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D7.2: Empirical model to analyse incentive structures

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This deliverable is subject to final acceptance by the European Commission.

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Executive Summary

When designing the governance of a data platform and related services for mobility a number of key issues ask for attention. This documents shows the first governance issues as they came up in interviews in Rome and Venice. The three cities are very different in terms of the governance “canvas” they provide to paint a governance structure on for PETRA. Key issues presented in chapter 2 are data quality assurance, integration of supply and demand related values, scoping issues, centrality of the governance, and the core values that should be guarded by the governance in a strong matter.

The document looks at incentives for different stakeholders to participate. These are obviously related to their values, which could reveal themselves in the interest that they claim and the identity that they take. In addition, values of regulating stakeholders could drive incentives for regulated stakeholders.

For example, interest of end-users could be related to shorter travel-times, their identity could be based on a sense of community and they can be held to specific legal conditions by general regulation of governments. These all can drive their inclination to participate and make a system like PETRA successful.

Chapter 3 looks ate the different expected types of incentives for the various stakeholders: end-users, transport operators, service and data providers, authorities and research and development related actors. The list structures the analysis of the upcoming case studies, where the relevance of these incentives for the governance of data platforms on mobility will be validated.

Chapter 4 looks at for theoretical models for the governance of data platforms for mobility. Three are archetypical: market, hierarchy and community. In the first, competition drives the development of data provision, services and infrastructure use. In the second, governmental decision-making drive that development. In the third, community drives that development. The forth model points at the most realistic option: governance will be a mix of the three, with for example the ability to use mobile operator location data driven by market forces, the use of infrastructure and public transport operator data driven by hierarchy and the willingness to join as a user of the app driven by a sense of community. In the cases, we will look at the use of elements of all three models in the governance.

Finally, chapter 5 presents the first set-up of a stress test. How do we evaluate the various elements of the governance, market, hierarchy and community on data, services and infrastructures? Key factors are defined that drive the strength of that particular governance model, demand and supply levels for the market, legitimacy and politization for the hierarchy, size and trust for the community models.

This document is the basis for the upcoming analysis of real-world governance of data platforms in mobility related environments in WP7.

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1 Introduction

PETRA – Personal Transport Advisor: an integrated platform of mobility patterns for Smart Cities to enable demand-adaptive transportation systems is a project funded by the Seventh Framework Programme of the European Commission under Grant Agreement No. 609042. It provides the technological foundation for developing a service platform that connects the providers and controllers of transport in cities with the travellers in a way that information flows are optimized while respecting and supporting the individual freedom safety and security of the traveller.

Due to worldwide urbanization, major problems of cities are often related to urban congestion, accessibility, liveability, air quality or traffic safety. The aim of the PETRA project is to minimize (a set of) these problems by advancements on sustainable city-wide transportation development and increasing the knowledge on emergent trends in mobility, while meeting the city users' mobility information needs and simultaneously having the cities' best interest.

Within this deliverable, the analytical model for governance and business models for PETRA is described, including the possible relations between stakeholders, data and services and user requirement. This document, together with the contextual model (D7.1), will be an input for the governance handbooks the PETRA project will produce.

1.1 PETRA Project Overview

The goal of the PETRA project is to develop a service platform that connects the providers and controllers of transport in cities with the travellers in a way that information flows are optimized while respecting and supporting the individual freedom safety and security of the traveller. In that respect cities will get an integrated platform to enable the provision of citizen-centric, demand-adaptive citywide transportation services. Travellers will get mobile applications that facilitate them in making travel priorities and choices for route and modality. The work will result in a citywide transportation system comprised of several sub-systems that involve transportation services and policies to be adaptive to the travel demand of the citizens. To achieve this, the platform will fuse different data from various city sources, travel operators and citizens, perform a broad class of predictive analytics, detect the real-time events based on the analytical information and real-time data, and provide information services to the transportation service providers and city stakeholders to optimize the transportation offerings, taking citizens' interests into account directly. The envisioned platform will address key research challenges by:

a) enabling a coherent model of mobility patterns via the capture of their multi-dimensional, collective, analytical and dynamic aspects;

b) driving the application of this model via incorporation into various transportation services and city-level policy evaluations;

c) paying specific attention to the governance aspects on how to handle the public – private and privacy issues of connecting travellers, cities and data and transport providers together through such a platform.

Three cities with different use cases will evaluate the platform and will host three demonstrations of a mobile Personal Mobility Advisor app.

To achieve its goals, PETRA conducts original research and applies technologies from the fields of Big Data Management, the Internet of Services, Semantic Web, AI Planning, Stream Processing, Simulation, Data Mining, and Human-Computer Interaction. For more information, please refer to the project Website at http://petraproject.eu/.

1.2 Deliverable Purpose, Scope and Context

The purpose of this deliverable is to structure the analysis of governance models and business models of data platforms. WP 7 is focussing on the governance of the PETRA data platform, with its final aim to design governance that fits the goals of PETRA and the existing institutional and governance environments of Tel Aviv, Rome and Venice. In addition, the work package will develop handbooks to be used by other cities that are developing data platforms for mobility.

To analyse the best fit between the governance needs of a data platform on mobility and the existing institutional and governance environment, the work package will analyse the governance of existing data platforms on mobility and logistics, to learn from these and translate these lessons into design guidance for cities contemplating the (further) development of infomobility systems, in particular data platforms on mobility.

1.3 Document Preparation

This document is primarily prepared by TU Delft with input from interviews in Venice and Rome. The document builds on the outcome of earlier plenary meetings. These meetings provided a perspective on the key stakeholders, data sources and possible high-level designs, including a range of options conditioning the governance. This is all captured in deliverable 2.1.

HLD concepts were developed in these meetings, forming the basis for our perspective on the key tasks of the data platform. This allows us to relate these tasks to stakeholders, evaluate their incentives, and develop a comprehensive overview of governance and business models.

In Rome and Venice interviews were carried out to understand the institutional context in which PETRA will have to function in these two cities. In addition, earlier research was revisited that analysed both inter-organizational governance models for data platforms as well as metropolitan governance of mobility, both throughout Europe as well as in Tel Aviv.

The models will form the basis for a further analysis of governance in Europe of data platforms and metropolitan mobility systems. Eventually, this will be the basis for the two handbooks for governance design and the designs of the governance of the platforms in Tel Aviv, Rome and Venice, to be validated by the partner cities.

1.4 Document Status and Target Audience

This document is listed in the Description of Work (DoW) as “public”, as it provides general information about the contextual models for governance of PETRA and can therefore be used by external parties in order to get according insight into the project activities.

While the document primarily is aimed at the project partners, this public deliverable can also be useful for the wider scientific and industrial community. This includes other publicly funded projects, which may be interested in collaboration activities.

1.5 Document Structure

This deliverable is broken down into the following sections:

- Chapter 1 provides an introduction for this deliverable, including a general overview of the project, and outlines the purpose, scope, context, status, and target audience of this deliverable.
- Chapter 2 provides a overview of the empirical quick scan that has been carried out in Rome and Venice, to understand the institutional and governance environments in which the governance of the data platform will have to be fitted. In February a similar quick scan will be carried out in Tel Aviv.
- Chapter 3 introduces the analytical model for the incentives that will be included in the analysis of both the governance in the three cities as well in other cases to be analysed.
- Chapter 4 introduces three integrated theoretical models that illustrate the width of the solution space to be used in designing the governance for the data
- Chapter 5 finally introduces the stress test that will be used to analyse the governance designs for uncertain or changing factors.

2 Empirical validation

2.1 Overview

The key outcomes from the interviews in terms of the stakeholders identified in Venice and Rome is presented in this chapter. This is our first empirical validation of the approach the research has taken. The key question this chapter is answering is: what empirical particularities in governance did we discover from the interviews in Rome and Venice?

