Travellers may not know the transfer node structure.
- Overriding the needs and the preferences stated in the user profile whenever this is relevant.
- Provision of relevant requirements and selection criteria, e.g. regarding modes, time, price, etc. It might also be relevant to request just the use of transport services that comply with active subscription products.

Choose between transport alternatives:
The Traveller will get information about relevant transport alternatives as a response to the input on the travel demand and also in the case of deviations that makes it necessary to re-plan the journey. The Traveller can choose the most relevant alternative.

Get travel support
During the travel, the Travellers should get relevant information and support. During normal situations, this information and support may for example include

- Transfer support, e.g. information about the route to use at larger terminals/stations, the gates/tracks from where the next leg starts, and the departure time for the next leg.
- Status information, e.g. information about expected arrival times at next transfer location.

If deviations or disruptions affect the ability to follow the selected travel plan, the Traveller will be notified and supported to limit the negative effect of the situation. This means a new session with travel planning (see the "Choose between transport alternatives") with a demand derived from the original plan.

Choose between transport alternatives – see above.

5.2 Provide MaaS

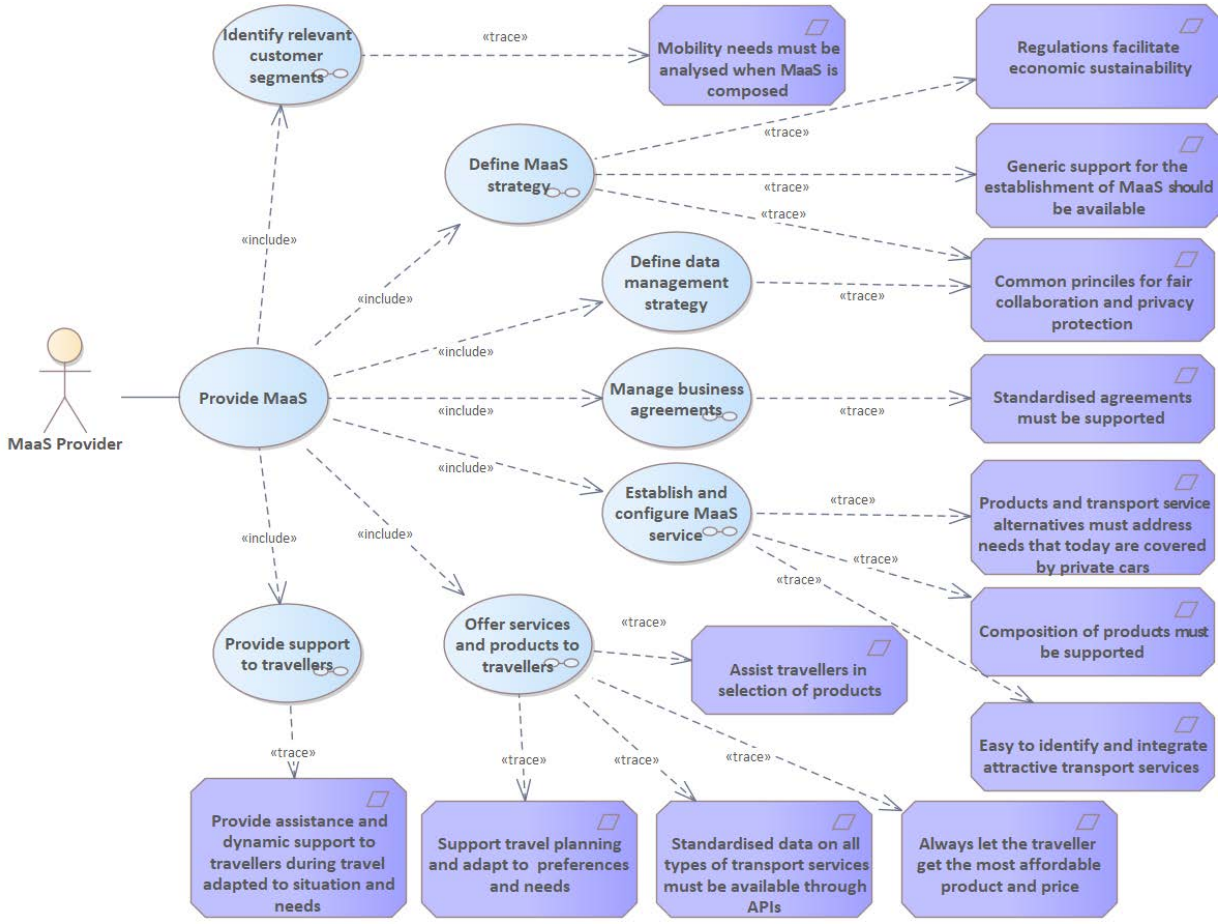

Figure 15 Use case: Provide MaaS

The detailed use cases included in the Provide MaaS use are depicted in Figure 15, and they are further described below.

5.2.1 Identify relevant customer segments

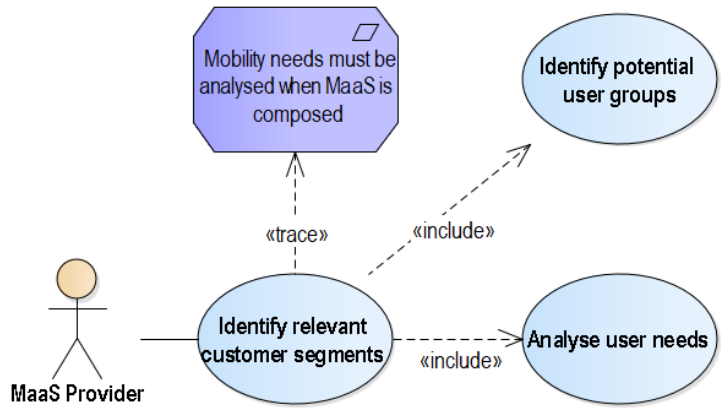

Figure 16 Use case: Identify relevant customer segments

The market for the MaaS service in general must be analysed as well as the market for the integration of different types of transport services and modes.

Many potential MaaS Providers are already providing transport services or even integrated mobility services to Travellers. Thus, they may have access to market data, and they may also be in a position to carry out trials to investigate the popularity of new services.

User groups and user needs must be analysed. Within one user group there may be users with many different needs and requirements to the MaaS service.

Identify potential user groups

Many aspects have to be analysed, among others

- Relevant transport services, e.g. micro mobility, car sharing, scheduled and on demand services
- The need for combinations of transport services, e.g. better support for first/last mile
- The needs of specific user groups, e.g. elderly
- The needs in rural areas vs urban areas
- How can specific user groups be convinced to give up car ownership
- How can the flexibility provided by private cars be replaced
- Collaboration with Auxiliary Service Provider to provide deliveries, e.g. from libraries, grocery stores, restaurants and coffee shops.

Analyse user needs

A user profiling must be carried out. Data on existing users from user profiles, product sales, and journey executions must be analysed to identify user characteristics and to learn about the characteristics of different user groups and the functionality to be covered by the MaaS service.

