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**The Future of Payment Systems in Urban Public
Transit: A Two-Cities Case Study**

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Master's dissertation presented to the Instituto
Coppead de Administração, Universidade Federal do
Rio de Janeiro, as part of the mandatory requirements
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ABSTRACT

JOHNSEN, Kjell Eirik. **The Future of Payment Systems in Urban Public Transit - A Two-Cities Case Study**. 2016. 135p. Thesis (Master in Business Administration) - Instituto COPPEAD de Administração, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2016.

This dissertation provides a comprehensive overview of the public transport organizations in the cities of Rio de Janeiro, Brazil and Trondheim, Norway. The organizational structure of both are described and analyzed. A special focus is given to the payment systems currently implemented and the development of these. New developments in the payment industry provide several possibilities, and the usefulness of these is discussed. Willingness to adopt new ticket media and methods of payment are demonstrated in Trondheim, but only very reluctantly in Rio de Janeiro. Another general trend in public transport is the move towards mobility, and it is uncovered that this issue is base for the development of the public transport in Trondheim, but to a far lesser degree in Rio de Janeiro. Interviews and secondary data provide detailed information of structures and relationships. To provide different views and deepen the understanding of the data, ecosystem, scenario and platform analysis are presented. The ecosystem analysis shows that while Trondheim has a keystone participant in the AtB, the corresponding actor in Rio de Janeiro, Fetranspor must be seen as a dominator. The public transport systems in both cities are controlled by the central actors, and freely operational business platforms are restricted by these. The key finding in the future of the payment systems is that all actors in both cities agree that the future system will be ID-based.

Keywords: Public transport, Rio de Janeiro, Trondheim, mobile payment, mobility,

RESUMO

JOHNSEN, Kjell Eirik. **The Future of Payment Systems in Urban Public Transit - A Two-Cities Case Study**. 2016. 135p. Thesis (Master in Business Administration) - Instituto COPPEAD de Administração, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2016.

Esta dissertação fornece uma visão abrangente das organizações de transporte público nas cidades do Rio de Janeiro, Brasil e de Trondheim, na Noruega. A estrutura organizacional de ambas é descrita e analisada. Um enfoque especial é dado aos sistemas de pagamento implementado atualmente e o desenvolvimento destes. Novas técnicas no sistema de pagamento oferecem várias possibilidades, e a utilidade destas será discutida. Determinação em adotar novos sistemas de bilhetes e métodos de pagamento são observados em Trondheim, enquanto que no Rio de Janeiro percebe-se mais relutância. Outra tendência geral no transporte público é a passagem para a mobilidade, e é descoberto que este problema é a base para o desenvolvimento do transporte público em Trondheim, mas em muito menor grau, no Rio de Janeiro. Entrevistas e dados secundários fornecem informações detalhadas das estruturas e dos relacionamentos. Para fornecer diferentes pontos de vista e aprofundar a compreensão dos dados, ecossistema, cenário e plataforma serão apresentados algumas análises. A análise do ecossistema mostra que, enquanto Trondheim tem a maior empresa de transporte chamada ATB, a empresa correspondente no Rio de Janeiro, é a Fetranspor que deve ser vista como uma dominadora na área. Os sistemas em ambas as cidades são controladas pelas empresas centrais e plataformas livremente operacionais são limitados por estes. A descoberta principal nos sistemas de pagamento no futuro é que todas as empresas em ambas as cidades adotarão um sistema que será baseado em ID.

Palavras-chave: transporte público, Rio de Janeiro, Trondheim, pagamento móvel, mobilidade.

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LIST OF ABBREVIATIONS

AFC	Automated Fare Collection
BRT	Bus Rapid Transit
EMV	EMV alliance (American Express, Discover, JCB, MasterCard, UnionPay, and Visa)
FinTech	Financial Technology
GPS	Global Positioning System
ITS	Intelligent Transport Systems
LRT	Light Rail Transit/Transport
MNO	Mobile Network Operator
NFC	Near-Field Communication
NPRA	Norwegian Public Roads Administration
PTA	Public Transport Authority
PTO	Public Transport Operator
SIM	Subscriber Identity Module
TSM	Trusted Service Manager
USIM	Universal Subscriber Identity Module
VLT	Veículos Leves sobre Trilhos (Light Rail Transport)

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1 Introduction

Just a few years ago taking the bus into the city required preparations on several levels. One had to know where to find the nearest bus stop, know which route would take you to the right place, or if none were directly available, where to interchange, one had to know the timetable so as to avoid a long wait at a deserted bus stop, and finally, one had to have money to pay for the ride. Not so anymore. Today a quick check in a smartphone app will tell from where, when and which route you need to take. And the same app will let you buy a ticket without the need for cash or seeking out a physical point of sale simply by the entering of a pin code, or offering your fingerprint as identification, the ticket price charged directly to your card or account.

At the same time, cars have become commonly owned by everyone, at least in the developed part of the world, and provide an undeniable convenience and comfort advantage over using the bus or other public transport. And so the car usage has expanded at the expense of public transport during the last decades (LITMAN, 2015).

On the other hand, traffic congestion has become a problem in all big cities of the world, parking is expensive and hard to find, air pollution from exhaust fumes and road dust is a serious health issue in many cities and finally, road transport is one of the main contributors to human CO₂ release into the atmosphere. This has led governments in many cities to introduce measures to reduce car usage. Maybe the best known example is London, where authorities introduced a congestion charge for driving into London during business hours, to reduce traffic by shifting the mode of transportation from private to public modes. (LEAPE, 2006)

Such measures provide opportunities for new enterprises to enter into markets previously unavailable by offering new technology and services previously not requested. However, the way public urban transit is organized can vary quite a bit from country to country and between cities in each country. Historic factors, local topography, demographic factors and national policy on public vs. private enterprises will affect the way the public urban transit is organized. An enterprise coming from abroad, or even from a different part of the country or another industry will have problems navigating this environment.

In the research literature, case studies involving one or more cities is a popular way of exploring phenomena and relations in sociology and technology, thereby also providing valuable insight into the urban public transit system in the examined cities.

In this dissertation, two very different cities will be examined: Rio de Janeiro in Brazil and Trondheim in Norway (see base data in Table 1). The first topic for the study is the payment systems in the public urban transport, their nature and development up to today, ongoing changes and predictions for the future. (Research topic 1)

Table 1: Case cities base data. Data in parentheses are for the metropolitan areas. (Author)

	Rio de Janeiro	Trondheim
Population	~6 453 000 (~12 280 000)	~184 000 (267 000)
Area	1 221 km ² (4 539 km ²)	321.81 km ² (7,295 km ²)
Modalities	Bus, metro, train, BRT, VLT, boat	Bus, Boat, (BRT)*
No. of buses	~9000 (~24 000)	~300

However, the manager of an enterprise seeking to enter into the respective markets will be challenged finding valuable information that is not easily obtained due to in part the complexity of the systems, in part the unofficial connections and ties and last, but not least the language challenges. In Rio de Janeiro most available literature is in Portuguese and in Trondheim in Norwegian. Neither language is commonly mastered by others than citizens of the respective countries (and Portugal for Portuguese, obviously), and little literature seem to exist in English. The specific cities are chosen due to the researcher's connection with them. Rio de Janeiro has been the place of living during the period before and during this research, and Trondheim is the permanent city of residence. Thusly, these cities have offered the best and most available possibilities to reach sources for interviews, thereby providing the best possible starting-point for the research.