2.2 The cases of Venice and Rome

Venice and Rome have been studied to validate the governance model as outlined in D.7.1 on existing infomobility initiatives (wider then data platforms). Three one-hour, semi-structured interviews were conducted in each city. Respondents were selected to attain insights in the relevant governance context for data platforms like PETRA. In Venice, interviews were done with respondents from the transport operator ACTV, interest group Associazione Defisa Consumatori (ADICO) and the municipality as a transport authority. In Rome, interviews were done with respondents from a private transport operator, a policy making agency and the municipality as transport authority.

The institutional context of infomobility in Venice and Rome is, of course, similar. It is managed by local authorities under Italian law and regulations. The institutions are also subject to change. The liberalization of the local transport system has led to a completely new organization of the system. The various territorial authorities have taken on a central role, both in terms of funding and management. For rail transport, the main authorities are the Regions; for road and public transport, the Regions delegate most of the tasks to the local authorities. They are to some extent tendering out public transport, but future legislation around this matter remains unsure. Here differences among cities occur. Rome has tendered out 20% of public transport services to a private company. 80% has been mandated to an organization fully owned by the Municipality. The local public transport services in Venice are operated under a contract of service. It is a Joint-Stock Company wherein the city of Venice is the largest shareholder with over 73% of the shares; other shareholders are all public.

Another difference is the existence of a Mobility Agency in Rome. The Municipality delegates decisions on service planning. In particular, these technical agencies decide on the mobility strategies. They also establish the percentage of contracting and then issue tenders to select the operators who provide the service. Also some regulatory functions are delegated to the Mobility Agencies. Venice is currently developing towards creating a mobility agency which might be a similar overarching regulatory authority.

2.3 Emerging governance issues

For both cities we give the top ten governance issues as mentioned by the respondents when asked to anticipate the actualization of a future data platform like PETRA.

Venice	Rome
• Synchroning and integrating information from many different sources • Having effective tools and resources to be able to adapt the offer of transport services (for example the number of runs) based on the actual demand and the congestion situation assessed on a real time basisHaving the appropriate tools, resources and legal framework to obtain real time information on the number of passengers on board, to be able to compare it with the number of ticket validations and use this to detect fare evasion episodes. Anticipating maintenance costs of the data platform, given the high standards of availability, quality and reliability a transport operator may want to uphold • Dealling with role ambiguity (e.g. local political stakeholders might represent specific interests and request changes to the service, that do not always match with the possibility to run the service in the most efficient way and therefore affect the work of operatorsDefining in a non ambiguous way roles and responsibilities for providing data, ensuring data quality and also for data ownership (e.g. Google demanded that the transport operator would be responsible for the nature of the information Google provided, but Google remained owner of the information) • Allowing for a negotiable system where the interests of all stakeholders are taken into consideration, but where decisions are made in the interest of the community as a whole, therefore ensuring that the data platform does not become a prerogative of a few influential stakeholders. Coping with scarce resources (e.g. partnerships	• Dealing with a multiplicity of transport operators and their various preferences, software, contracts and data • Defining the relevant scale and how to mix up different scales (urban, provincial) • Dealing with principal-agent problems between authority and operators • Overseeing the amount of changes and their total impact on the system • Mixing up support and control. How to entice actors to join if they might get controlled by the systems as well? • Facilitating normal days as well as extreme days (e.g. Pope days). How and when to scale up and down? • Creating strong problem ownership if the amount and variety of participants is changing • Defining formats of information exchange where actors have to comply to and actually have something to lose • Arranging for trade-offs between e.g. information quality and the degree of integration • Maintaining trust and goodwill, considering the factors above

such as relationships between transport operators and customers) • Ensuring the appropriate legal framework, tools and resources to fight vandalism. Avoiding technological dependencies from the vendors, so that the technological system can evolve in the most efficient way with a high level of integrability and scalability without depending on proprietary solutions (e.g. electronic ticketing system).	

Table 1 Governance issues in two cities anticipating a future data platform like PETRA

2.4 Validation

Discussing governance issues with the stakeholders in both cities, raised the following observations:

- Studying these two cities generally confirms that governance is considered important as well as challenging for the success of data platforms like PETRA. As mentioned in D.7.1, variety is a major source of governance challenges. This relates for example to the scale issues, role ambiguity and various other sources of variety that are mentioned in the table above. As a result of these sources of variety, the Rome case displayed several governance challenges. These related to software, contracts and data characteristics. For example, respondents in Rome described that the data they use came from local and regional transport operators. The local operator gave the data for free. The regional operator got paid for it.
- The governance challenges mentioned in D.7.1 also reflect in the account of the respondents. We will discuss this briefly here:
    - *Data quality assurance*. The quality of data differs among modularities (i.e. trains, busses, bikes, boats etc.). There are several possible causes for this. For example: the management of some modularities is more mature than the management of others. For example bike sharing initiatives are relatively new compared to bus transport. The quality of data also depends on the formats used, which may get politicized, because a change of format for data exchange may imply costs. Who defines these formats, defines the data quality, possibly without overseeing and/or prioritizing this issue.
    - *Integration of supply and demand*. The infomobility initiatives focus on multiple values, different values for different related stakeholders. Some of these values concern demand, such as travel efficiency. Others are anticipated by suppliers. This involves questions like: are tourists interested in destination X? Is the app unique enough? Also on the supply-side, some values are addressed by policies, such as health and environment, crowd control and safety.
    - *Scoping*. The geographical scale appeared hard to define and changing. Urban systems are dynamic and their mobility impact stretch far over the borders of the city. This results in regularly defining and redefining the scale

of infomobility and any redefinition potentially results in again different prioritizations by different actors. For example: local, provincial and national operators operate in different arenas and have different agendas. Why should a provincial operator want to optimize an urban system?

- *Centrality*. Centrality typically is tied to the efforts to integrate data and services and the actors that represent them. The perception of problem ownership by the central actor - i.e. the municipality - is vital here. Such a 'problem owner' is vital to tackle minor and major issues, just to keep on moving the infomobility project. Differences appear with respect to this problem ownership in the two cities studied. In the Rome case, the municipality aspires to actively participate in and contribute to infomobility. In the Venice case, the municipality does not consider it a matter of their direct concern. In general, it is currently presumed to be relevant for the transport operator, although for the future AVM could develop into an mobility agency. Another example of an issue on the way is the involvement of the police in the Rome initiative. Data are used for supporting travelers, but may also be used for control (i.e. fining). Why would a taxi company be willing to provide information if they at least perceive that this information will also be used by a central authority to issue penalties?
- *Core values*. This challenge hasn't been observed as prominent in the cases. A core value is privacy, but there is yet no consolidated expereince for the management of privacy in complex integrated data platforms. For example: some data will get disclosed. Not all data are gathered with the intention to get disclosed. When is this problematic? The higher the ambitions to open up, the more prominent this issue may get.

- The governance challenges identified in the cases were largely about data and services rather than infrastructure issues. Currently, this seems to be related to the governance fragmenation, with infrastrucutes in the hands of separate entities. We will still consider infrastructure issues in further case studies to uncover this.
- At first sight the governance challenges seem to be applicable to both cities. The main institutional difference between Rome and Venice is the central coordination of infomobility by the Mobility Agency in Rome. This resounds in some governance challenges. In Venice preserving data on passenger transport is more an issue than in Rome. These are of course challenges for all governance efforts, but may be even more challenging without a strong central transport authority. This suggests that the institutional context matters.

Finally, we observed no clear analytical distinction between the governance aspects of data platforms like PETRA and the technical management of it. Issues like data reliability, synchronization and enrichment, for example, are essentially technical-managerial challenges but nevertheless also frequently mentioned for their challenging governance aspects as well. The technical management of data platforms like PETRA is understood as considerably interwoven with its governance context

3 Incentives for relevant actor categories

3.1 Overview

For the design of the governance of PETRA, it is important to understand the incentives that the different stakeholders experience in the context of the platform. Part of the analysis of the cases in WP7 will look at the reality of incentives: which incentives exist and how do they influence the behaviour of the different stakeholders related to the platform. Obviously, relevant focus for this research is the way in which these incentives contribute to the continuation and amelioration of the platform. This chapter sets up that analysis. The key question is: what are expected incentives for the different stakeholders?