5.2.2 Define MaaS Strategy

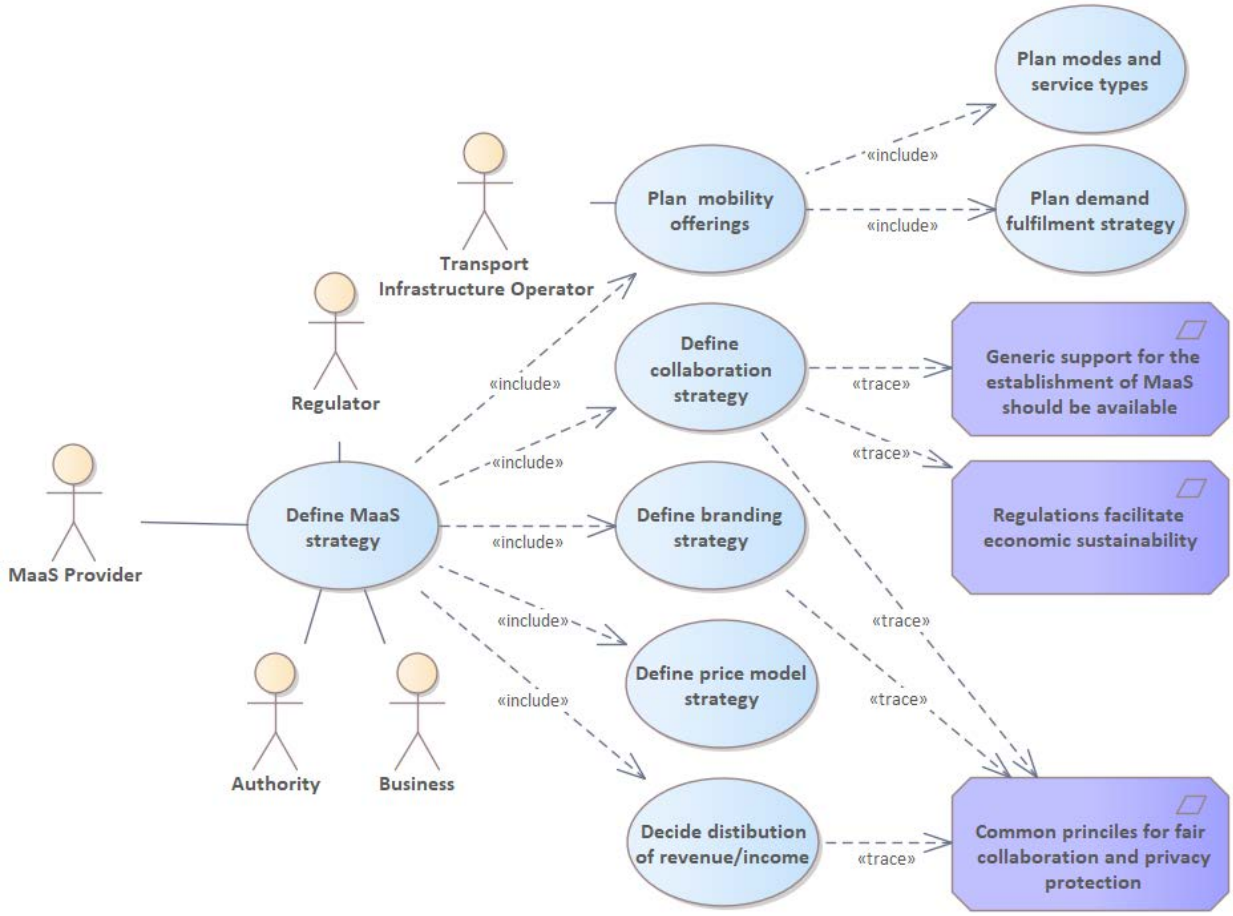

Figure 17 Use case: Define MaaS strategy

For commercial MaaS Providers, a Business (e.g. the owner) may influence the strategy. For public MaaS Providers, local Regulators and Authorities may have an influence. The work on the MaaS strategy must in general be influenced by

- Results from the market analyses described in section 5.2.1.
- The policy and decisions made by local or national Regulators and Authorities, e.g. the policy with respect to micro mobility, parking restriction, and low emission zones with limited car use.
- The physical infrastructure planned and managed by Transport Infrastructure Operators, e.g. the infrastructures for soft modes, parking areas for micro mobility and shared cars, and transfer node infrastructures where several modes are connected.

Plan mobility offerings

If possible, the MaaS Provider should work with local Regulators, Authorities and Transport Infrastructure Operators on how the MaaS service can contribute to a fulfilment of the transport policy and be adapted to local infrastructures.

Plan modes and service types:

Strategies for how MaaS can replace private cars must be made. This includes strategical decisions regarding the transport modes to be offered, the volumes of the transport services, and type of products to offer.

The MaaS Provider must also decide where a federated MaaS service should be provided or not. This decision will to a large extend depend on the ability to provide a federated MaaS. This cannot be done until Mobility Data Space with all data needed from all relevant areas are implemented.

Plan demand fulfilment strategy:
The demands identified through the market analyses must be considered with respect the different transport service types, and the capacities needed, the type of products to be offered. The use of relevant Transport Service Providers must also be decided.

The products must be identified based on the user profiling in 5.2.1. As described in section 5.1.2, there are three types of products, pre-paid subscription products, pay as you go products, and combination products. A strategy for the price models must be defined. They may for example target different user groups (adults, children, students, elderly, etc.) and/or use patterns (e.g. use in zones, travel frequencies, and travel distances).

A strategy for a fair assignment of tours to different Transport Service Providers must be made. The strategy should guide the digital services, and it should be shared to arrange for transparency and trust. Transport Service Providers joining the MaaS ecosystem should be able to see that

- The transport services they provide are not hidden or made less important than other services.
- The assignments of tours to Transport Service Providers are based on the characteristics of the transport services and the preferences of the Customers/Travellers, and not on unfair algorithms.
- Good transport services have the potential to get more users.

Define collaboration strategy
Collaboration aspects to be addressed are described below.

Collaboration on strategies and knowledge building with:

- Local Regulators and Authorities. If possible, the MaaS service should be adapted to local policies. It is advantageous for the MaaS Provider to collaborate with Regulators and Authorities on strategies for service offerings, capacities, integration with different types of transport services, etc.
- MaaS Community. New knowledge may be gained through a participation in such a community (see section 5.6).

Collaboration on services with:

- Transport Service Providers. It might be a challenge to integrate services from several Transport Services Providers of the same type as they might be competitors. Regulations may make it possible for commercial MaaS Providers to re-sell public transport services.
- MaaS Data Integrator. The use of data from the MaaS Data Integrator may make own data integration superfluous and reduce costs.
- MaaS Facilitators. The use of services from an external MaaS Facilitator might ensure access to high quality services that are maintained and updated. This will reduce risks and might also reduce costs and limit the need for digital expertise in own organisation.

Collaboration regarding access to and use of data with:

- Customers/Travellers. The data governance must be emphasized. A good protection of the user data might increase the willingness to share data and also the willingness to allow use of data in the work on knowledge generation and service improvements.

- MaaS Facilitators. External services from MaaS Facilitators might collect and generate data, and MaaS Facilitators may offer services for the management of the data, and they may also offer data-based services, e.g. data analysis, statistics, data aggregation, etc.
- Transport Service Providers. MaaS can generate valuable data on mobility patterns, user preferences, willingness to pay, etc. Transport Service Providers may benefit from access to such data, and the MaaS Provider should consider sharing data with other members of the ecosystem.

Define branding strategy

Transport Service Providers may feel that they lose the control with their own services when they integrate in MaaS. The MaaS Provider's strategy should address how the visibility of the individual transport service providers should be maintained.

Define price model strategy

Aspects to consider are among others:

- How to promote a transition from car ownership to use of Maas products.
- Use of pre-paid subscription products vs pay as you go products
- Fairness. The following must be considered:
    - Cross-subsidies: Should Travellers using cheap services like public transport have to pay extra to reduce the price for other Travellers' use of costly services like car sharing?
    - Guarantee for lowest price: Should the product used by a Traveller be dynamically adapt to what is the best product according to the Traveller's travel pattern?

Decide distribution of revenue/income

The payment to the Transport Service Providers will be defined as a part of the business agreements (see section 5.2.5) but the principles for such agreements should be designed as a part of the strategy. Aspects to consider are among others [18]:

- Mobility offerings (type of services, quantity, etc.)
- Equity contribution to the MaaS service (e.g. vehicles, infrastructure, personnel, facilitation)
- Government support
- Return of investment

5.2.3 Define data management strategy

External MaaS Facilitators might offer services for value added data management and data analysis. The use of such services must be considered.

MaaS Solutions will collect a lot of data about Customers and Travellers, e.g. data about about

- User profiles
- Planned journeys/current journey
- Use of products and related payments
- Search history in the travel planner
- Journey history
- History regarding use of products and payments

The principles for the management of personnel data associated with Customers and Travellers must be defined. It is important that the privacy of such data is protected. A proper consent management must be planned and implemented, and data sovereignty must be ensured. These concerns are addressed by the following measures in the Data Governance Act and Data Act:

- Measures to ensure that data intermediaries will function as *trustworthy* organisers of data sharing or pooling within the common European data spaces (Data Governance Act)
- Put in place *safeguards* against unlawful data transfer without notification by cloud service providers (Data Act).

The sharing of data via for example Mobility Data Spaces must also be considered and planned, as this will be beneficial to the society. The following measures in the Data Governance Act can are enablers for this:

- Measures to make it easier for citizens and businesses to make their data available for the benefit of society.
- Measures to facilitate data sharing, in particular to make it possible for data to be used across sectors and borders, and to enable the right data to be found for the right purpose.