Therefore, a wider examination of the public urban transport systems in the two cities will also be performed so as to provide such managers with a useful tool to navigate the business landscape in the respective cities. (Research topic 2)

2 Literature Review

To get an overview of the urban public transit business, a business ecosystem analysis is useful, and we will begin by defining the various aspects of this analysis. The ecosystem analysis is a good foundation for a further analysis of platform-mediated business networks, and we will continue with a review of this theory. As the public transit usually is a public good, and government is involved, a look at the theory behind public value, how it is created and how it is assessed will also be performed.

Finally, as the thesis is ultimately about the future of public transport, scenario planning will be used to explore various possible futures, and try to indicate business strategies for them. The theory will be reviewed in the final part of the literature review.

2.1 Business Ecosystems

To view a firm's position in the world Michael Porter defined his "Five Forces" method for analyzing suppliers, customers and competitors – both current and potential (PORTER, 1979). Later he also described the "Value chain", to indicate how value is created inside the company, and by suppliers, customers and other involved parties (PORTER & MILLAR, 1985). This view, however comprehensive and clarifying is not suited to give the full picture of the world the firm exists in. Therefore, much has been written about business networks in various forms and with varying terminology. A model that really gained traction and is considered central today is the *business ecosystem* model. Viewing the business environment as an ecosystem with the overarching property that all the members are important for the survival of the system as a whole. The analogy is to ecology and the ecosystems in the nature, and was described in the business literature in the early 90's. One of the earliest articles is by James F. Moore, "Predators and Prey: A New Ecology of Competition" in Harvard Business Review in 1993 (MOORE, 1993). In this article Moore outlines the analogy, pointing out some of the comparable features. The nature ecosystem normally encompasses of different species of animals, mammals, birds and insects, as well as plants, bacteria and the basic environment (soil, minerals, temperature etc.). A business ecosystem will often cross a variety of different industries, sometimes presumably unrelated.

When performing an analysis – any kind of analysis, the viewpoint is influencing the results. In Moore's case, the view is from inside a firm that enters the voyage of innovating and launching a new product in the market. This will make his view of what the ecosystem is

a bit different than for us viewing an industry from the outside. Therefore, Moore talks about the failing of ecosystems, where we from the outside would call it the failure of a firm inside an ecosystem, which if it were replaced by another firm would not cause the ecosystem to fail, but simply evolve. This thought becomes interesting if imagining every firm looking at the world as an ecosystem where itself is the center instead of being a smaller node in a larger ecosystem. Then, because of the different viewpoints, an ecosystem analysis may give different results based on which company is performing it

Of course, an ecosystem may also collapse, but following the analogy with nature, this is rarely due to the disappearance of one species only. A collapse (in the business world) would rather be due to a change in the customer preference, removing the whole foundation for the ecosystem to exist.

2.1.1 Ecosystem Life-cycle

Evolution of a business ecosystem goes through four stages according to Moore (1993). These are Birth, Expansion, Leadership and Self-Renewal.

2.1.1.1 *Birth*

This first stage is about establishing a new firm and forming the ecosystem around it and secure the participants to the company's products or services. Developing the right value proposition for the customer is also vital in this stage. Cooperation is often more effective than competition, but still establishing leadership is a point. (MOORE, 1993). At this stage the platform theory that we will investigate later claims the importance of obtaining critical mass of supporters. Moore (1993) also holds out that in the birth stage of an ecosystem, established firms with large resources could do well to not participate directly, but wait until the market is stabilizing. With ample resources, the most promising contender can be appropriated, shortcutting the stage of development where size and market position not necessarily is an advantage. If we look to the theories of platform-mediated networks that is explored in the next chapter, this advice forms an interesting contrast with the first mover advantage as described by Eisenmann (2007).

2.1.1.2 *Expansion*

Moore (1993) lists two conditions for an ecosystem to enter the second stage of development: I) the business concept has reached a level of development and maturity that

makes it appealing to a large number of customers. II) The firm must have the potential to scale up the concept to satisfy this large market.

This is the phase where established companies can their power in areas like marketing, sales and operations, maybe at the expense of the smaller companies that were winners of stage 1 (MOORE, 1993).

Today, smaller companies may well reach out to a great number of customers. Modern days' internet and social media should make this a much easier task than when Moore's article was written. The second condition still applies though, at least for firms that manufacture physical goods. No one considers distributing digital content on physical media anymore, at least not for the mass market. The constraints of manufacturing and logistics therefore obviously don't apply to apps and other digital content, making Moore's predictions less accurate.

Another issue that has arisen since Moore wrote his article are the platform-mediated business networks of today. Terms like first mover advantage and critical mass are now very relevant for every firm operating in such networks, and influence the expansion of both firm and ecosystem directly. These networks are so important for modern-day business that we will analyze them in a separate chapter.

2.1.1.3 Leadership

When the ecosystem reach what we could call maturity and the battles for leadership are largely over, maintaining and expanding on the position is important for the firm, given that it has the leader position. Through positioning and size, the leader have acquired the necessary bargaining power to maintain a relative stability, allowing the members of the ecosystem to compete, expand and consolidate their businesses. (MOORE, 1993)

An important point Moore makes is that competition is not necessarily the main point of this stage. Quite commonly, central partners are dependent of each other to exist in the ecosystem, even though they are competing.

2.1.1.4 Self-Renewal

Moore (1993) points at two factors that may occur in stage 4: Eventually new innovations outside the ecosystem will give rise to other ecosystems threatening the existing community. Alternatively, an external event like a government legislation or a sudden customer shift will threaten the ecosystem. The two factors may occur separately or together,

in which case they tend to reinforce each other. Such changes are normally more favorable for new or small ecosystems, which make sense, as these are less complex and therefore easier to adjust to the new reality. Again looking to the platform-mediated networks theory, Eisenmann (2007) describes similar effects, in what he calls platform envelopment, which is the effect that another platform, not necessarily competing grows big, and simply takes over your business.

The essence in the fourth stage is continuous innovation in the business ecosystem. However, innovation alone may not be the only answer. For a firm with a dominant position in the ecosystem some optional approaches exist. 1) It is possible to keep the lead by using one's power to slow down the growth of other ecosystems. 2) Innovations happening outside can be included into the ecosystem. 3) A fundamental restructure of the firm, allowing for a new and radically changed environment. (MOORE, 1993)

2.1.2 Ecosystem Health

A central term for Moore (1993) is co-evolution, which indicates that all the companies in an ecosystem should evolve together and is a condition for keeping the ecosystem healthy. Iansiti and Levien (2004) expands on this and lists three factors important to ecosystem health. These are Productivity, Robustness and Niche Creation, and we will look closer at these terms below.

2.1.2.1 *Co-Evolution*

Moore (1993) is taking this term from the anthropologist Gregory Bateson. It simply means to describe how different entities within an ecosystem affect each other. If one provider of a product releases a new feature for a product, all the other providers of similar products have to do the same. New possibilities in logistics may alter production schemes, etc. The idea is that one firm, or one value chain is not alone. There are connections of most firms go way beyond this.

2.1.2.2 *Productivity*

The ecosystems productivity can be viewed as its ability to produce the intended output. In nature this involves the utilization of nutrients and energy in the form of sunlight to produce living organisms, that in turn form the base for other organisms and so on.

The business equivalent is the continuous input of technology and innovation along with raw materials, manpower and knowledge to keep developing new products and services, as well as lowering costs and increasing efficiency (IANSITI & LEVIEN, 2004).

Measuring the productivity of an ecosystem over time seems to be a complicated issue, at least if all participants are to be taken into consideration. Iansiti & Levien (2004) mention using return on invested capital as a relatively simple method, not the least as it is suited to compare productivity over time.