3.2 Incentives types

Incentives are expectations of an improved situation to a stakeholder making a specific choice. The key choice of the stakeholders we are researching here is whether and how to contribute to the (PETRA) platform in all possible ways.

3.2.1 Enticing stakeholders to contribute

First of all, the PETRA platform can improve its value to the users when more relevant data sources that align with the modelling approaches can be used. Not all data are relevant to PETRA, but many different forms of mobility related data could support the quality of the PETRA platform for end-users but also for the dashboard users.

Second, the strength of the platform is that it could allow for the development of various forms of services. The obvious service is the separate app or app addition that provides fully integrated, aware and real-time support to the traveller on his journey. It is integrated because it includes all possible modes and options, it is aware because of the high level of data used, and it is real-time as it is based on the current situation and modelling the near future. However, others could develop different services on the platform, which could further increase the value of the platform.

Third, the platform itself will need direction to keep developing in the future. This can be arranged in various ways in which stakeholders are involved in setting the rules for the maintenance and improvement of the platform. We can expect technology developments, data shifts, user demand changes, regulatory transformations, all providing a reason for PETRA to react. These could change the business case of PETRA, and reset the incentives. This illustrates how the governance of PETRA is dependent on its environment and that PETRA in the core needs governance that can guide it through such changes.

As said, incentives are in essence expectations, based on value created for stakeholder, by a new situation, for which stakeholder can choose to contribute. The stakeholder expects a relation between his contribution to the new situation and value to him of this new situation. In case of the platform, an incentive can be the profit that stakeholders have from selling data, or expected market share improvements, or better relations with other relevant stakeholders.

3.2.2 Challenges

A key challenge with incentives is uncertainty. The value created is often depending on more stakeholder's actions or specific other development. These actions or developments might be uncertain, leading to uncertainty about the incentive. This section focuses on incentives that can be created into the PETRA environment to create value for and support from the stakeholders. That is a theoretical and simplified view of the reality of incentives. In the case studies we will include the way in which uncertainty plays a role in the effect of incentives that do exist or will be worked into the PETRA platform environment.

Incentives work on different levels differently. What can be an incentive on an organisational level, might not reach the individuals that do the key work on an individual level. That tension between organisational level and individual level is an aspect of the incentives that we will take into account, for as far as the data in the case studies allows us to do so.

In the economic literature incentives are often modelled as monetary value. However, literature has shown that the values are far more varied and complex and often monetization does no justice to the value experienced by the stakeholder. As a consequence we will look at incentives not simply as a monetized value, but do justice to the way in which the stakeholders make their choices towards a data platform.

Incentives can be related to the interests of the stakeholder. This is when the stakeholder has a direct gain from the expected situation, expressed in the values below. In addition, value can also be when the stakeholder is strengthened in its identity. For example, value can be created for public entities when the public role in city is valued and recognized. Moreover, value can be created by compliance to regulation. Non-compliance will generally create disvalue.

	Interest-based	*Identity-based*	*Regulated*
End users	Shorter travel-time Lower time uncertainty More travel options Higher comfort level More sustainable travel	Sense of community, users Sense of community, region Status Morality	Legal standards Contract implications
Transport operator	More passengers More income Less complaints	Passenger satisfaction Worker satisfaction All-inclusive public transport Professionalism/skills	Concession requirements Contract implications
Service and data providers	More income More data Better	Status Mission Expertise	Contract implications
Authorities	Compliance with policy goals	Public interest	Legal tasks Concession requirements Contract implications
R&D actors	More data Innovation	Fundamental ideas	Contract implications

Table 2 First exploratory list of incentives

The case studies will look at the incentives that the various stakeholders experienced in the three types of contributions mentioned above. We will explore them further below.

3.3 Incentives on different roles in (PETRA) data platforms

In this section we will look at the key roles that stakeholders can have on the PETRA platform (or similar data platforms). We will address the possible transactions to be looked at when developing the governance and reviewing it for a stable incentive structure.

3.3.1 Incentives on data provision and quality

An obvious choice for stakeholders that has importance for the platform is whether or not to provide data to the platform. A key aspect of that data is whether the quality of the data is secured. All kinds of stakeholders can provide data to the platform. The current PETRA urban data catalogue (UDC) shows what data is valuable for the PETRA platform. It distinguishes between the following data (adapted from v3 of the UDC):

- Map information (locations of relevant objects: nodes and links)
- Flow information (individuals, vehicles)
- Mode related information
    - Public transport service information
    - Car park information
    - Bike share information
- Infrastructure information
- Attraction point information
- Policy information (speed limitations, road closures, exclusion zones, parking diversions)

On most data, a distinction can be made between historical data (how traffic normally flows) and real-time information (how traffic currently flows). That distinction is important in terms of incentives. The value of the different data is expected to be different, with higher value placed on real-time, and the concerns about providing real-time data can be more substantial. This means that securing a reliable stream of real-time quality data is expected to require more effort and will have to result in stronger incentives to the provider to work on, then is historical data.

3.3.2 Incentives on service use and service development

The PETRA platform first and foremost will be built to provide real-time integrated travel advice to end-users, with the possibility to authorities to influence the stream of travellers. To establish the viability and the expected governance, the case studies in WP7 will look at those services, who holds the development and maintenance of that type of services and what incentives they have.

Currently, for the three cities working on the PETRA platform the stakeholders seem to be obvious, with municipalities driving the development in Rome ad Venice and the NTA driving the development in Tel Aviv. So, the case studies will look closer at incentives within governmental departments.

However, there is a second aspect. The platform holds a strong promise to other services to be developed on its basis. The development of new services can have a positive or negative incentive on the core service of PETRA. For example, other services (outside PETRA) can include travel planning on the basis of the PETRA platform in a way which is more attractive to travellers. The case studies should answer the question in what form additional services should be incentivised to overall strengthen the PETRA platform and in what forms there is a risk of diluting the value of the PETRA platform to existing key stakeholders.

3.3.3 Incentives on platform maintenance and improvement

A third type of incentive is that of the maintenance and improvement of the platform itself. PETRA will need a datacentre, the form of which is already in development. In the current perspective on what the PETRA platform is going to be we see three lines of value development that have to deliver an incentive to those maintaining and improving the platform. The first line is that of the app and the service it provides to the different users. That could provide an incentive for maintenance and improvement, for example by realizing a revenue stream. The second line is that of the dashboard, in which policy makers can create value by (re)directing the streams of travellers in the city. Also, that could create enough value for them to contribute to the maintenance and improvement of the platform, in kind or in monetary form. The third line is that of data users, where the platform through its integration of data creates value for other users of that data. Here the options for incentives other than monetary seem limited, as the users of that data are currently not part of the key stakeholders of the PETRA platform.

3.3.4 Incentives that interconnect the different roles

Finally, we will look at the cases that link the different elements mentioned above. Incentives provide stability when they are parallel. For example, as a data provider creates value for the platform by delivering a steady stream of high-quality and relevant data, stability of the service provision is helped if data provider receives enough value back from its contribution to the PETRA platform. That could be monetary or it could be other value. For example, a public transport operator could provide its stream of passengers or electronic ticketing data to the platform and receive in return the integrated view on traveller streams that PETRA produces to improve its planning of services.

3.4 Conclusion

This chapter indicates the first set of incentives that have to be understood to develop a stable governance system for the PETRA platform. It provides the basis for our analysis of real-world governance of data platforms and which incentives play the most important role in that governance. We make two distinctions, the value that the incentive is for the stakeholder (interest, identity or regulation based) and the activity for the PETRA platform (data provision and quality, service use and development, platform maintenance and improvement).

The analysis is not limited to monetary incentives. If incentives are skewed, monetary incentives can balance that through a monetary transaction. However, the PETRA platform

allows for a lot of tit-for-tat or in-kind value creation, without a monetary element to the transaction. These we will also evaluate in the cases to be carried out.