5.2.4 Manage business agreements

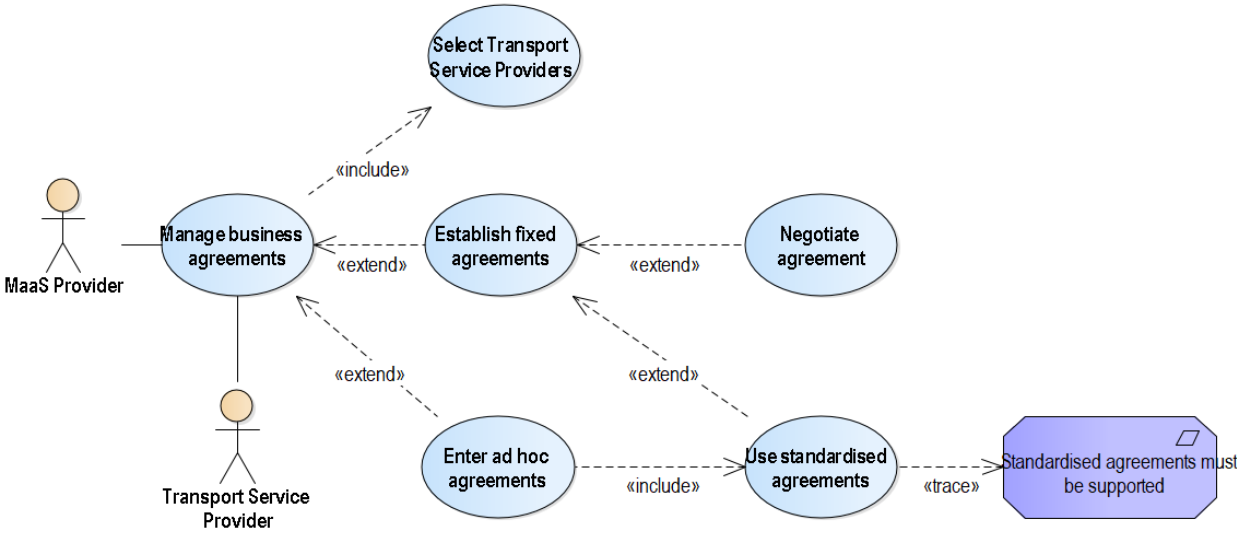

Figure 18 Use case: Manage business agreements

Business agreements are traditionally negotiated manually by the parties involved, and contracts are established and signed to define requirements and conditions.

In a federated MaaS, the MaaS Providers can re-sell services from many different Transport Service Providers located anywhere, and there might be just a few sales per Transport Service Provider. Thus, traditional negotiations and establishments of contracts will be too costly. ***Electronic and standardised* agreements** must be used, and such agreements may in the future also be an option for non-federated MaaS services to save time and effort. Standardised agreements may in addition also make the integration in MaaS services easier and more transparent for Transport Service Providers.

Select Transport Service Providers

In a non-federate MaaS, this is done manually based on the strategies established in 5.2.2.

In a federated MaaS, the selection is triggered by the Traveller's choice of transport services in the travel planner. The Transport Service Provider is the provider of a selected service.

Establish fixed agreements

The use case is relevant for fixed agreements for non-federated MaaS services.

Negotiate agreements:
The use case is relevant if a standardised agreements is not used, and a manual agreement has to be negotiated. The MaaS Provider and the Transport Service Provider will agree about:

- The transport services to be provided (service properties, volumes, locations, etc.)
- The economic issues (price models, payment details, financial settlements, etc.)

Use standardised agreements:
The use case is relevant if a standardised agreement is used. In such cases, the Transport Service Provider offers a standardised agreement template with pre-defined values, e.g. regarding

- Max capacity that can be provided
- Price models offered and related conditions
- Payment details
- Other conditions

The MaaS Provider will, based on the above, provide an agreement where the capacity, the relevant price models, and the duration of the agreement are defined. For fixed agreement, the capacity will be for the whole duration of the agreement. For ad hoc agreements (see below), the capacity and the duration will be related to one journey.

Enter ad hoc agreements
The use case is relevant when digital, standardised agreements are used in federated MaaS services. In such cases the MaaS Provider do not have an agreement with the Transport Service Provider, but a Traveller requests services from the Transport Service Provider.

Use standardised agreements – see above.

5.2.5 Establish and configure MaaS service

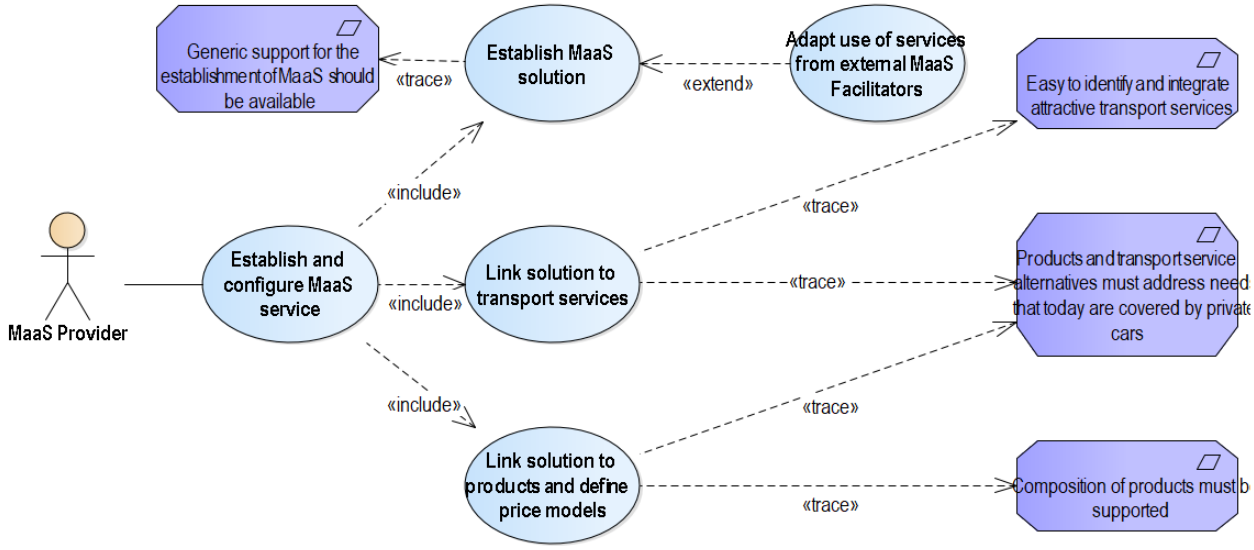

Figure 19 Use case: Configure MaaS service

Establish MaaS solution

The digital services needed in the MaaS solution must be established according to the strategy defined in 5.2.2 and 5.2.3, especially the part regarding collaboration with external MaaS Facilitators. Parts of the MaaS solution may for example be built on to of such services.

Adapt use of services from external MaaS Facilitators:
This use case is relevant if the MaaS solution is built on top of solutions/services provided by external MaaS Facilitators. The solutions/services must be adapted to the needs of the MaaS Provider.

Link solution to transport services

The selected transport services and Transport Service Providers (see 5.2.4) must be integrated into the travel planner through use of data provided by the MaaS Data Integrator.

In a federated MaaS, all services provided in the Traveller's area of interest may be relevant, and the selection of services is ad hoc and made by the Traveller. Thus, the travel planner must find and integrate data on all relevant services. This puts extra requirements on the MaaS Data Integrator.

Link solution to products and define price models

The selected products (see 5.2.2) must also be added to the system, and the MaaS solution must support the selection of products according to well defined rules and make it easy for the Traveller to buy and manage any product and to have an overview of the products bought. The selection of products must be integration in the travel planner. When travels are planned, it must be possible to use pay as you go products, pre-paid products, or a combination.

For each product, a price model must be defined. It may cover the price for different user groups (adults, children, students, elderly, etc.) and use patterns (e.g. use in zones, frequencies in use, and distances).