2.1.2.3 Robustness

The more robust an ecosystem is, the better suited it is to survive when circumstances change. In the nature, the current situation of global warming is a good example. Robust ecosystems will adjust and prevail, but marginal ones will probably collapse and disappear – or be replaced by new ecosystems more suited to the new reality.

In the business environment, changing circumstances are different of course, but still the analogy holds. Examples could be severe currency change or inflation, technological change or government legislation or regulation. (IANSITI & LEVIEN, 2004)

A simple measure of robustness can be the survival rate of firms in the ecosystem (IANSITI & LEVIEN, 2004).

2.1.2.4 Niche Creation

In nature, the corresponding term would be diversity. Both in business and in nature, greater diversity normally means better resistance to sudden change, as well as better potential for innovation. In business ecosystems, we talk about niches to denominate areas where firms that are closely connected “reside”. The more niches, the more diversity and thus the higher probability of survival of the ecosystem as an entity. The measure for health, though is the ability to create new niches, which could be in addition to or replacing existing niches. The idea is that when new niches are created, it is a strong indicator that the level of innovation is high. (IANSITI & LEVIEN, 2004)

2.1.3 Ecosystem Strategy

We have previously mentioned that the size and shape of an ecosystem is dependent on the viewpoint of the analyzer. Seeing from the point of view of a specific firm will give different results than seeing the industry as a whole, for example.

The position in an ecosystem – given that the view is larger than the firm in question, is subject to strategic choices within the firm itself, often defined by the range and nature of the products and services offered.

Iansiti and Levien (2004) define four different roles a firm can have in an ecosystem, along with the characteristics and potentials. These are Keystone, Dominator, Niche and Commodity, and we will further analyze them below.

2.1.3.1 Keystone

Like keystones in buildings, from where this analogy is taken, keystone firms are crucial to the ecosystem, and their removal may cause its collapse. In other words, being a keystone in an ecosystem is an ideal situation for a firm's survival. (IANSITI & LEVIEN, 2004)

This keystone position implies that the firm in this position is enabling and perhaps increasing the productivity of the ecosystem as a whole by improving connectivity between other participants, or adding to the creation of new products. (IANSITI & LEVIEN, 2004)

To be able to acquire the position as a keystone, Iansiti and Levien (2004) claims that the firm must create and share value. Creating value usually means that the firm must offer a platform for the ecosystem. We will analyze platforms further in a later chapter. To share value, the keystone firm must ensure that it doesn't capture all value created for itself. E.g. by allowing subcontractors to exist instead of integrating vertically.

2.1.3.2 Dominator

Being a dominator in an ecosystem is a dangerous position according to Iansiti and Levien (2004). They differentiate between the physical dominator and the value dominator. To a certain degree, being a physical dominator can be sustainable, while a value dominator will ultimately cause the ecosystem to collapse. Physical domination is when a firm is creating value, but is highly integrated vertically and/or horizontally, leaving little value left to be captured by other participants. The value dominator mainly leverages its power to extract as much value as possible without creating much.

2.1.3.3 Niche

Most firms will adopt a position as a niche player in the ecosystem. One way of viewing niches is as “fixed” slots in the ecosystem, which subsequently are occupied by a

firm. (MOORE, 2006). These niches can be open to varying degrees, allowing for different firms to compete for the slot. Niche firms are to a greater extent dependent on other firms in the ecosystem than keystones and dominators. Maintaining a high level of innovation and specialized strategies are among the important factors for a niche firm to stay relevant, else being made irrelevant or displaced are likely outcomes. (IANSITI & LEVIEN, 2004)

2.1.3.4 Commodity

The place nobody wants to be is as a commodity. Firms in the ecosystem should make every effort diversifying and innovating to avoid commoditization of their products and services. (IANSITI & LEVIEN, 2004)

Niche players are at risk of being commoditized by keystones' or dominators' processes of expansion or self-renewal. (MOORE, 1993) If the keystone/dominator wants to remove a possible opponent, or increase the possible number of support firms offering their products and services, opening up standards or interfaces may enable more firms to compete, but risks turning the product or service into a commodity.

2.2 Platform-Mediated Business Networks

A network can in its loosest form be defined as "a system of interconnected nodes" (EISENMANN 2007). We know networks from the physical world, e.g. computer networks, water and gas supply networks, roads and roads, and in the virtual world in social networks. In this dissertation we will not consider these, but focus on networks organized by a profit-seeking firm, thus making them *platform-mediated* (EISENMANN, 2007).

The concept of business networks and the effects that connect and work between the participants is not new. Network effects were first described in 1974 by Jeffrey Rohlfs of Bell Labs in his article "A Theory of Interdependent Demand for a Communications Service" where he among other things discusses the startup-problem and critical mass.

2.2.1 Different networks

A platform-mediated network will consist of one or more groups of *network users*, as well as a *platform provider*, offering some kind of service that makes the participation in the network worthwhile for the users (EISENMANN, 2007). If there is only one group of network users, the network is called a *single-sided network*. This is typically the case when all the users share the same way of exploiting the network, the classic example is fax machine

users (EISENMANN, 2007). If two groups of network users have different roles, the network is called a *two-sided network*. The networks formed in the “sharing economy” are typical examples, like Uber. Passengers form one group of users, while the drivers form the other. Uber is providing the online platform allowing the two groups to connect and interact. Networks can also have three groups of users and are called *three-sided networks* (EISENMANN, 2007). An example is Apple’s AppStore platform, where developers, users and advertisers form distinct user groups. We will label all networks with more than one side *multi-sided networks* in this dissertation.

2.2.2 Network Effects

The participants in a network are subject to *network effects*, meaning that the number and nature of the other members of the network affects the value of participating in the network, also called *demand-side economies of scale* (SHAPIRO & VARIAN, 1999; EISENMANN, 2007).

Network effects can be positive or negative depending on the influence on the value of network participation. Shapiro & Varian don’t use the term network effect, but talk about *positive feedback* and a *virtuous cycle*, alternatively a *vicious cycle* for positive and negative network effects.

If network effects affect users of the same group, they are said to be *same-side network effects*, in the literature also labeled *direct network effects* (EVANS, 2009). In multi-sided networks, it is common that the network users on one side of the network affect the value of participating the network on the other side. The relevant factors can be both the number of participants, as well as other properties like age, income, gender etc. These are called *cross-side network effects* (EISENMANN, 2007) or *indirect network effects* (EVANS, 2009).

2.2.3 Network Externalities

In short, network externalities occur when one network user affect another without any compensation being paid. (SHAPIRO & VARIAN, 1999; EISENMANN, 2007; EVANS, 2009) The term is regularly used for both positive and negative varieties of such effects. However, the term has essentially the same meaning as network effects, which Shapiro and Varian (1999) goes far in indicating.