4 Theoretical models of actors, roles and incentives

4.1 Overview

To get a first perspective on possible ways in which the governance of the platform could work, including a stable set of incentives, this section provides a number of models. Key question: what theoretical models are possible, linking the expected stakeholders to the platform and what are the expected incentives in the models?

The basis for this section is the high-level designs that were developed by the PETRA team. In two sessions the team worked on possible forms in which the services within PETRA could be set up and at what particular stakeholders it should be aimed.

As in all the cases to be analysed, in Tel Aviv, Rome and Venice the possibilities on how to set up the governance are limited by the institutional and governance environment in place. The PETRA project looks beyond those cities for governance into the wider possibilities for governance of data platforms for mobility. The models here provide a first indication of the wider solution set of governance possibilities.

This section also looks at possible business models. Governance and business models are related. The governance model includes the set-up of incentives for stakeholders to relate them to the platform. For the governance model to be viable as a business model, the sum of all the incentives should be positive.

The aim of this section is mainly to illustrate the so-called generic solution space of governance models. This solutions space is the theoretical set of all possible options of governance for the PETRA data platform, limited to the European context. The models presented here illustrate integrated sets of choices in that solutions space.

The development of the models was started by the complete PETRA project team in a number of high-level design workshops. Based on these high-level designs the TUD developed a number of governance models. These are not tuned yet to Tel Aviv, Rome and Venice, but generic. This is in line with their role: illustrating integrated models of governance of a starting point for the empirical analysis of governance of data platforms for mobility.

The models will be discussed by looking at the key stakeholders, their role and incentives to contribute and the upsides and downsides of these theoretical governance models.

4.2 Market

The platform is run as a separate commercial service, outside the public realm. In a market model two characteristics stand out. First, incentives are essentially financial. Transactions on services or data are balanced through financial remuneration. Second, the governance of the platform is driven by choice of consumers, all consumers, not just end-users. Third, the platform is agnostic in terms of the direction of its development. There are several revenue streams possible. Which revenue stream is the largest drives the development of the platform. In that sense, governance of the platform is narrow: value driver is the value of the platform. The direction the platform is developed in is essentially

driven by the market with little other governance, the demand of functions by transport operators, authorities and service providers for the platform and the supply of data available.

End-users can use the app as a high-quality travel planner. They can use the app as in a “freemium” model. Simple travel advice is provided for free to create market penetration, for more advanced functions the end-users have to pay. This provides a first revenue stream for the platform management costs of PETRA. One of the possible ways to “pay” as an end-user is through sharing of data to the platform. The sales of those data provide the platform with a second revenue stream.

Transport operators can buy-in to the service, for example by providing a customized environment. For transport operators the PETRA platform is a full-service concept: it provides them in a simple manner with a high-quality travel planner or with a value addition to existing travel planners.

Data providers are paid for their data, unless the data is freely available. The platform is set up to be flexible in the data sets it can use. The aim of this is to use competition between data providers as a mechanism to drive the price down. Other revenue streams should be substantial enough to allow for data procurement. It is also an incentive to drive app-created data from the end-user.

Service providers can become clients of the platform. Possible users of the data or analysis can buy access to the platform data and analysis. Mobility service providers can pay the platform to influence the position of their services in the options provided to the end-users.

Authorities are not the core stakeholders here. A public authority is merely a specific client of the platform. If they want to have the possibility to influence the stream of travellers, this option is provided to them as a service by the platform at a price. It can be compared to an internet search engine, with the possibility of companies or authorities to influence the ranking, inclusion or addition of options to the end-user.

R&D developers can easily step in, buy data from the platform and conduct their own analyses on that data, which they can sell themselves. Or they can provide value added services through the relations the platform has already developed with its clients, including the end-users.

The model has clear upside. The model is highly demand driven. Governance of the platform itself is narrowly focused on changing revenues. Coping with that platform has to be flexible, both in a technical sense as well as in a market orientation. When changes occur in the data available, in the demand for services, or the key source of revenue, the platform will quickly shift its focus.

The model also has a clear downside. Many separate demands can be related to the platform. However, the real value of the platform is the integration of functions by authorities, end-users, data-providers and mobility service operators working in sync to provide the best service with regard to the values of all these stakeholders. The market option is flexible, but also fragmented. Bringing that integration will be harder with the market model, as a coordinated and shared entry with a great proposition to the end-users will be more difficult to realise as the short-term bottom-line is driving the design choices.

This model is most in line with the high-level design concept 3 (“Pro-active trip mobility assistance”)[1]. That concept is squarely focused at providing a service to end-users. For this market model, the highest value is created by having a great number of end-users, which then can be monetized in the relations with other stakeholders.

4.3 Hierarchy

In the hierarchy models, the government is driving the platform. Governance is taking place within the public sector, as part of a governmental department. The platform is in essence a public sector tool, to forward economic, mobility and environmental policies in the city. The governance of the model is heavily centralized and easily integrates the different elements related to the public authority.

End-users are addressed as the visitors and citizens of the cities. For the citizens it is a public service provided to them by their local governments, for the visitors it is part of the tourist information services many public authorities are providing to their visitors.

Transport operators are included for as far as they contribute to providing a public service. Public transport operators are obviously included. Their role is limited in the governance. The public authority is providing its visitors and citizens with a full range of public services, including public transport and travel advice. The role of the public transport operators is limited to carrying out that service and possibly delivering data to enable the service.

For other non-public transport operators (car sharing, taxis) their role in this model is less clear. To have a fully integrated set of mobility options in the platform, their services should be included. This increases the value of the service to the visitors and citizens and creates increased legitimacy. However, the value this creates to these mobility service provides will be hard to remunerate into funding for the platform. Its positioning as a public service hampers a full commercialization of relations with transport operators.

Data and service providers also come in two distinct forms. On the one hand, public data providers (infrastructure managers) have a clear and limited role: deliver the data to the platform, as sanctioned by public decision-making on the role and data sources of the platform. For other data providers, two models are possible: procurement of data and a possible regulatory obligation to provide data. For the former, think about cell phone stream data (not from the app) provided by mobile operators; this could be procured. For the latter, think about taxi regulation that demands data about occupancy and locations of all taxis in the city.

Public authorities play a key role. The governance of the platform falls within the standard governance model of the public sector in a city. There can be a difference in how politicized the governance is. The platform could be seen as standard public service provision, without much public debate on form, cost and quality. This allows for a slower, integrated development of the platform. The platform could also become an instrument in more politicised environment. This would lead to a more focused, less broad and integrated development, as generally specific public goals are attached to the platform development. For example, politically the platform gains a lot of support because of its

[1] See appendix B for the various high-level design concepts

possibilities to reduce harmful emissions. In that case, the focus will be on redirecting travellers to less emitting modes, which in turn could be hindering acceptance of the platform and app by a wider set of travellers.

R&D developers play a more distant role in this model. Only if the public authorities adopt a principle of open-data and open-source, the data can be easily available to other researchers.

This model has a clear upside. Its governance is largely in place, centralistic with the possibility of integrating the various elements of public policy (from aimed at tourist, to environmental, to mobility).

The downside of this is that governance will be its monolithic character, which could keep key stakeholders, possibly with crucial potential for the platform, with no clear possibility to step in. For example, mobile phone data providers might be able to step in on the market model, developing future returns on that model. This is much harder in this hierarchy model where the key stakeholder, public authorities, is seen as the bearer of the system, with other stakeholder taking a less involved role.

This model is mostly in line with high-level design concepts 1, 2 and 4 (“mobility community”, “tourist community” and “alerting and event detection”. The community parts are set up within the existing democratic institutions of decision-making. Citizens play their normal, distant role in deciding on the development and direction of the platform, which is different from the way in which the concepts would work in a network governance model, as mentioned below. Concept 4 is aiming squarely for the value the platform has for the public authorities and as such is most at place in this model.

4.4 Network and community

In the community model the financial remunerations between stakeholders are left to a minimum. Stakeholders contribute in kind to the platform and are also paid in kind, for as far as possible. The incentives are a mix of interest-based and identity-based.