5.2.6 Offer services and products to travellers

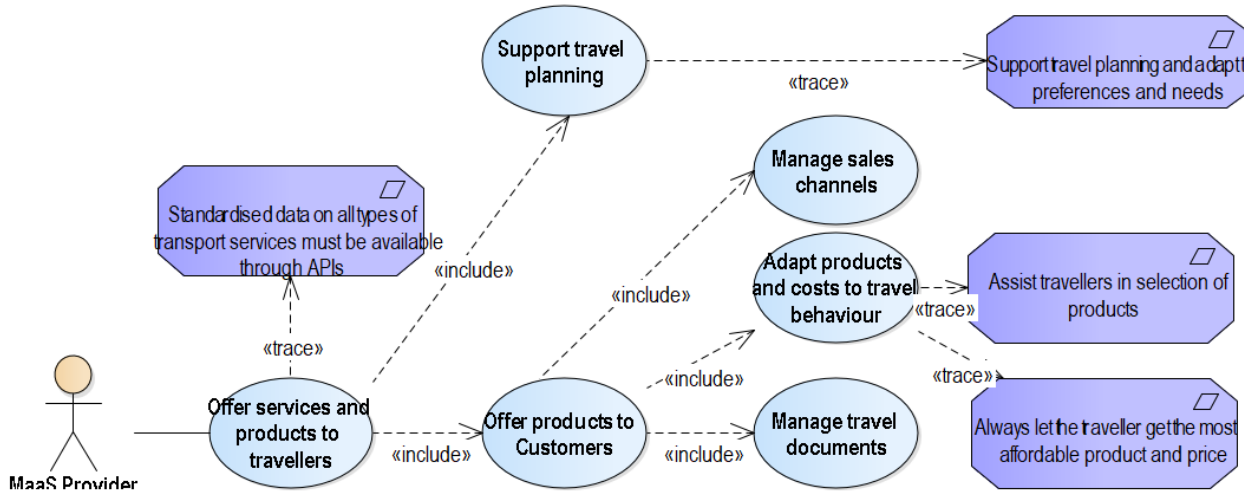

Figure 20 Use case: Offer services and products to Travellers

The use of the travel planner should be promoted as this will generate data about the mobility patterns of the Travellers, and such data can be used to improve the MaaS service.

Support travel planning

The MaaS service should

- Adapt the travel planning to the needs and preferences defined in the user profile of the Traveller unless this is overridden.
- Support door-to-door planning (and not just planning between transfer nodes).
- Include all relevant transport services into the travel planner. In a non-federated MaaS, this is all selected transport services. In a federated MaaS, this will be all transport services in the relevant geographical area that are prepared to be included into a federated MaaS (they share data, allow standardised agreement, support electronic booking, etc.).

Offer products to Customers

Manage sales channels

Products may be offered in several ways:

- Pay as you go products and combination products may be sold via the App, and preferably through the travel planner. The use of the travel planner will ensure that the correct product is sold, and it will also encourage the use of the travel planner and thereby provision of data about the journey.
- Pre-paid submission products may be offered via the MaaS App with information that support the choice of the preferred product. In this case, the travel planner might not be used. If so, information on the journeys may not be provided.

Adapt products and costs to travel behaviour:

If the travel pattern over time shows that the product used is not the most affordable product, the MaaS service should automatically switch to the most affordable product.

Manage travel documents

Travel documents proving that products are paid for and active must be manged by the system. The system must keep track of expiry dates and times and notify the Traveller before it expires, so that a new product can be purchased in case this is needed.

5.2.7 Provide support to travellers

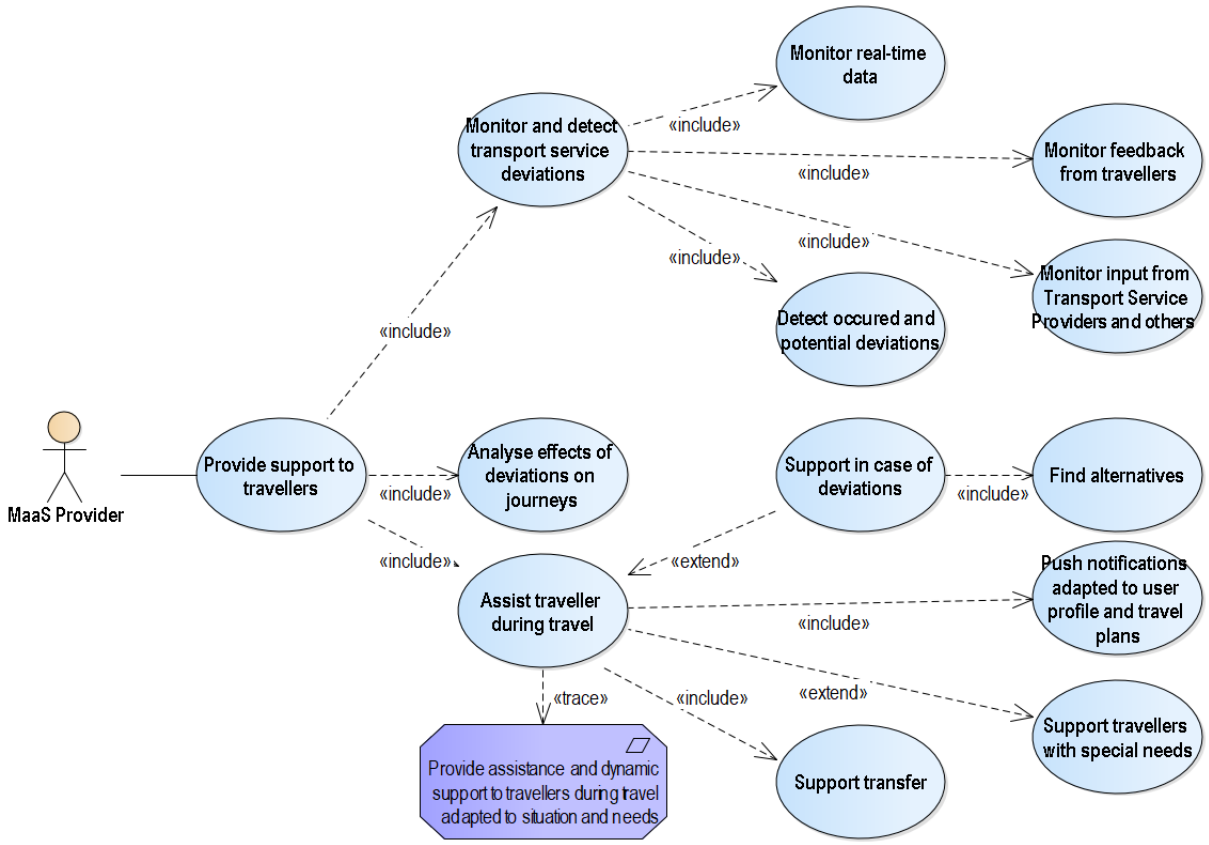

Figure 21 Use case: Provide support to travellers

The use of the travel planner should be promoted as this will

- Generate data about the mobility patterns of the Travellers, and such data can be used to improve the MaaS service.
- The use of the travel planner gives advantages to the Traveller. Assistance can be provided in case of deviations.

Monitor and detect transport service deviations

Available data must be used to monitor the situation. This may be

- Real-time data on the transport service. Real- time position data may for example indicate delays.
- Input from Transport Service Providers, Travellers and others. Problems with one transport service (e.g. due to weather conditions) might also indicate that there with be problems with other services.

The data must be analysed to detect deviations occurred as well as situations that might lead to deviations.

Analyse effects of deviations on journeys

When deviations are detected, the effects on planned journeys must be analysed. The effects might for example be one or more of the following:

- Late arrival of transport means to be used to start point.
- Late arrival to transfer node but can use next leg as planned.

- Late arrival to transfer node with difficulties regarding next leg. Cannot transfer in time.
- Late arrival to destination.

Assist Traveller during travel

Travellers should get support if such support is not turned off.

Push notifications adapted to user profile and travel plans:
The Traveller should for example get notifications about:

- Upcoming transfers some time in advance. The transfer should be supported - see below.
- Occurred or expected deviations. More information should be provided – see below.
- Arrival to destination some time in advance.

Support transfer:
Before transfers, the Travellers should for example get information about

- Expected time of arrival to transfer node.
- Expected time the transfer will take.
- Expected departure for next leg.
- Routing information in transfer node.

Support in case of deviations:
Information about type of deviations should be provided as well as information about the expected consequences. In case of delays, this might for example be:

- The next leg can be used as planned
- The delay will cause difficulties with the next leg . If so, the Traveller has to re-plan the journey, and the MaaS service will assist the Traveller in a re-planning of the journey.

Support travellers with special needs:
Some Travellers might have special needs and they should be easy to request assistance.