2.2.4 Critical Mass

A fledgling firm offering a platform will at the starting point have no users. The way network effects work, the more network users, the more valuable, and therefore interesting the platform is for new, potential users to join. In the field of sociology, the issue of collective action has been studied for decades. From this the theory of the critical mass has emerged as a theoretical concept (OLIVER et al, 1985). Oliver et al point out two fundamental conditions for a critical mass to emerge (1985): The shape of the production function and the distribution of interest and resources across the group of potential contributors. Briefly, the production function can have different shapes depending on the situation, in general accelerating (with increasing marginal returns on contributions), decelerating (with decreasing marginal returns on contributions), linear (proportional marginal returns on contributions) or a combination, of which the ‘S’ shape is commonly known in the fields of economy and finance. Further, the distribution of interest and resources across the group of potential contributors is important. The more heterogeneous these factors are, the easier it is to form a critical mass. If the group is completely homogenous, then either all or none will contribute (OLIVER et al, 1985). For a newly started platform, it can be assumed that the value increases for each contributor, hence an accelerating production function and an exponentially growing number of network users. However, in the beginning, some outer manipulation must happen to start the process, often labeled the startup-problem (RHOLFS, 1974; EVANS, 2009). For multi-sided platforms, this becomes even more complicated, as the value for users in joining one side of the network is dependent on the number of users on the other side. This is commonly referred to as the chicken-and-egg problem in the literature (EVANS, 2009). Especially in a situation where alternative platform providers are competing, it is crucial for the platform to reach a *critical mass* of network users. This can be said to be the number of users where the network effects get strong enough to “automatically” pull new users to the platform. (EVANS & SCHMALENSEE, 2010)

To get from zero to critical mass as rapidly as possible, it is common to *subsidize* one or more sides of the network. There are different schemes for this. Sometimes the platform provider offers a service free of charge to one side of the network, while charging the other. Or one side may subsidize the other. Or the platform provider may subsidize both sides of the network for a certain period of time. (EISENMANN, 2007)

2.2.5 Willingness to Pay

The maximum amount an individual network user will accept to pay for a given product or service. Assuming positive network effects, the Willingness to Pay (WTP) will increase when the number of participants in the network increases. However, for each expansion of the network, the WTP will increase less. Also, for each new network user, the individual willingness to pay is smaller. (EISENMANN, 2007) The latter makes sense, as the early adopter will normally be more willing to pay for a product or service than a laggard.

2.2.6 Winner Take All

Networks with more than one platform provider often show instability. Eisenmann (2007) calls this the *Winner Take All Networked Market*, indicating that the situation with several providers will consolidate until one main provider is left and competitors are either gone or reduced to niche players. Shapiro & Varian (1999) calls the effect *Positive Feedback*, lending a term from the music industry (Acoustic Feedback or Audio Feedback: "...is a special kind of positive feedback which occurs when a sound loop exists between an audio input (for example, a microphone or guitar pickup) and an audio output (for example, a loudspeaker)...") (Wikipedia: Audio feedback)) indicating that a positive network effect will increase because of itself.

2.2.7 Platform Actors (Providers, Sponsors and Component Suppliers)

A *platform provider* is the agent offering the technology, meeting place, product or service that enables the network users to connect and do their business (EISENMANN, 2007; SHAPIRO & VARIAN, 1999; EVANS, 2009). The platform provider doesn't engage in the undertakings between the users in any direct way, other than making it possible, easier or more economic (EISENMANN, 2007). A good analog example is the real estate agent, who assists a seller of a property to find buyers, and obtain a good price. He assists buyers finding a property that fits the buyer's needs and budget. The transaction itself is between buyer and seller, with one or both paying a fee to the agent for his services. In technology, especially today's online world, examples of platforms are plentiful. Indeed, what has been labeled the sharing economy is based on the principle of platform-mediated networks. Examples like Uber and AirBNB should require no further explanation.

A *platform sponsor* is not necessarily involved in the transactions between the users at all (EISENMANN, 2007). The sponsor controls the underlying technology, and has the power

to change it and to decide who gets to be network users and not. Most commonly, the platform sponsor is also the platform provider. The distinction is nevertheless important for two reasons. The sponsor may not be involved as a provider at all, or the relationship between sponsor and provider can be a many-to-many relationship (one or more platform providers may work with one or more platform sponsors). A platform sponsor can for example be a technology owner, holding a patent and licensing this to a provider without participating directly in the market.

Sometimes, the platform provider has to rely on one or more *component suppliers* to make the platform work (EISENMANN, 2007). For example a radio station connecting listeners and advertisers. To facilitate this platform, the radio station must rely on electronics manufacturers to make the radios needed for the listeners. Eisenmann (2007) talks about component-based network effects working between component suppliers, platform provider and the network users. In the example above, between radio manufacturers, radio station and listeners.

2.3 Scenario Planning

Urban public transport is, or should be undergoing dramatic changes, as the new age of the Internet of Things and the “New Economy” develops. Intelligent Transportation Systems (ITS) and Smart Cities are buzz-words of our time. Disruption seems to be everywhere. Among the questions asked by practitioners are “How can these new technologies be adapted to public transport?” and “Will private initiatives disrupt the public transport industry as we know it? And if so, how?” The ambition of this dissertation is not to provide specific answers to these questions, but rather to describe possible alternatives. A methodology well suited for this work is a scenario analysis. Well described in the literature and with roots back to WW2, this should provide useful insight in the future of public transport. In fact, scenario planning is not one thing, as it has become popular all over the world. Some models require lots of quantitative data and mathematical models, while others are inherently qualitative in their approach. (AMER et al, 2013)

In my analysis, I will use the scenario framework presented by Garvin in his “A note on Scenario Planning” (GARVIN, 2006), which again refers back to Lawrence Wilkinson’s article “How to Build Scenarios” (WILKINSON, 1995) and work by Peter Schwartz. These fall into the category of techniques called ‘Intuitive Logics’, described by Huss and Honton

(1987) and is a pure qualitative approach. The main components in Garvin's version are shown in Figure 1.

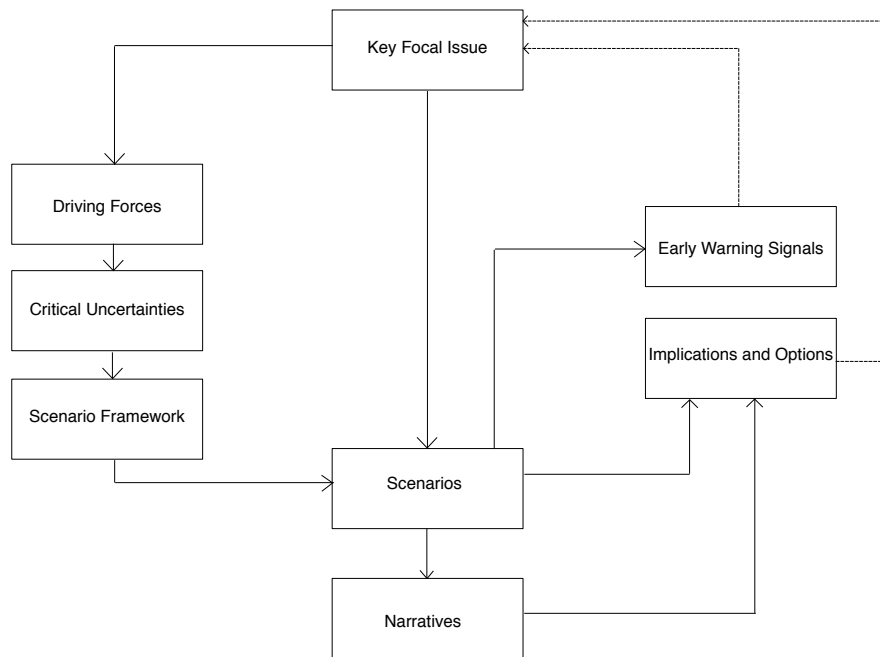


Figure 1: Scenario Planning Components (GARVIN, 2006)

The analysis itself is conducted in five stages (GARVIN, 2006):

Stage 1: Orientation: Focal issue defined.

Stage 2: Exploration: Driving forces defined.

Stage 3: Scenario Creation: Scenarios created with narratives.

Stage 4: Options Consideration: Strategies, actions and changes defined.

Stage 5: Integration: Early warning signals developed.

Stage 1: Orientation: Focal issue defined.