The PETRA platform is in public hands. It has a clear public style and the direct governance is coupled to the democratic controls in place in the city. Community is not only reflected in the “publicness” of the PETRA platform and its direct governance from within the existing public sector authorities.

PETRA is developed as a digital community; end-users are invited to share travel experiences and experiences with the PETRA app, including their own travel data. The data feedback is increasing the value of the platform by increasing the data quality. The comments and feedback can play an important role in the governance. New services can be introduced and evaluated using the social side of the PETRA app; forums and twitter interactions. In that way the community side of PETRA is also reflected well in the governance side.

Transport operators contribute based on their public role. They provide a municipal or regional transport service. They can give travellers that participate advantages, like free travelling kilometres or days, to strengthen the internal cohesion. In return, they can provide a better service, plan more effectively, and possibly efficiently their services based on the data and analyses they can obtain from the platform.

Data contributors are mostly participating on a tit-for-tat basis. Open source and open data are the key governing principles. Service providers using the data from the platform are allowed if they adhere to these principles. Government-controlled data (like induction loop and camera data) is provided because open-data is seen as the way forward for most governmental data. Privately controlled data is shared mostly on the remuneration through the use of other data and analyses from the platform, which can work on the premise that data providers are also service providers. The first principle for data providers in this model is data-in, more data-out.

Service providers can also participate on the basis of data-out, service-in. For example, public transport operators can get data out of the system if they contribute by providing benefits to end-users. For example, they could provide cheaper season tickets or free travel kilometres for high volume end-users providing their own travel data.

Authorities are core stakeholders of this model, especially for the more integrated incentive links between end-user and data provider. Their role in the community is ensuring stability and trust. They tie a lot of the different stakeholders together through existing relations, for example as a road infrastructure manager as well as a public transport provider. This allows for a large community with a lot of possibilities for creating synergies and mutual benefits. Trust is an important element of the governance. A community is as strong as the commitment of the stakeholders involved. That commitment is voluntary, and if they do not trust the platform or other stakeholders any more, the platform is vulnerable. This could for example become apparent in the way that the public authorities are dealing with perceived privacy issues or transparency in how they intervene in the platform transport planning algorithms.

R&D actors should be able to step in easily into the community to use the data and contribute on the basis of that data. An open source model should govern the relation with the R&D stakeholders: if you build something based on what you take out, you put it back in.

The value created is heavily dependent on the size of the community. The community should be easily scalable. In addition, trust is an important value for this model as a whole. The governance should be able to deter and expel participants in the community that do not behave according to the rules the community expects.

The model has an upside in that it is relatively low risk. There is a limited need for funding and the platform can grow despite a limited need for funding. The base of the governance is that the various stakeholders start contributing and taking out, without much need for high investment starts.

It also has a downside. In the start-up phase, data is needed for a quality of data and the resulting quality of service to the end-user. This is needed for enough use to create the value for the governmental agencies in directing the travel flows. Substantial use can in this early phase be hard to realise, as the community has to grow more evolutionary than the other models. It could not reach the threshold use to take off as a valued platform of travel advice.

This model is mostly in line with high-level design concept 1 (“mobility community”). In that model, the community link between policy makers and end-users is the clearest and strongest, in line with this governance model.

4.5 Mixed

In the reality of governance of a data platform like PETRA, a mix of the above models is inevitable. For some commercial stakeholders, like mobile phone operators, the market model will seem the most logical. They generally are directly seeking monetary remuneration for the data they provide and do not have the inclination to get involved in the platform itself. For other stakeholders, like the end-users, maybe community-oriented governance makes more sense. And for the governmental authorities, hierarchy might seem the logical way to relate organizationally to the data platform. And the expectation in our empirical analysis of governance of data platforms for mobility is to see a variety of elements of the above approaches used.

A mixed model has strength, as every stakeholder will have a relation to the platform in which suits its preference. However, on the level of the overall model it has a risk, in that the values and related incentives in one model might be disvalue and disincentive in another model. For example, the community is relying heavily on trust, which could be broken by the distant, uninvolved position the market puts stakeholders in. A stakeholder wanting to maximise financial gains from the platform, built also on community governance, can break that community by breaking trust.

Mixed models are expected to have additional governance in place, to protect the values of the different stakeholders.

4.6 Conclusion

The sections above present three theoretical models of governance from a particular governance perspective, market, hierarchy and network/community. These will guide the empirical analysis of the governance of data platforms in WP7.

5 Stress test

5.1 Overview

A stress test typically shows how a particular governance model will cope with change. Does change affect the ability to facilitate implementation or management of the data platform? We will answer this question in three steps.

First we will clarify the concept of 'robustness'. Second we will describe the core assumptions about the incentives needed to make PETRA function. These core assumptions are relevant for our stress test. If an assumption proves to be vulnerable, the robustness of PETRA can be at stake. Third we will further elaborate on the origin of change. After a picture is made of possible broader trends that are relevant for data platforms for mobility, a tool is provided to conceptualise governance change as relevant to PETRA. The stress test is a confrontation of the assumed incentives with change as conceptualised.

5.2 Robustness

"Robustness" can be typified in two ways:

- 'Robustness' in a literal sense. This is keeping on functioning under change by resisting change. The governance model then has to prove strong enough to stay untouched while still maintaining the ability to facilitate the platform.
- Adaptiveness. This is embracing change rather than resisting it. The governance model then has to be flexible enough to change itself, while maintaining the ability to facilitate the platform.

Both interpretations are oriented on the functioning of the governance model as facilitator of the implementation and management of the platform. However, the data platform demands an extra feature, because it relies on the cooperation of several actors. It is therefore possible in theory that a governance model facilitates a platform that is functioning, but few people use it and it doesn't significantly influence mobility patterns as desired. In other words: the model (and the platform) are robust enough to resist change, but are not relevant. For this reason we introduce 'relevance' as an extra criterion for our stress test. Table 3 shows our idea of stress resistance. We will define a particular governance model as stress resistant if it is both robust and relevant.

	Not robust	**Robust**
Not relevant		
Relevant		Stress resistant

Table 3 Stress resistance of governance models

5.3 Core assumptions behind PETRA

We have identified several core issues regarding data platforms like PETRA. There is a variety of actors involved (7.1 chapter 3). The variety of actors - i.e. their interests and identities - challenges coordination (7.2 chapter 3). The actors operate in an institutional context - including jurisdictions, regulations and roles - that is a given for any governance model for data platforms for mobility (7.1 chapter 4). Within this context a governance model involves specific governance choices that highly determine the way and motives actors cooperate with each other. These choices concern data assurance, integration of supply and demand, scoping, centrality and core values (7.1 chapter 5; 7.2 chapter 2). As a result of governance choices and the institutional context actors have incentives to cooperate – either being identities, interests or regulations. Regulations may influence either identities or interests.

The core reasoning here is that the PETRA platform has to rely on cooperation, but this cooperation is not a given. Cooperation is a kind of behaviour that can be influenced as depicted in figure 1.