5.3 Provide transport services

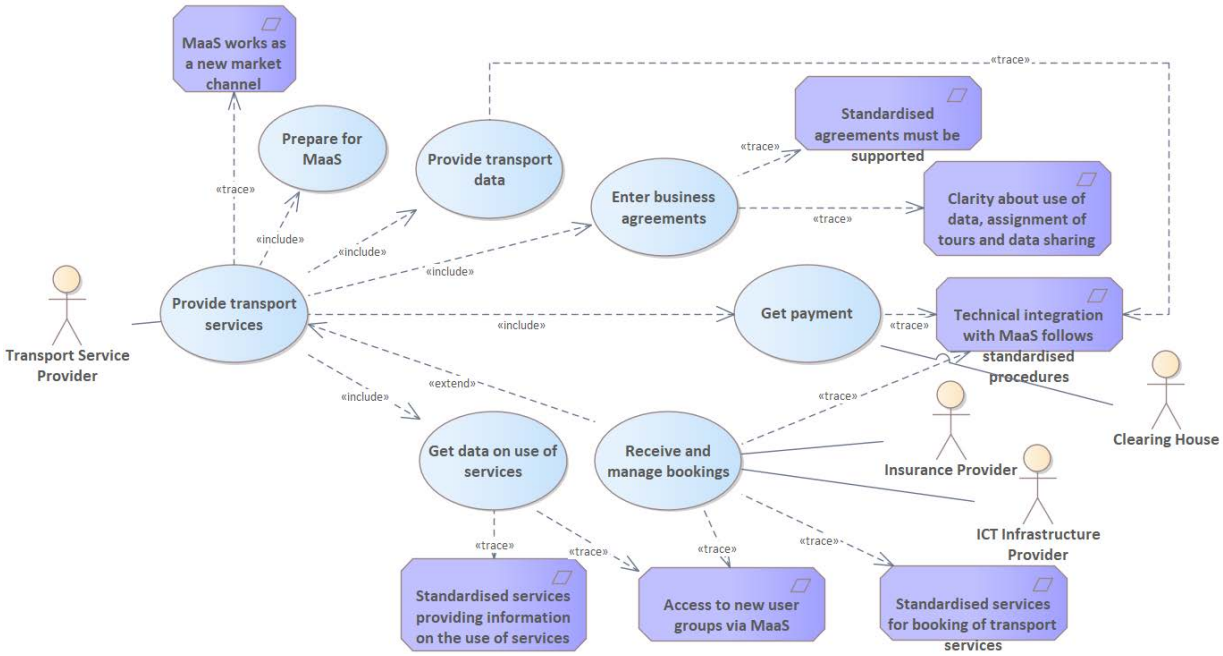

Figure 22 Use case: Provide transport services

The detailed use cases included in the Provide transport services use case are depicted in Figure 22 are they are further described below. Note that the focus is on issues of relevance to MaaS and not on the other activities of the Transport Service Providers (fleet management, etc.).

5.3.1 Prepare for MaaS

The Transport Service Provider must prepare for a digital inclusion in the MaaS Ecosystem. This may include API support for the following:

- Bookings (when relevant).
- Mode or service specific issues, for example support for keyless access, verification of driver licence, acceptance of conditions, and acceptance of insurance (when the transport service requires this).
- Standardised agreements when this becomes relevant (see 5.2.4).
- Fulfilment of new regulations regarding which data that should be shared (see 2.1).

5.3.2 Provide transport data

The Transport Service Provider must share data with the MaaS Data Integrator. This will include data on

- Static issues (e.g. route plans) aligned with a common set of transfer nodes.
- Real-time data on the execution of the service.
- Other data on the service when this becomes relevant, e.g. data on available capacity.
- Template for standardised agreements when this becomes relevant (see 5.2.4).

5.3.3 Enter business agreements

If standardised agreements are not used, the Transport Service Provider must negotiate with and enter traditional agreements with MaaS providers.

If standardised agreements are used, the Transport Service Provider must support the use of such agreements.

5.3.4 Get payment

The financial settlements from the use of the transport services as a part of MaaS must be handled. The payment from the MaaS Provider is handled via a Clearing House.

5.3.5 Receive and manage bookings

Received bookings must be manged, and resources (seats, transport means, etc.) must be reserved whenever this is relevant. For some services, the Transport Service Provider has to check with an ICT Infrastructure Provider (e.g. road authorities with digital services) that the Traveller has a valid driver license. The purchase of insurances may also have to be supported through interactions with an Insurance Provider.

5.3.6 Get data on use of services

A lot of data might be collected from the MaaS Service, and depending on the agreement between the MaaS Provider and the Transport Service Provider, the Transport Service Provider might also get access to parts of the data. Such data might be useful for the further development of the transport service. The data might for example be about:

- How the transport service is used in a larger context, e.g. the services used on the previous leg and the services used on the next leg.
- The share of this services compared to other services in the MaaS ecosystem.
- The share of journeys where this service was used.
- The share of journeys where this service was provided in a travel alternative from the travel planner but not used.

5.4 Integrate and mediate data for MaaS

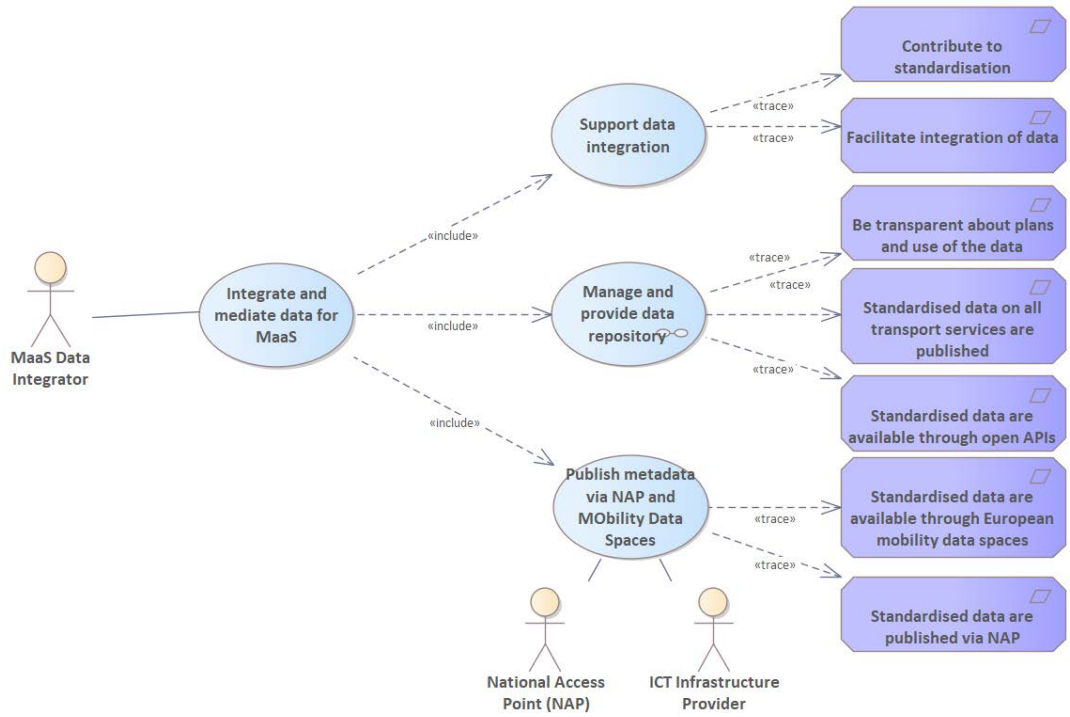

Figure 23 Use case: Integrate and mediate data for MaaS

The detailed use cases included in the Integrate and mediate data for MaaS use case are depicted in Figure 23, and they are further described below.

5.4.1 Support data integration

The quality of the data needed in MaaS and the compatibility with standards is crucial. It might be a challenge for many Data Providers to understand and to fulfil the requirements. The MaaS Data Integrator is an expert on data needed in MaaS, and will

- Select the standards to be used and elaborate rules regarding how data on different transport service types should be mapped to these standards. International standards should be applied whenever possible, and the MaaS Data Integrator may also contribute to such standardisation.
- Select standards to be used and elaborate rules regarding the data needed for federated MaaS, e.g. how MaaS Providers should provide data about their MaaS service, products and coverage (area and modes), and how Transport Service Providers should provide input to templates for standardised agreements.
- Identify and define requirements for other types of data of relevance to MaaS and travel planners, e.g. meteorological data, geographical data, data on traffic conditions, data on transport networks, and data on traffic regulations. The latter may for example be geofence information for zones with e-scooter restrictions (e.g. regarding access and speed), parking zones, speed limitation zones, zones with limited access, etc.
- Provide feedback and guidance to Data Providers regarding the provision of relevant data and to support their adaptation of the data to requirements regarding quality and use of standards, and to ensure that they can deliver timely updates of the data as required.

The MaaS Data Integrator may also participate in in standardisation work to ensure that all relevant aspects are covered by the standards.