Defining the focal issue of the analysis is important as the output will depend on the choice. In this case we are examining the public transport systems of two cities. We will prepare different scenarios for the cities, as very different factors are controlling the development. Public transport is a huge field, with several aspects of interest, and the focal issue of the study is important to approach the analysis from the right direction. E.g. choosing the bus driver welfare as focal point for the study will give a different approach and different outcome than if the payment and ticketing systems were chosen. For this analysis, the latter will be chosen as the focal issue. Thus, we will concentrate on issues related to the payment systems, but this doesn't mean that other aspects aren't important. We will see that issues as

diverse as the political situation in the country, the oil price and smartphone development have influence on the analysis.

Stage 2: Exploration: Driving forces defined.

The driving forces of development consists of different aspects. We can broadly organize them as drivers and inhibitors for the development. Furthermore we can differentiate between trends and uncertainties. The trends are issues that are quite certain. Developments that are already ongoing are trends. Ongoing shifts in social classes are trends. Uncertainties are typically the political situation, economic factors like currency development, oil and other commodity prices etc. Also whether a development that we can see has begun will actually continue, if a certain technology will prevail over another.

To create the scenarios, we focus on the two major uncertainties that we can find.

Stage 3: Scenario Creation: Scenarios created with narratives.

Before creating the scenarios, we first draw up a framework to ensure that all scenarios consider the same factors. For this analysis the following framework was created:

- Political situation in country and region,
- Economic situation (national and local),
- Security situation (this is mainly an issue in Rio de Janeiro, where it is important),
- Mobility
- Modalities,
- Fetranspor (in Rio de Janeiro), AtB (in Trondheim)
- Payment system in the public transport
- ITS in general
- Summary

Based on this framework, four scenarios are created along the axis of the two key uncertainties.

Stage 4: Options Consideration: Strategies, actions and changes defined.

In this stage, the strategies to follow in the different scenarios should be considered. But whose strategies? Doing this work from the research viewpoint doesn't require any strategies as we don't have any stakes in the public transport system beyond this dissertation. Therefore, some possible strategies for some of the actors will be sketched.

Stage 5: Integration: Early warning signals developed.

Basically, this stage considers what signals should be watched out for to indicate which direction development is turning. If any of the scenarios will play out as written, if some issues are different and the scenarios should be revised, and so on. The figure in chapter 3 indicates that the scenario analysis should be iterated based on observations of the world relative to the indicated scenarios and strategies. In other words, a scenario analysis should ideally be an ongoing process with constant reiteration and revision of uncertainties (which will eventually either turn into events or be discontinued) and rewriting the scenarios. This study is offering a first round of analysis with the faults and possibilities that follows.

2.4 Urban Public Transport Payment Systems, a Theoretical Background

The payment process and payment systems are crucial parts of all public transport. Even though subsidies are common, an average of 50% of revenues come from passenger payments. Choosing the optimal method, equipment and financial models are issues of much interest and focus from the public transport community. Recent years' rapid development in ICT, FinTech and along with these, new business models and financial structures, open new possibilities in the public transport sector. Demands for more environmentally friendly transport has increased the focus on public transport and placed greater demand on its efficiency and usefulness.

We can locate 4 distinct approaches to the issue:

2.4.1 Available technology in the market.

2.4.1.1 *Automated Fare Collection (AFC)*

An Automated Fare Collection (AFC) system is key to developments and innovation in the public transport, or as commonly called Intelligent Transportation Systems (ITS). Most common today are closed-loop systems, owned and operated by the public transport authority. These require special media, most commonly smart cards, readers/writers or validators, a back office system and a central clearing house (PUHE et al, 2014).

An AFC can offer value to users through automatic calculation of best fare, quantum discounts etc. based on historical travel data gathered in the back office system. This means

that the user doesn't have to choose a special ticket for his ride, which makes the user experience easier (PUHE et al, 2014).

Most common user media today are contactless smart cards with varying background technology. Some are plain pre-paid cards, while other function as an electronic purse or e-money, enabling the user to pay for other goods and services than just transport (PUHE et al, 2014; BIS, 2003). The next natural step in the evolution of payment methods will be (and is already many places) using mobile phones. Contact-based cards are still in use, but are rapidly being replaced by more modern technologies.

Puhe et al (2014) describe how the validation technology used can be divided into 3 categories:

- Check-in/check-out (or tap-in/tap-out), which is the common way to validate NFC-based contactless smart cards. The technology requires the user to hold the card near the validator. When the check-out part is implemented, detailed information about the travel is available, but this is not always used.
- Walk-in/walk-out, is a technology that enables reading of the ticket media upon entry and exit without the user having to take it out of his pocket.
- Be-in/be-out, is related to walk-in/walk-out in that the user doesn't need to take any action to validate his ticket. The ticket medium is automatically read, and it is detected when the user enters and exits the vehicle.

Another important factor in the AFC is whether ticketing is gated or ungated. In a gated ticketing system, validation of the (electronic) ticket is required to gain access (open turnstiles) to the vehicle. In an ungated ticketing system, the passenger must ensure to have the correct ticket purchased and validated, but may freely board the vehicle. Passengers are then subject to random controls to verify that correct tickets are purchased and validated. In most cities, gated ticketing systems is the norm (as in Rio de Janeiro), whereas ungated ticketing systems are common in Norway. (ATB, 2016)

2.4.1.2 E-ticketing

Ticketing is the process of buying the right to use or access a service. Traditionally, a paper ticket was issued as proof of purchase, to show when entering or accessing the service. Ticked validation was performed by stamping or punching a hole in the ticket upon entry. The concept of e-ticketing is taking the process into the modern age by replacing the paper ticket with an electronic one.

The electronic ticket media can be a smartcard, a mobile phone or in theory any other device equipped with a unique electronic id. (HUOMO, 2009) In theory, biometry could also be used (fingerprint, retina scan), but such systems are not commercially available yet. Most common is NFC (Near Field Communication) technology, which for public transport purposes is available in smartcards and mobile phones (HUOMO, 2009).

2.4.1.3 Smartcards

Contactless smartcards have been used by public transport operations globally since the late 1990s, when it was introduced on the Hong Kong metro (DELOITTE, 2015) and is until today the most common ticket medium in public transport. It can use contact-based or contactless technology. The card itself is credit card-sized, and contains an embedded microchip. On contact-based cards, the chip surface is exposed to provide the necessary contact points for the card reader. The most common standard for contact-based smartcards is ISO/IEC781 (PUHE et al, 2014). Contactless smartcards have the chip completely embedded into the card, along with an antenna to connect with the card reader. Connection occurs when the card is brought in close proximity with the reader (<10cm). The reader generates a magnetic field that is used to power the chip in the card, and the communication process is initiated. There are several standards governing contactless smartcards, among others ISO/IEC14443, ISO/IEC15693 vicinity card, Felica¹ ISO/IEC15408 EAL4; and NFC ISO/IEC18092 (PUHE et al, 2014).

Smartcards can be reloadable, or preloaded only, depending both on the technology used and on the business model chosen (SMART CARD ALLIANCE, 2011). Smartcards can be either open loop or closed loop. Open loop cards work the same way as a regular debit/credit card, and is often branded by one of the major brands, like Visa, MasterCard or American Express. The cards can be used everywhere the brands are accepted. Closed loop cards on the other hand, can only be used in terminals and readers provided by the card issuer. The loading of value, payment- and clearance processes are all handled by the the issuing party. (FIRST DATA CORPORATION, 2010) In public transport, closed-loop cards have been common, and still are. However, reports and white papers point out the usefulness of adopting open loop systems, and we should probably see such systems implemented in the future (FIRST DATA CORPORATION, 2010 and others).

¹ FeliCA smartcard brand manufactured by Sony.

2.4.1.4 Mobile payment

Mobile payments can be done in several ways, some using mobile communication, some using NFC technology. Figure 2 gives a good overview of mobile payment related to contactless payment in general.