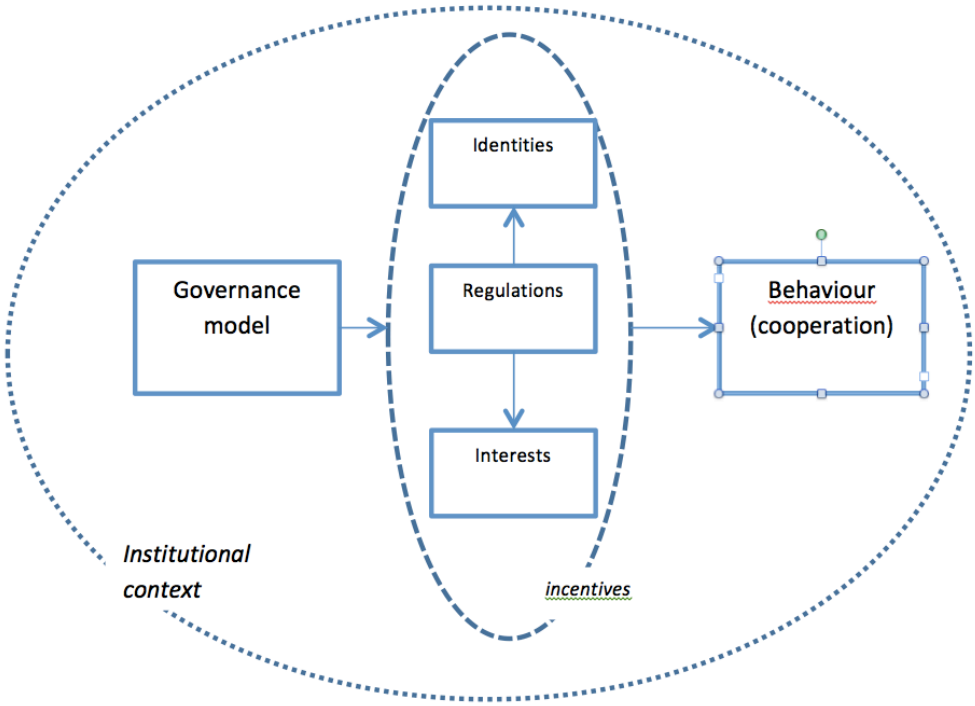

Figure 1 The reliability chain of cooperation

Cooperation is needed from various actors. We have identified 5 categories of actors (7.1 chapter 3)

- End Users of the PETRA products (i.e., city residents and tourists);
- Transportation providers (i.e. public transport operators, car sharing operators,etc.)
- Service and/or data providers (i.e. mobile communication providers, ITS providers, city event organizers, tourist organizations, etc.)
- Authorities (i.e. mobility agency, implementing strategies for incentives, etc.)
- R&D actors (i.e. universities, research centres, etc.)

Authorities and R&D actors are shaping the playing field of the data platform, the latter by providing solutions. They are however not part of the playing field themselves. We will focus on cooperation by the other three categories of actors, seeing authorities and R&D actors as problem owners here. Moreover we will make a split between infrastructures and services, like in 7.1 chapter 4.

The success of PETRA depends on cooperation by all these actors, but in specific ways, depending on their roles. We assume that actors will cooperate if they have incentives to do so. This suggests that for success of PETRA incentives to cooperate are assumed. We will identify the core assumed incentives for success.

1. More use of travel advice and mobility services provides incentives to provide data to the platform
End users may automatically provide data to the platform when using travel advice and mobility services. However, for some of these transactions permission is needed, either implicitly or explicitly. This makes this relation a subject of identity or interest incentives.
2. More use of infrastructure provides incentives to provide data to the platform
This involves the same reasoning.
3. An improvement of the quality of travel advice and mobility services provides incentives to provide data to the platform
The quality of travel advice and mobility services may result in more (technical) possibilities to transfer data to the platform. It is also possible that end users and mobility service providers gain commitment to support the platform as a return of good service.
4. An improvement of the quality of infrastructure provides incentives to provide data to the platform
The same holds for infrastructure quality.
5. An increase of data provision to PETRA provides incentives to improve the quality of travel advice and mobility services
This sounds logical. The more data are provided to PETRA, the more data can be processed, the more adequate the services may get. Furthermore, an increase of data may legitimize further investments in the data platform.
6. More use of travel advice and mobility services provides incentives to improve the quality of travel advice and mobility services
More use legitimizes (and sometimes even finances) new investments in services, which may improve the quality.
7. More use of infrastructure provides incentives to improve the quality of infrastructure
The same holds for infrastructure use and quality.
8. An improvement of the quality of travel advice and mobility services provides incentives to use them
9. An improvement of infrastructure provides incentives to use it
These are basic economic incentives.
10. An improvement of the quality of infrastructure provides incentives to improve the quality of travel advice and mobility services
Because infrastructure facilitates services, better infrastructures lowers the costs of service provision and makes further improvement of those services more attractive.

Figure 2 shows the assumed incentives in one diagram.

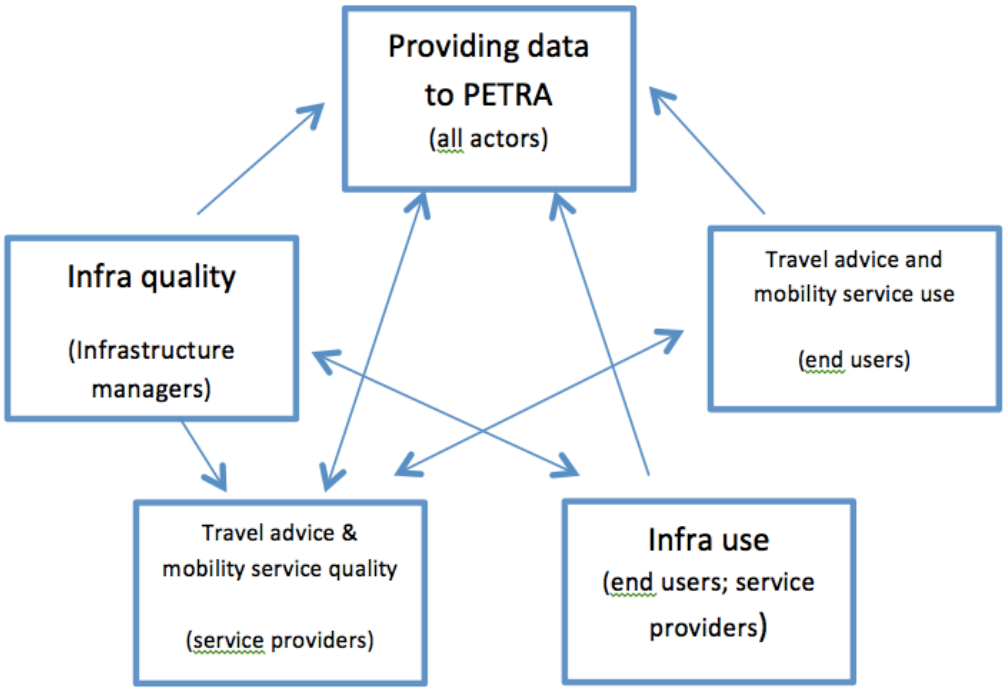

Figure 2 Assumed incentives of data platforms for mobility

The incentives all seem self-evident. So at first sight, they do not seem very susceptible to change. This, however, is only partly the case. First, we see three mutual relations. Data provision to PETRA and travel advice & mobility service quality seem to have potential to nurture each other. The same holds for use and quality of both infrastructure and service provision. That said, the potential to nurture each other may also suggest a potential for decay, if the values involved are going down instead of going up. This makes the system and its governance sensitive to change. Second, the relations may depend on for example the likeliness of investments or the willingness of sharing data. These may also depend on external factors, such as the market situation or the community-building capacities of the initiative respectively.

5.4 In search for the origin of change

As for any organisation, no matter how self-evident, PETRA will be subject to change. Our stress test involves finding out how the validity of the incentives as assumed may be influenced by change. This change is invoked by the governance model and the institutional context wherein governance is shaped. In this section we propose a way to point out change as relevant to PETRA.

A search for the nature and origin of change, of course, is a time-consuming activity for analysts and gurus all along. The future by definition is unsure and it will ever be a challenge for analysts to get a grip on it. Change in the institutional context of data platforms can, for example, be categorized as follows:

Technological change. PETRA is invoked by new possibilities of ict. Technological change may further provide both opportunities and threats to the data platform for mobility. Incremental change may nurture PETRA if its governance will facilitate its alertness. Radical change may make technological systems redundant.

Economic change. Conjuncture may seriously affect the willingness to invest in data platform and added services. It affects the financial capacity of those needed to make the platform and services work.

Legal change. As pointed out in 7.1 chapter 4 data plaform initiatives are bounded by all kind of legal conditions. Examples are jurisdictions and ownership structures. If these change, compliance issues will arise and may compete with economic issues and community issues.