5.4.2 Manage and provide data repository

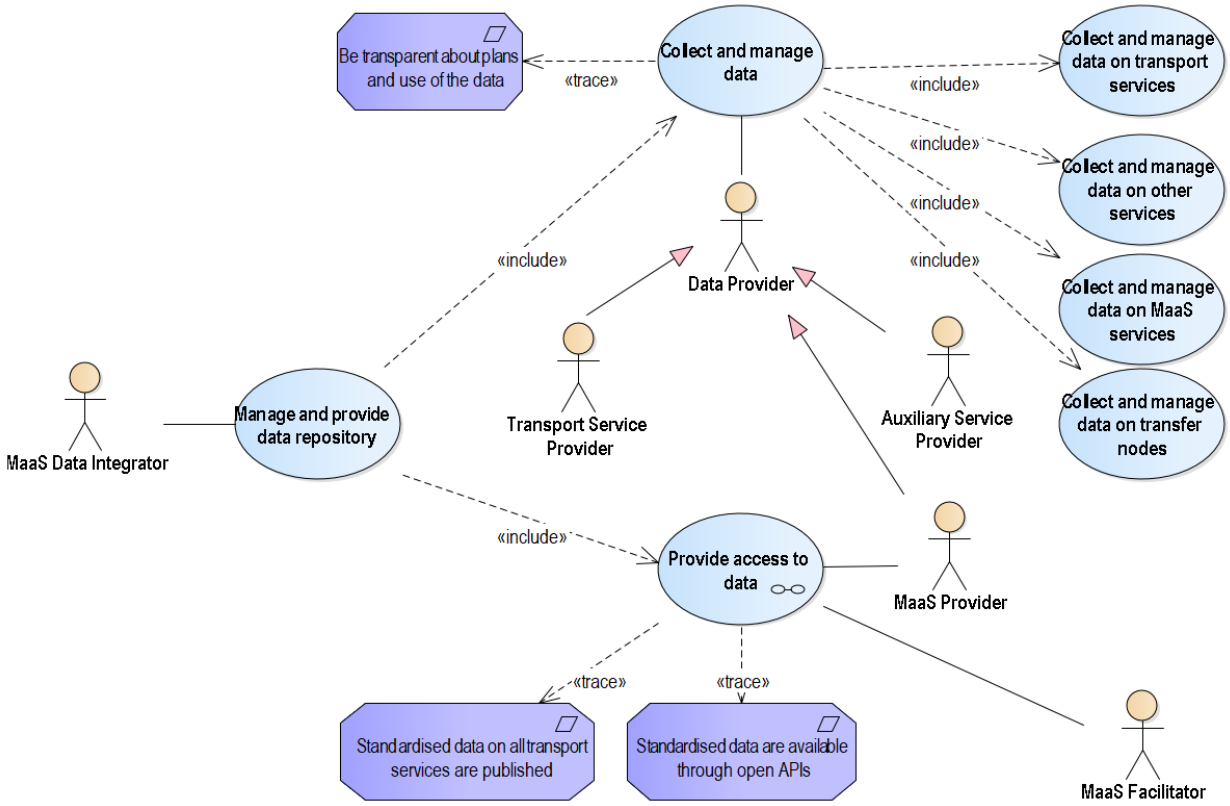

Figure 24 Use case: Manage and provide data repository

The MaaS Data Integrator will collect data of relevance to MaaS from different Data Providers and manage the data. The data must comply with standards and rules regarding format/syntax, semantics, harmonisation (e.g. us of common references to transfer nodes), and quality.

Collect and manage data

Data from Data Providers are collected and managed.

To arrange for trust, the MaaS Data Integrator must be transparent about a well-defined policy regarding how the collected data is managed, used and protected.

Collect and manage data on transport services:
The following data must be collected and managed about all relevant transport services:

- Service descriptions, e.g. mode, type (e.g. scheduled or on demand), and coverage (area)
- Service characteristics (e.g. route plan)
- Real-time data (position, capacity, expected arrival times, etc.)
- If relevant, standardised agreement template with content

Collect and manage data on MaaS services:
The following data must be collected and managed about all relevant MaaS services:

- Service descriptions may for example address mode, transport service type, scheduled or on demand, and coverage (area)
- Product information with prices

Collect and manage data on other services:
Many types of data might be of relevance to MaaS, e.g. with respect to the travel planning:

- Meteorological data
- Geographical data, e.g. points of interest and maps/geographical information objects
- Data on transport networks, e.g. the topology of the road network, and details on topography, details on network elements (lanes, etc.), short cuts, bicycle routes, etc.
- Data on traffic conditions and traffic situations, e.g. dynamic data on driving conditions, traffic incidents, accidents and disruptions as well as other situations that may affect the traffic flow and travel times.
- Data on traffic regulations, e.g. geofence information for zones with e-scooter restrictions (e.g. regarding access and speed), parking zones, speed limitation zones, zones with limited access, etc.

Collect and manage data on transfer nodes:
The following data must be collected and managed about all transfer nodes (stations, terminals, ports, stops, etc.):

- Overview of all transfer nodes with unique identifiers and geographical location (coordinates). The transport services will refer to the identifiers of the transfer nodes they visit.
- Transfer node details, e.g. stop points and related modes (transport services should refer to the stop points they use), transfer times between stop points (for larger transfer nodes), and details on the transfer nodes (entry points, services offered, etc.).

Provide access to data
The MaaS Data Integrator will provide access to the data managed via open APIs, and the data will be used by MaaS Providers and MaaS Data Facilitator.

5.4.3 Publish metadata via NAP and Mobility Data Spaces

The MaaS Data Integrator will publish metadata on the available data via the relevant National Access Point or via ICT Infrastructure Providers managing Mobility Data Spaces. Metadata must be provided as well as documentation of the data and the APIs.

5.5 Offer services supporting MaaS

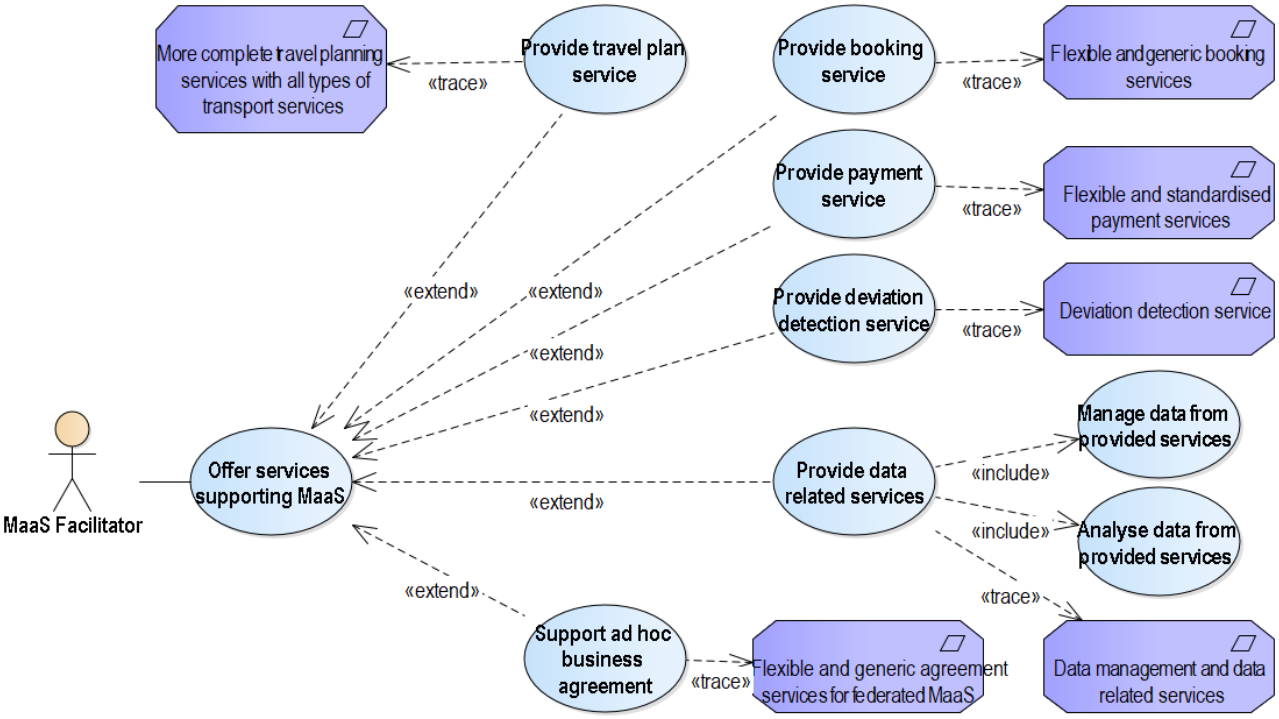

Figure 25 Use case: Offer services supporting MaaS

The detailed use cases included in the Offer services supporting MaaS use case are depicted in Figure 26, and they are further described below.

5.5.1 Provide travel plan service

The MaaS Facilitator may offer a travel planning service that can be used as a basis for a travel planner. The data needed will be collected from the MaaS Data Integrator.