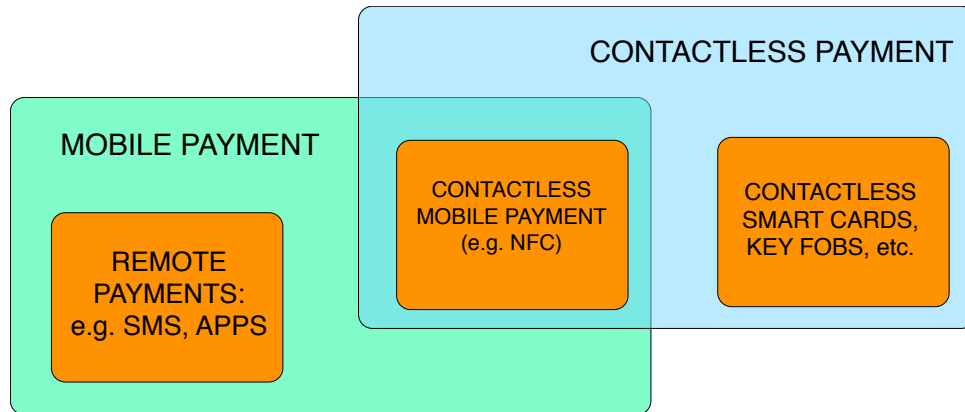


Figure 2: Categorization of mobile and contactless payment (adapted from Huomo 2009)

Mobile payment has been available for several years already, originally via premium SMS solutions (MALLAT et al, 2009), then over WAP (Wireless Application protocol), and as smartphones have become common, through mobile applications, or ‘apps’ and using NFC technology for near-field payments. As smartphones have become increasingly powerful, WAP is no longer used in most markets, as full HTML has taken over (Wikipedia: WAP).

Contactless payments function much like with smartcards. The NFC-equipped mobile phone is held close to a reader, and a data exchange is initiated. As with smartcards, several applications can be stored on the phone, and depending on the nature of the transaction require choices or other actions from the user. Market penetration for NFC payments is still lagging even after the introduction of services like Apple Pay and Android Pay in the last couple of years. One reason for the slow diffusion of this technology is that several new stakeholders previously not engaged in payment processes have become involved adding to a complex ecosystem consisting of numerous stakeholders with differing agendas and expectations. (HUOMO, 2009)

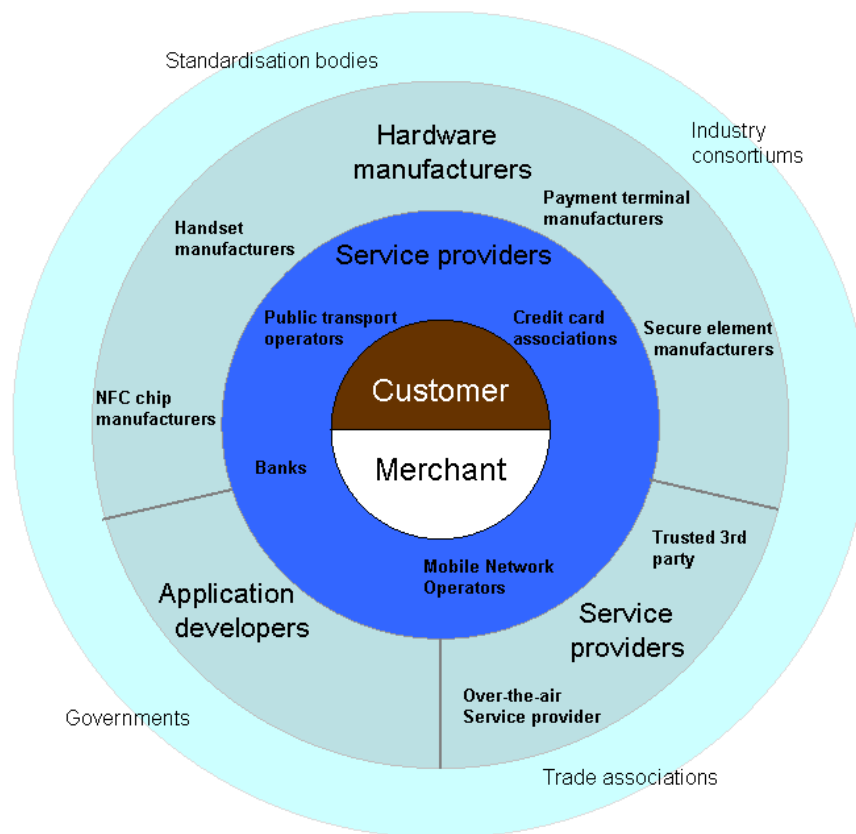


Figure 3: Stakeholders in the mobile payment ecosystem (Huomo2009)

In the case of public transport, the most important stakeholders are the mobile network operators, the financial institutions and the public transport operators (HUOMO, 2009). However, the picture has become even more complex since Huomo's article (2009), as the handset manufacturers like Apple and Samsung are entering the service provider area with their payment solutions, bringing further issues of incompatibility of technologies and services that at this moment still have not been resolved.

In public transport, several solutions for mobile payment are active. NFC-based solutions have been tried out, and is used several places (NFC FORUM, 2011). SMS-based solutions, where a premium-priced SMS is sent, and a validation code returned have been used for a long time (MALLAT et al, 2009). Since 2011, a mobile app has been used in Trondheim, Norway offering a general payment solution for all smartphones, as the validation code is provided in the form of a QR code for visual reading (ATB, 2016).

2.4.1.5 ID-Based Payment

When Apple launched its payment functionality Apple Pay in 2014, the concept of ID-based payments made a big leap. The concept requires a secure element embedded in the

phone, where account information is stored and connected uniquely to the device. When a payment is made, an encrypted transaction identifier is created and sent to the clearing-house operator. This transaction identifier contains all necessary data, including the id of the payer, the payee, the time and the amount and currency paid. The clearing-house subsequently debits the account of the payer, crediting the account of the payee. (<http://www.apple.com/apple-pay>, ATB, 2014)

ID-based payments have many advantages over prepaid cards (which is most common in public transport today). Placing the transaction clearance entirely in the cloud, reader equipment can be kept simple, without the need for much processing capacity, continuous downloads of fares and regulations etc. The user can always receive the best price, i.e. no periodic agreements need be made and administered. Higher security, as no value is stored in the ticket medium, which also may have many different formats (cell phone, key fob ('electronic keychain', smartcard, id tag, etc.). It is easier to provide seamless support for multi-modal travel. Among the disadvantages are the need for the ticket reader to be online all the time. If this is impossible black-lists of invalid IDs must be distributed regularly and stored in the reader. (ATB, 2014)

2.4.2 Public transport authorities' priorities and demands.

2.4.2.1 *Public value*

For public transport authorities, it is easy to focus on the economic efficiency and the quality of the service provided by public transport providers. However, the public has wider responsibilities than to offer efficient and quality transport to its citizens. (CARLI, 2011)

The concept of public value was proposed in 1995 by Mark Moore as a response to the New Public Management paradigm and the neoliberalism that was popular in administrations both in America and Europe at the time. He held forward that the government had a larger role than just being the framework for society setting out the rules without further interest in society as such. According to Moore, the government has a responsibility "as a creator of public value and a pro-active shaper of the public sphere (politically, economically, socially and culturally)" (BENINGTON & MOORE, 2011). Another important issue of Moore's was the role of public managers. He saw them as something more than "inward-looking bureaucratic clerks and passive servants to their political masters", but rather as the ones who set the agenda on how to run and develop society.