Political change. The data platform and services initiatives involve issues that are potentially prone to political and societal discussion. Changes in political ideas may therefore have considerable impact. Examples of political issues are privacy, quality of life, and employability, of course in combination with traffic management.

Scenarios made out of these broader change potentials will provide sensitivity about the nature and origin of change where particular governance models may have to deal with. However, they remain very broad and the potential variety is high. Moreover, they inevitably hide many soft assumptions and many ‘unknown unknowns’ will be left out.

This raises the need to point out change some closer to the governance model. In other words, changes that may origin from the institutional environment must be determined in such a way that all possible changes are covered conceptually, yet the relevance for specific incentives is clear. For a method to do this we refer to the variables for markets, hierarchies and networks as described in 7.2 chapter 4. These variables provide a dashboard per institutional category - data, services, and infrastructure.

For example: initiatives such as PETRA - at least partly - involve markets. Market variables as described in chapter 4 are demand (high - low) and supply (high - low). These variables are relevant for incentives. For instance, the higher the supply of services like PETRA, the tougher competition, the lower the chance that users will use the PETRA service. This chance is related to data provision to PETRA (incentive 1). Market changes can be depicted in the table below. In this table a trend is drawn of rising supply.

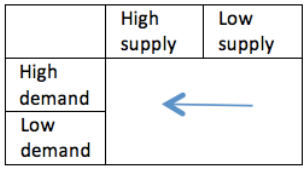

Figure 3 A trend diagram

A same table can be drawn concerning the hierarchies in data platform initiatives. These depend on the legitimacy of the hierarch and the politicization of issues. Regarding communities a table can be drawn along the dimensions trust (high - low) and community size (large – small; see chapter 4).

The resulting three tables cover a considerable amount of scenarios. If these markets, hierarchies, and communities are specified over data, services and infrastructures, a dashboard of possible shifts emerges.

The dashboard as depicted in Figure 4 represent governance scenarios for PETRA, and point towards opportunities and risks for PETRA. For example: the governance of services in a specific city may be a combination of market-, hierarchy-, and community elements. As far as the hierarchic part is concerned, a trend towards politicization and high legitimacy is an opportunity for PETRA, because it provides both public attention and a willingness to comply to rules from government. The other way around, low politicization and low legitimacy involves a risk for PETRA. End users and agencies will not feel incentives from government - to improve services. This would be a risk, if market incentives and community incentives would not compensate.

The blue arrows in the dashboards are illustrations of possible development (not related to the examples explained above). The dashboard is a device that shows major shifts relevant to incentives for data platforms for mobility. Developments towards the bottom right put more stress on the governance. Developments to the top left reduce stress to the governance.

For example, let's look at a situation where PETRA buys data on the market from mobile telecommunication operators. With high demand from the PETRA system and high supply by operators the governance can work. PETRA governance could use competitive forces to reduce costs or improve the quality of the data. When the market is limited, because of few suppliers, costs could be driven up, putting pressure on PETRA to reach its goals. A case could be the merger of mobile operators, reducing the competition in the market, raising prices for data and thus challenging a, at that moment stable business model for PETRA. The red arrow below illustrates how the dashboard could show that.

Or, if government is hierarchically governing the infrastructures (which is mostly the case), a strong and politically supported legitimacy of that governance support the PETRA possibilities to direct the travellers in collectively more optimal ways over that infrastructure. A case of this could be that active and valued politicians promote a redistribution of traffic over the infrastructure, for example through influencing routes or modal choices. The green arrow below illustrates how the dashboard could show that.

Or, if communities are the basis of governance for the services (the development of services relies heavily on community as a mechanism of decision-making), this could put stress on the governance of PETRA. A reduction of trust could challenge the possibilities for a community to develop the services. A case could be that a breach of privacy rules occurred, leading to a reduction of trust in a large community-driven governance. The yellow arrow below illustrates how the dashboard could show that. Please note, a community could also be democratic open decision-making on service development, with the ability of participants to step in.

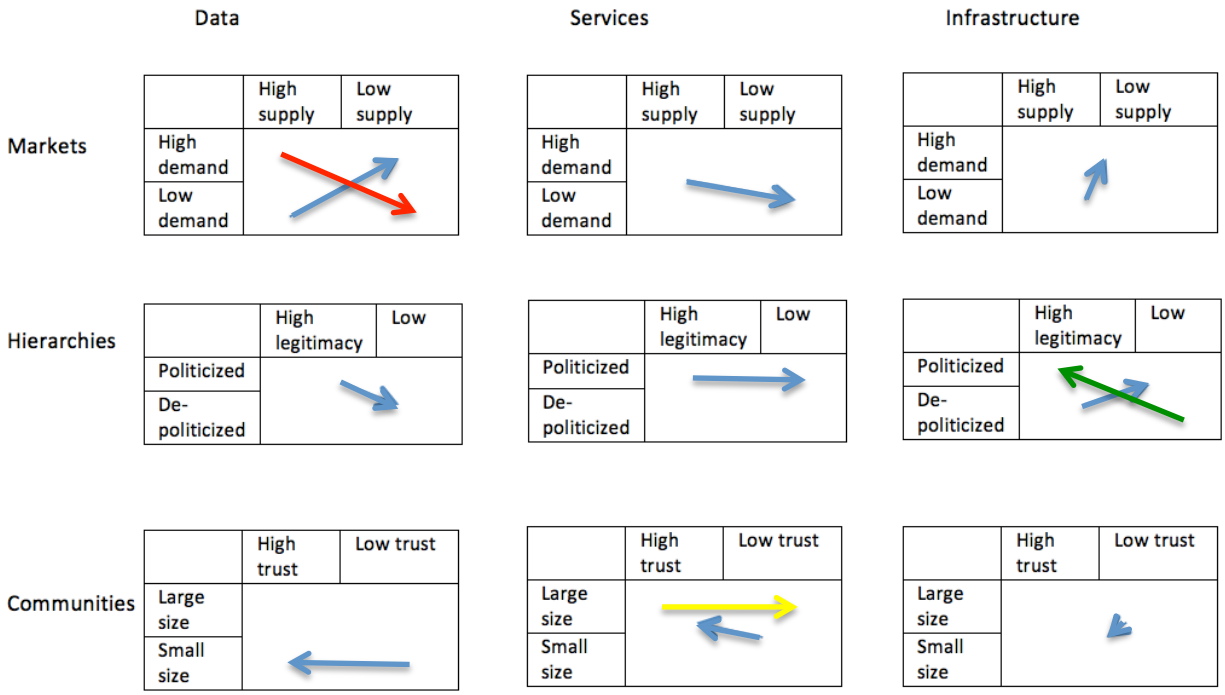

Figure 4 A dashboard showing major changes

5.5 Summary

How does this section of dashboards, diagrams and tables add up to a stress test? We summarize our reasoning briefly below.

A governance model is stress resistant if it keeps on facilitating platform implementation and management in times of change and helps the platform to stay relevant.

Any data platform relies on cooperation by a variety of actors. This way they assume actors having incentives to cooperate. We identified 10 general incentives. They are affected by both the governance model and the wider institutional context.

This wider institutional context provides many potential changes. We provided a dashboard that depicts all major changes that are relevant to the incentives.

These devices facilitate carrying out a stress test. A possible way to do so is using the following steps:

1. Select assumed incentives (figure 2) and apply them to the specific data platform for mobility.
2. Select scenarios
3. Per scenario depict changes on the dashboard
4. Theorize the sensitivity of the selected incentives by varying on the dashboards

Of course steps 3 and 4 can also be done without scenarios. Then the analysis is inspired by specific governance choices regarding data assurance, integration of supply and demand, scoping, centrality and core values.

6 Conclusion

This deliverable shows the key aspects of governance that will be part of the empirical analysis for WP7.

The deliverable shows the empirical validation of concepts in Rome and Venice. It structures the incentives we will incorporate in our analysis and design strategies. It also illustrates the solution space available by describing three conceptual and integrated models based on market, hierarchy and community approaches. Finally, we describe the stress test: the approach to analyse the sensitivity to changes in stakeholder incentives of possible designs for the governance of data platforms like PETRA.