5.5.2 Provide booking service

The MaaS Facilitator may offer a service booking of transport services as an integrated part of the travel planning services. The booking service may also offer additional services needed for some transport service types such as a verification of driver licences, insurance, keyless assess, etc.

5.5.3 Provide payment service

The MaaS Facilitator may offer a service for electronic payment as an integrated part of the travel planning and booking services.

5.5.4 Provide deviation detection service

The MaaS Facilitator may offer services for monitoring of deviations related to planned journeys. The transport services to be used will be monitored as well as other issues that may affect the timeliness and execution of each leg. On detection of a deviation or a foreseen deviation, mitigating actions may be suggested.

5.5.5 Provide data related services

The MaaS Facilitator may offer data related services linked to the services above. Data retrieved from travel planning, bookings, payments, and journey executions can be collected and managed. Value added services may also be offered based on the collected data, e.g. data analyses, statistics, prognoses, etc.

5.5.6 Support ad hoc business agreements

The MaaS Facilitator may offer services related to standardised agreements, e.g. agreements needed in federated MaaS. The MaaS Facilitator may manage the agreements and offer services to both parties regarding the management and follow up of such agreements.

5.6 Participate in MaaS community

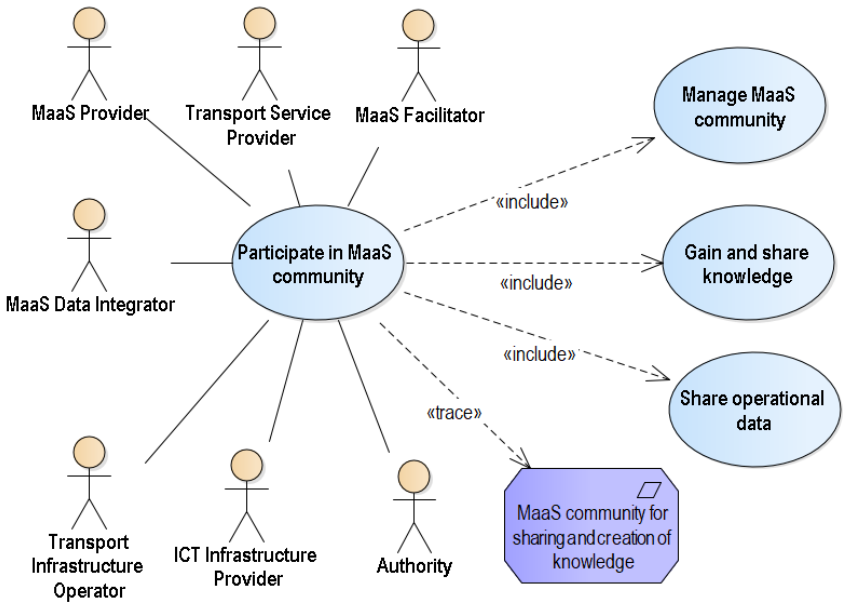

Figure 26 Use case: Participate in MaaS community

The use cases included in Participate in MaaS community are further described below.

5.6.1 Manage MaaS community

A community open to all parties with interest in MaaS should arrange for formal and informal communication and collaboration. The participants may represent the public sector, the private sector, and research organisations and may include Authorities, Transport Infrastructure Operators, ICT Infrastructure Providers, MaaS Providers, Transport Service Providers, MaaS Data Integrators and MaaS Facilitators. The community may be lead by a representative from one of these roles.

Different types of communication and collaboration channels should be provided, e.g.:

- Digital channels for communication and collaboration
- Informal and ad hoc events where emerges issues are discussed.
- More formal events where people can meet, present experiences, share knowledge and discuss

5.6.2 Gain and share knowledge

Regulators, Transport Infrastructure Operators, ICT Infrastructure Providers, MaaS Providers, Transport Service Providers, MaaS Data Integrators and MaaS Facilitators should through participation in the MaaS community gain new knowledge of relevance, and they should also share knowledge.

5.6.3 Share operational data

Regulators, Transport Infrastructure Operators, ICT Infrastructure Providers, MaaS Providers, Transport Service Providers, MaaS Data Integrators and MaaS Facilitators should through participation in the MaaS community share operational data on the transition towards more sustainable transport to facilitate learning.

5.7 Other use cases

This section provides use cases for the secondary stakeholders that are not sufficiently accounted for in section 5.1, 5.2, 5.3, 5.4, 5.5 and 5.6.

5.7.1 Manage financial settlements

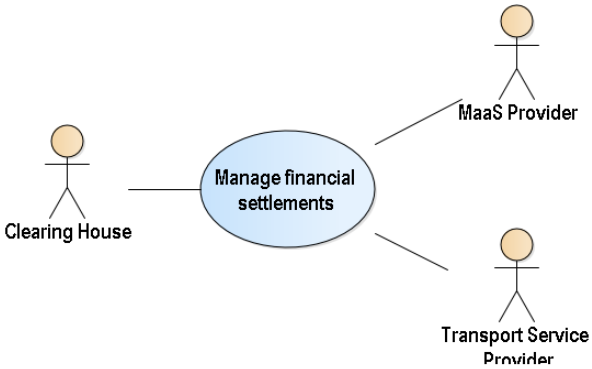

Figure 27 Use case: Manage financial settlements

Clearing Houses support the financial settlements between MaaS Providers and Transport Service Providers according to well-defined rules.

5.7.2 Find, get and use data

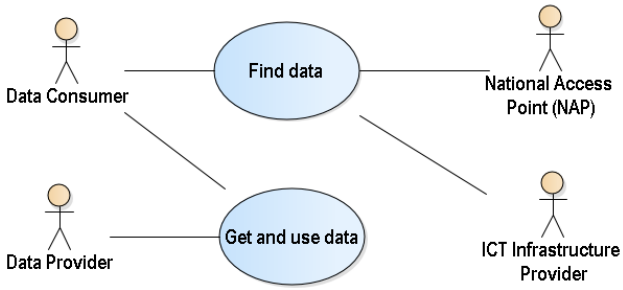

Figure 28 Use case: Find, get and use data

Data Consumers will find/discover relevant data through metadata provided by National Access Points (NAPs) and ICT Infrastructure Provides providing Mobility Data Spaces. The metadata will link to the Data Provider, and the Data Consumer will get the data from the Data Provider and use the data.

5.7.3 Facilitate electronic payment

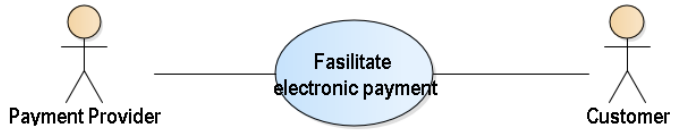

Figure 29 Use case: Facilitate electronic payment

The Payment Provider will facilitate electronic payments from Customers.

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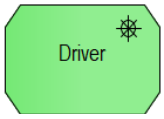
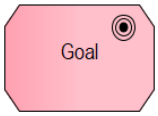
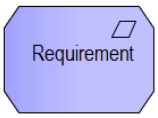
Appendix A Notations used

A.1 ArchiMate Motivation diagram notation

ArchiMate is a standardised of The Open Group and specifies the ArchiMate Enterprise Architecture modelling language (see https://pubs.opengroup.org/architecture/archimate3-doc/toc.html). The modelling of aspects of relevance to enterprise architectures is supported by a graphical modelling notation. Different types of model elements are provided. In this report we use a selection of the motivation elements to model motivation diagrams and a selection of the business layer elements to model the functionality needed.

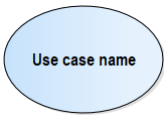
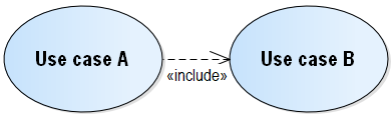
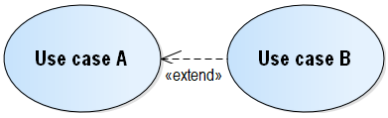
The table below shows the notion used in the ArchiMate motivation diagrams. It consists of boxes with a symbol in the upper right corner, lines, and arrows. In addition to the symbol, we also use colours to better distinguish between the different model elements.

Notation used	Description
	A **driver** for a stakeholder role, i.e., what motivates the stakeholder role to an adaption to MaaS.
	A high-level statement of the **goal** of a stakeholder role, i.e., the intent, direction, or desired end state.
	A **requirement** represents a statement of a need defining a property of the MaaS ecosystem as described by the architecture.