To conceptualize his ideas, Moore proposed a framework called “The Strategic Triangle” as seen in Figure 4: The strategic triangle of public value (BENINGTON & MOORE, 2011). It is based on three necessary processes.

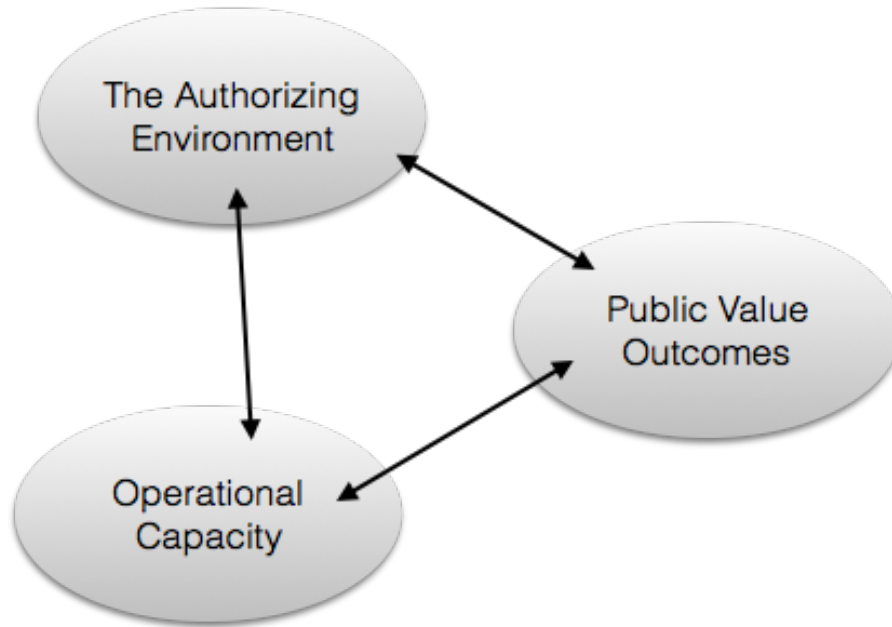


Figure 4: The strategic triangle of public value (BENINGTON & MOORE, 2011)

The idea behind the framework is that the three elements are interdependent, but distinct. Firstly, it is the process of defining what is the public value of any specific issue or situation (Public Value Outcomes). Secondly, creating the authorizing environment, or gather the support from the necessary stakeholders, political leaders and others needed to realize the task at hand. Thirdly, the necessary resources must be secured, so that the public value outcomes can be realized.

After Moore’s book, many researchers have developed methodologies and frameworks to adopt the ideas of public value to different industries and environments. Veeneman and various associates have researched public values in public transport (VEENEMAN & KOPPENJAN, 2010; VEENEMAN et al, 2006). They found that the values upheld by governments for public transport were fairly consistent and can be divided in the following groups:

Table 2: Different types of public values in public transport (VEENEMAN et al, 2006)

	Profile	Examples
Type A	Vulnerable groups	• Accessibility (for partially handicapped) • Affordability (for the less well-off) • Availability (for those living in more remote

		areas)
Type B	Positive externalities	• Economic development of urban areas • Mobility (general) • Quality of life (general)
Type C	Negative externalities	• Quality of life (impact of public transport) • Safety (other traffic) • Health (people living in the vicinity)
Type D	Functioning of the sector	• Quality (service provision) • Security (employee, customer) • Reliability (employer, carrier)
Type E	Functioning of government	• Democratic legitimacy • Reliability (government) • Efficiency (use of public resources)

Based on the theories of Moore, and the works of Veeneman and others, Carli proposes a framework for measuring public value in public transport. He also adds the environment to his list of public values, as the issue of environmental sustainability along with energy and space efficiency are becoming recognized and increasingly valued by administrations.

Table 3: Framework for public values in public transport (CARLI, 2011, simplified by author)

Public Value	Objective	Indicators
Social Inclusion	Accessibility for disabled Affordability for less well-off Service provision Availability across city	Proportion of low floor vehicles Availability and extent of concession tickets Increase in service level in last 5 years Asses service level in outer areas
Economic development	City development Quality of city living Mobility within city	Area of city and number of residents Length of network by mode Number of vehicles by mode Length of bus lanes and segregated right of way for trams
Quality	Quality of vehicles and infrastructure, comfort and cleanliness; simple transport information.	Observe condition of shelters and vehicles: they are clean , comfortable, have good information and are wheelchair

	Quality indicators	accessible. Compare satisfaction surveys.
Environment	Integration with other sustainable transport modes. How many vehicles in the city's bus fleet can be described with clean diesel. How many vehicles in the city's bus fleet can be described as: Powered with Liquid Petroleum Gas (LPG), Liquid Natural Gas (LNG), BioFuel, Ethanol, Electricity, other sustainable fuel	Observe position of bicycle facilities. Number of vehicles Number of vehicles
Value for money	Increase in patronage last 5 years Reliability of services Service intervals by mode in peak hour Average cost on public transport	Increase in person trips per day by mode Percentage of late arrivals Proportion of <15 minutes services Cost of weekly tickets
Safety and congestion	Average speed buses/trams/trains in peak hour	Km per hour

2.4.2.2 Platforms and networks

As an increasing number of services related to public transport become digitized, among them payment systems, it should be expected that the sector is becoming interesting for the entry of private actors the same way as we have seen in the personal transport business with companies like Uber and Lyft and the hotel/hospitality business with Airbnb (as the most obvious examples these days). Such companies can be expected to turn the urban public transport into a networked industry, providing various platforms for businesses. Some platforms are not at all new, though. Public transport authorities commonly provide platforms for transport operators and others to interact with the individual traveler. What is new is that payment systems have the potential of becoming platform-mediated businesses, as mobile apps are available for electronic ticketing, and international financial institutions and credit card companies are launching their technologies to compete.

The idea of platform-mediated networked businesses is not new and substantial literature is available (see separate chapter for a summary of features). However, little is yet published on the new platform business possibilities in public transport, and it is one of the ambitions of this dissertation to examine if platform-mediated businesses are indeed emerging, and what mechanisms promote or inhibit such development.

2.4.2.3 Integrated ticketing

The concept of integrated ticketing is meant to allow for a single ticket to be used across different modalities and also in different regions and counties. Traditionally it has been common (and is still today many places) that each individual transport operator and each transport modality has operated with individual tickets, even after electronic ticketing of various kinds has replaced the paper tickets. While being easy to administer for the transport operators and authorities, this has not been particularly user friendly, especially for non-frequent travelers. To facilitate a wider use of public transport, it is therefore important to develop integrated ticketing systems. At the local and regional levels, a lot has already been done, but the ambition should be to extend functionality across regions, and also to non-transport, but related operations like museums and other tourist venues (PUHE et al, 2014).

2.4.2.4 Modalities

By modalities are meant the different means of public transportation, like bus, ferry, VLT, tram, metro etc. It is also common to include private means of transportation, like cars, bicycles and walking (SPICKERMAN et al, 2014). The increasing load of traffic in the big cities is already causing considerable impact on peoples' lives, and will continue to do so in the future. More focus on using multiple modes of transportation, and also combining private and public transportation modes will be necessary to solve congestion problems (SPICKERMAN et al, 2014). Payment systems are also important to enable the multi-modal future of public transport. Integrated ticketing systems, integrated tariffs, secure processing and automated handling are all vital components (SPICKERMAN et al, 2014).

2.4.3 Public transport operators

About the public transport operators' willingness to invest in new technology, and their ability to capitalize on these technologies and the possibilities they enable.