7 Appendix A: High Level Design Revised Matrix

Design variables	Data types into platform	Data enrichment	Services	End users travel services specific tuned towards	End users data services specific tuned towards
	Historical city data to assess patterns Public transport planned service Traffic data (GPS or sensor loops)	Trip planning Trip prediction Statistics	Pre-trip advice On-trip advice Dashboard	Citizens Tourists	Policy makers Infrastructure managers
	Attractions data	CO2 emission modeling	Reachability	Cyclist	Public transport service providers
	PETRA app locations feed	Profiling	Real-time awareness	Reduced mobility	Non-public transport service providers
	Cell phone streaming	Origin/destination modeling	Loyalty scheme	Groups	Event organizers
	CO2 sensors Public Transport real time data PT ticketing	Diaries	Social sharing		Police

Legend:

Design variables: aspects of PETRA on which a high-level choice has to be made

Basic options: options that every version of PETRA will include and cater for

Choice options: options that we can choose to implement into PETRA.

The options above are based on the existing PETRA documents and the discussions in Venice and Rome. They provide a basis to develop some (sub)concepts for PETRA in which we combine design choices into concepts. A (sub)concept is a combination of options under all design variables with an internal logic.

An example illustrates the idea of a concept. A concept could be “Community”. All users of the PETRA app feed their locations back to the platform. They see the value in this because users of that data, like public transport operators provide them with benefits through a loyalty scheme that can earn them free travel on public transport. Also PETRA provides them values because of the quality real-time multi-modal trip planning. Public transport operators participate because they have access to the dashboard and better predict passenger flows. The operators work with municipal authorities to improve the modal split in the region, related to specific policy goals that the municipality can monitor in the dashboard. You can see how specific options above are ”strung” together to a concept.

A second example illustrates the sub-concept. A sub-concept could be “Policy monitor”. Policymakers want to monitor CO2 emissions on the dashboard. They have sensors available and provide the data to the platform. The platform models CO2 emissions of trip options and nudges users into options with less CO2 emissions.

So, a (sub)concept is a combination of options with a story that strings the options together into a story with an internal logic.

8 Appendix B: HLD Concepts

8.1.1.1 Concept 1: MOBILITY COMMUNITY

Subconcept 1.1: Location-enhanced trip support (active options in bold)

Design variables	Data types into platform	Data enrichment	Services	End users travel services specific tuned towards	End users data services specific tuned towards
	Historical city data to assess patterns Public transport planned service Traffic data (GPS or sensor loops)	Trip planning Trip prediction Statistics	Pre-trip advice On-trip advice Dashboard	Citizens Tourists	Policy makers Infrastructure managers
	Attractions data PETRA app locations feed Cell phone streaming CO2 sensors Public Transport real time data PT ticketing	CO2 emission modelling Profiling Origin/destination modelling Diaries	Reachability Real-time awareness Loyalty scheme Social sharing	Cyclist Reduced mobility Groups	Public transport service providers Non-public transport service providers Event organizers Police

Subconcept 1.2: Enhanced trip support with real-time Public Transport (active options in bold)

Design variables	Data types into platform	Data enrichment	Services	End users travel services specific tuned towards	End users data services specific tuned towards
	Historical city data to assess patterns Public transport planned service Traffic data (GPS or sensor loops)	Trip planning Trip prediction Statistics	Pre-trip advice On-trip advice Dashboard	Citizens Tourists	Policy makers Infrastructure managers
	Attractions data PETRA app locations feed Cell phone streaming CO2 sensors	CO2 emission modeling Profiling Origin/destination modeling Diaries	Reachability Real-time awareness Loyalty scheme Social	Cyclist Reduced mobility Groups	Public transport service providers Non-public transport service providers Event organizers Police

sharing

Public
Transport
real time data

PT ticketing

8.1.1.2 Concept 2: TOURIST COMMUNITY

Subconcept 2.1: City exploration support (active options in bold)

Design variables	Data types into platform	Data enrichment	Services	End users travel services specific tuned towards	End users data services specific tuned towards
	Historical city data to assess patterns Public transport planned service Traffic data (GPS or sensor loops)	Trip planning Trip prediction Statistics	Pre-trip advice On-trip advice Dashboard	Citizens Tourists	Policy makers Infrastructure managers
	Attractions data PETRA app locations feed Cell phone streaming CO2 sensors Public Transport real time data PT ticketing	CO2 emission modeling Profiling Origin/destination modeling Diaries	Reachability Real-time awareness Loyalty scheme Social sharing	Cyclist Reduced mobility Groups	Public transport service providers Non-public transport service providers Event organizers Police

Subconcept 2.2: City exploration support with incentive management (active options in bold)

Design variables	Data types into platform	Data enrichment	Services	End users travel services specific tuned towards	End users data services specific tuned towards
	Historical city data to assess patterns Public transport planned service Traffic data (GPS or sensor loops)	Trip planning Trip prediction Statistics	Pre-trip advice On-trip advice Dashboard	Citizens Tourists	Policy makers Infrastructure managers
	Attractions data PETRA app locations feed	CO2 emission modeling Profiling	Reachability Real-time awareness	Cyclist Reduced mobility	Public transport service providers Non-public transport service

				providers
Cell phone streaming	Origin/destination modeling	Loyalty scheme	Groups	Event organizers
CO2 sensors	Diaries	Social sharing		Police
Public Transport real time data				
PT ticketing				

Subconcept 2.3: Enhanced tourist community (active options in bold)

Design variables	Data types into platform	Data enrichment	Services	End users travel services specific tuned towards	End users data services specific tuned towards
	Historical city data to assess patterns	Trip planning	Pre-trip advice	Citizens	Policy makers
	Public transport planned	Trip prediction	On-trip advice	Tourists	Infrastructure managers
		Statistics	Dashboard		

service Traffic data (GPS or sensor loops)				
Attractions data	CO2 emission modeling	Reachability	Cyclist	Public transport service providers
PETRA app locations feed	Profiling	Real-time awareness	Reduced mobility	Non-public transport service providers
Cell phone streaming	Origin/destination modeling	Loyalty scheme	Groups	Event organizers
CO2 sensors	Diaries	Social sharing		Police
Public Transport real time data				
PT ticketing				

8.1.1.3 Concept 3: PRO-ACTIVE TRIP MOBILITY ASSISTANCE

(active options in bold)

Design variables	Data types into platform	Data enrichment	Services	End users travel services specific tuned towards	End users data services specific tuned towards
	Historical city data to assess patterns Public transport planned service Traffic data (GPS or sensor loops)	Trip planning Trip prediction Statistics	Pre-trip advice On-trip advice Dashboard	Citizens Tourists	Policy makers Infrastructure managers
	Attractions data PETRA app locations feed Cell phone streaming CO2 sensors Public Transport real time data PT ticketing	CO2 emission modeling Profiling Origin/destination modeling Diaries	Reachability Real-time awareness Loyalty scheme Social sharing	Cyclist Reduced mobility Groups	Public transport service providers Non-public transport service providers Event organizers Police

8.1.1.4 Concept 4: ALERTING AND EVENT DETECTION

(active options in bold)

Design variables	Data types into platform	Data enrichment	Services	End users travel services specific tuned towards	End users data services specific tuned towards
	Historical city data to assess patterns Public transport planned service Traffic data (GPS or sensor loops)	Trip planning Trip prediction Statistics	Pre-trip advice On-trip advice Dashboard	Citizens Tourists	Policy makers Infrastructure managers
	Attractions data PETRA app locations feed Cell phone streaming	CO2 emission modeling Profiling Origin/destination modeling	Reachability Real-time awareness Loyalty scheme	Cyclist Reduced mobility Groups	Public transport service providers Non-public transport service providers Event organizers

CO2 sensors Public Transport real time data PT ticketing	Diaries	Social sharing	Police