A.2 UML 2.0 Use case diagram notation

UML, Unified Modelling Language, is a standardized modelling language with a set of notations for diagrams that can be used by system and software developers when specifying, visualizing, and documenting different aspects of software systems and business models. For more details, see https://www.uml.org/what-is-uml.htm.

A UML use case diagrams are used in this report to capture requirements to MaaS-related systems by describing the functionality to be provided, and to define requirements the systems pose on their environment. The model elements used in the use case diagrams are:

Notation used	Description
	Stakeholder involved in the MaaS ecosystem.
	Use case in the depicted use case diagram that is further described by the text below the diagram.
	The association with the «include» stereotype indicates that Use case B is a part of Use case A.
	The association with the «extend» stereotype indicates that Use case A in some cases is extended by Use case B.

Appendix B Mapping of stakeholder roles

B.1 Mapping to ISO roles

The stakeholder roles defined in section 3 can be mapped to the stakeholder roles defined in ISO Technical Report 7878 [8]. In general the roles overlap. This report has however defined additional roles to reflect that a flexible and modular establishment of MaaS is possible where a MaaS solution is composed on services from one or more actors that cover the aspects addressed by several roles.

This report	ISO DTR 7878	Comment
MaaS Provider	Mobility Service Provider	The ISO role also includes the following roles from this report: - MaaS Data Integrator - MaaS Facilitator - MaaS Clearing House
Transport Service Provider	Transport Service Provider	
Traveller	Mobility Service User	
Customer	Customer	
MaaS Data Integrator	-	In ISO: Part of the Mobility Service Provider role
MaaS Facilitator	ICT Service Provider Payment Service Provider	In this report, the MaaS Facilitator role is limited to MaaS related services supporting functionality/solutions for travel planning, booking, payment (the payment media part - in case of MaaS the solutions provided via the App), etc. In ISO, ICT Service Provider covers all types of ICT services, both generic and MaaS related. In ISO, the payment services have a separate role.
MaaS Clearing House	-	In ISO: Part of the Mobility Service Provider role
Data Provider	-	
Auxiliary Service Provider	-	
ICT Infrastructure Provider	ICT Service Provider	In ISO, the role covers all types of ICT services. In this report, the role is limited to generic ICT services.
Payment Provider	Payment Service Provider	In this report, the role is limited to cover generic online payment solution (e.g. use of credit cards), as defined by the Payment Provider role in the Fare Management System (IFMSA) architecture [11] In ISO, the role covers everything related to payments.
Insurance Provider	-	
National Access Point (NAP)	-	
Regulator	Regulator	In this report we have distinguished between the regulator(defining policies, strategies and regulations) and the more operative authority role.
Authority	Regulator	
Business	-	
Transport Infrastructure Operator	Transport Infrastructure Operator	

B.2 Mapping of roles to stakeholders in Norway

The table below shows examples of actors that may fulfil the different roles. The examples are mainly Norwegian stakeholders.

This report	Real actor examples	Comment
MaaS Provider	- Potential MaaS providers like Ruter, Kolumbus, Skyss, Entur, …	Provides services to travellers/customers Provides an MaaS App Integrates with Transport Service Providers through use of data delivered by the MaaS Data Integrator and services/solutions delivered by the MaaS Facilitator.
Transport Service Provider	- Public transport providers like Ruter, Kolumbus, Skyss, … - Car sharing providers like Hertz and Hyre - Micro mobility providers like Ryde, Voi, … - Providers of several types of transport services like Vy	
Traveller	- NN	
Customer	- NN	
MaaS Data Integrator	- Entur - MaaS Providers	MaaS Providers may decide to do the integration themselves
MaaS Facilitator	- Entur - MaaS Providers - Commercial service providers	Providers of travel planners, booking and payment solutions, data analytics services, solutions for standardised agreements, MaaS platforms that can be customised, … MaaS Providers may decide to develop solutions/services themselves.
Clearing House	- MaaS Providers - Trusted commercial actors	MaaS Providers may decide to handle the financial settlements themselves.
Data Provider	-	Many of the others
Auxiliary Service Provider	- Meteorological services (met.no) - Public road administrations - Other service providers (food, drink, …)	
ICT Infrastructure Provider	- Telecom companies - Cloud providers	
Payment Provider	- Nets	
Insurance Provider	-	
National Access Point (NAP)	- data.norge.no	
Regulator	- Government - National assembly	
Authority	- Public administration - Municipalities/Counties - Transport authorities and other authorities	
Business	- Commercial owners of MaaS operators	
Transport Infrastructure Operator	- Municipalities - Counties - Residential developers	

Appendix C Expected impact EU regulations will have on MaaS stakeholder roles

The table below describes expected impacts the measures stated in the Data Governance Act and Data Act may have on different MaaS stakeholder roles.

EU Measure	Roles this measure may impact	Expected impacts from EU measures
Data Governance Act		
Measures to facilitate the reuse of certain public sector data that cannot be made available as open data.	MaaS Provider	Additional government data related to travel patterns, city planning activities, infrastructure developments, new building developments, etc. may bring useful input to planning market strategies and MaaS service provision for the MaaS Provider.
	Transport Service Provider	Additional government data related to travel patterns, city planning activities, infrastructure developments, new building developments, etc. may provide useful input to planning market strategies and transport service provision for the Transport Service Provider.
Measures to ensure that data intermediaries will function as trustworthy organisers of data sharing or pooling within the common European data spaces.	Traveller / Customer	Trustworthy management of personal data can help mitigate concerns travellers / customers have with data sharing.
	Transport Service Provider	Trustworthy management of business sensitive data can help mitigate concerns transport services providers have with data sharing.
	MaaS Provider	Trustworthy management of business sensitive data can help mitigate concerns transport services providers have with data sharing.
Measures to make it easier for citizens and businesses to make their data available for the benefit of society	MaaS Provider	New digital infrastructures, tools and regulations can result in additional data (both transport data and other data) provided to the MaaS Provider (via the MaaS Data Integrator).
	MaaS Data Integrator	New digital infrastructures, tools and regulations can simplify effort related to data collection and data integration from TSPs and other data providers.
	Transport Service Provider	New digital infrastructures, tools and regulations can make it easier for TSPs to share their data with the MaaS Data Integrator.
Measures to facilitate data sharing, in particular to make it possible for data to be used across sectors and borders, and to enable the right data to be found for the right purpose	Traveller / Customer	Data sharing practice aligned across sectors and borders will enable the Traveller / Customer to use the same MaaS Provider / MaaS App in different countries.
		Data sharing practice aligned across sectors and borders can lead to new and innovative end-user functionality provided to the Traveller / Customer.
	MaaS Provider	Data sharing practice aligned across sectors and borders can open up new market opportunities in other countries and an increase in Travellers /

		Customers from other countries (than the MaaS Provider´s native country).
		Data sharing practice aligned across sectors can stimulate to innovative functionality in MaaS applications.
	Transport Service Provider	Data sharing practice aligned across borders may result in Transport Service Providers benefitting from new Travellers / Customers from other countries.
Data Act		
Facilitate access to and the use of data by consumers and businesses, while preserving incentives to invest in ways of generating value through data.	Transport Service Provider	An EU measure enforcing product manufacturers (e.g., cars and other vehicles) to share more of the data collected by their offered products may provide the Transport Service Providers increased data access and corresponding insight from vehicles used in transport services.
Provide for the use by public sector bodies and Union institutions, agencies or bodies of data held by enterprises in certain situations where there is an exceptional data need	MaaS Provider	The MaaS Provider may have to share more data to government level to prevent or mitigate exceptional situations such as catastrophes, pandemics, etc.
	Transport Service Provider	The Transport Service Provider may have to share more data to government level to prevent or mitigate exceptional situations such as catastrophes, pandemics, etc
Put in place safeguards against unlawful data transfer without notification by cloud service providers	Traveller / Customer	Such safeguards may give the Traveller / Customer more control of personal data stored "on the cloud".
	Transport Service Provider	Such safeguards may give the Transport Service Provider more control of business sensitive data stored "on the cloud".
	MaaS Provider	Such safeguards may give the MaaS Provider more control of business sensitive data stored "on the cloud".
Provide for the development of interoperability standards for data to be reused between sectors	Traveller / Customer	Improved cross-sector interoperability standards will enable the Traveller / Customer to use the same MaaS Provider / MaaS App in different countries.
		Improved cross-sector interoperability standards may result in increased functionality in MaaS service based on integrated data from other sectors.
	MaaS Data Integrator	Improved cross-sector interoperability standards will make data integration easier.
	MaaS Provider	Improved cross-sector interoperability standards can result in access to more non-transport data that can provide additional functionalities and services.