2.4.3.1 Financial models and payment processes

Traditionally, payments for public transport were made in cash on board the vehicle. This is still commonly available in many countries. Both Norway and Brazil have laws requiring cash to be legally tender, and thus a valid form of payment also for public transport. The handling of cash is costly and cumbersome, and constitutes a continuous risk for

robberies and fraud. Smartcards have therefore been in use for many years as a substitute. The added value for the passenger has been flexibility, as various products could be loaded onto the card. For the transit authorities and the transit providers, the smartcards meant a prepayment of all trips as well as large savings from not having to handle large amounts of cash. For both groups, the reduced risk of robbery was valuable. Still, the availability of cash payment has been important for some groups of passengers like infrequent travelers, tourists and other visitors from outside the city, children and elders, and the poor. (ATB, 2016)

Meanwhile, the field of finance technology (or “fintech”) is developing rapidly, bringing new solutions, actors and business models. This will have consequences for public transit as well, as customers eventually will require solutions that are aligned with the ones they use elsewhere in society. (AU & KAUFFMANN, 2008) In a report prepared by the Danish Payments Council (2014), several new methods are described, of which some are not suited for public transit, while others are already commonly in use.

The nine are as follows (DANISH PAYMENTS COUNCIL, 2014):

1. *Contactless technology* which makes it possible to pay by holding an instrument, such as a card or mobile phone, to a reader that registers the payment. The technology is particularly useful for small payments to be executed quickly without a PIN;
2. *mPOS terminals*, i.e. a device that enables the acceptance of card payments by use of smartphones or tablets. These terminals are mainly aimed at retailers who receive a limited number of payments but wish to offer their customers the possibility of making payments by card;
3. *Online banking solutions* – used for payment in online shopping. For these solutions, the consumer clicks on an icon in the online shop and is transferred to his or her online bank to authorize the payment;
4. *Online-based accounts* – are opened with a view to pay for online purchases. These are typically prepaid accounts to which the consumer transfers funds on an ongoing basis. Alternatively, the consumer may choose to link a card to the account. From a legal point of view, the funds held in this type of account are electronic money;
5. *Text message payments* – involves sending a text message from a mobile phone. This solution is especially used for the payment of bus and train tickets, parking charges and vending machine purchases as well as digital services such as games and ring tones;
6. *Payments using apps* – i.e. a piece of software, which is downloaded on a smartphone. As defined in this report, this type of solution is typically used for the purchase of goods and

services from individual payees and involves withdrawals from a card which the consumer has linked to the app;

7. *Digital wallets* – involves electronic registration of the consumer's cards. A digital wallet can be placed on a server for use in online shopping or it can be downloaded as an app on a smartphone;
8. *Prepaid cards* – a value stored on e.g. a chip or registered on a server. The prepaid funds are electronic money if others than the issuer accept them as means of payment;
9. *Overlay services* – a solution aimed at payments in online shopping. In connection with overlay services the consumer states his or her account number and online banking login and the provider subsequently executes the payment.

It is obvious that these methods vary greatly in their nature, something also mentioned in the report. There is also a mix-up of technologies and payment methods, e.g. nos. 1 and 8. A prepaid card (8) may very well be using contactless technology (1).

From the retail business we see a move from both Apple and Google to capture the payment business through their Apple Pay² and Android Pay³ solutions. The major credit card companies, through their EMV[®] technology platform (see chapter 2.4.3.2) initiative are moving forward. Banks and others are launching peer to peer (P2P) payment services, that are picked up by commercial actors like supermarket chains etc.

A stabilizing factor is the long investment horizons in public transport. In Norway tender periods have been as long as 10 years, making the uptake of new ideas and innovations slow. The size of investments is another factor. Replacing hardware in Rio de Janeiro's 24 000 buses is both costly and time-consuming.

2.4.3.2 EMV^{®4}

The description of the EMV[®] standard probably belong in the previous chapter, *Financial models and payment processes*, but it is so important in the international payment industry, that a closer description is warranted.

The standard is really a set of specifications intended to ensure “worldwide interoperability and acceptance of secure payment transactions” (quote https://www.emvco.com/about_emv.aspx), and is owned and maintained by EMVCo LLC, an

² <http://www.apple.com/apple-pay>

³ <https://www.android.com/pay/>

⁴ <http://www.emvco.com/>

organization owned by American Express, Discover, JCB, MasterCard, UnionPay and Visa, the largest credit card companies in the world at the moment.

The EMV standard provides specifications for cards and terminals as well as back-end systems and clearing procedures. Originally, the standard described only contact specifications, but has since been expanded and developed to contactless payment and mobile payment. The most recent development is a standard for tokenization, the latest addition to the electronic payment universe. Tokenization is the process where card or account number is replaced with a unique, transaction-specific token that acts as the identifier of the payment in the clearance process. This is the technology used in e.g. ApplePay. (<https://www.emvco.com>)

2.4.3.3 Business Models

“Change is coming to transportation, whether we’re ready for it or not. You can see it in public sector investment in intelligent streets and digital railways, automakers’ focus on next-generation vehicles and smart mobility services, and in the widening recognition that the “information everywhere” world will utterly disrupt the transportation status quo.”

This is the opening of the Deloitte report “Transport in the Digital Age – Disruptive Trends for Smart Mobility” (2015). There is little doubt that the changes in how business is done in a broader perspective also will influence the public transport sector. How and when is not clear from the available literature. Meanwhile, some modern adaptations are described:

Electronic ticketing and AFC systems (see chapter 2.4.1.1) have enabled a choice of business models for the public transport authority. Huomo (2009) identifies five distinct business models within the NFC ecosystem:

- Prepaid-value Model or Stored-value Model

This is currently the most common model for electronic ticketing (PUHE et al, 2014). The big advantage for the public transport authority aside from the avoidance of handling cash on board the vehicles is that the passenger has paid before traveling, thus minimizing losses due to missing payments. In this model, the travel value is stored in the card itself. It has to be preloaded, normally from a ATM type of machine or from a point of sale. The value can be in the form of travel money, or eCash, a fixed number of travels, or time-based (periodic) value.

- Enhanced Payment Card or Payment-provider Centric Model

This business model utilizes a contactless credit/debit card or an NFC equipped phone to directly pay the travel fare. The payment card or phone application is issued to

the end-user directly from the bank/card issuer, who administers the transaction, sometimes through a Trusted Service Manager (TSM) (See chapter 2.4.3.3.1.

- Post-paid model (commonly referred to as ID-based model)

In the Post-paid Model, the ticket medium, usually a smartcard or an NFC equipped phone is providing the user's identity. Combined with location and time information from the NFC reader equipment in the vehicle, the payment transaction is performed post-travel through the public transport authority's own business systems. If an NFC equipped phone is used, an alternative is to transfer the time and location data provided by the NFC reader in the vehicle together with the identification over the mobile phone network. The biggest advantage of the Post-paid model is the flexibility it offers with regards to ticket medium, as this only has to provide a secure identity, thus providing the user with better security as no value is stored in the medium. Biometry-based identification through fingerprint readers on phone or card ensures that only the registered user can travel with the medium. The main disadvantage is that the risk of fraud as the travel can be performed without coverage on the user's account. Systems of blacklisting identities and frequent update of these lists in the individual vehicles and/or passenger controls must be implemented to avoid this problem.

- Combined/Enhanced Collaborative Models

These models describe the possibility of placing multiple applications in one smartcard, in the same fashion as in a mobile phone. The NFC reader must activate the correct application in the card, which can be either a stored-value model or a post-payment model. In the enhanced model, the user can choose payment model, either directly through the credit card provider, or through the public transit operator/authority.

- Embedded Secure Element/(U)SIM

The secure element containing the unique identifier required is normally located in either the (U)SIM card in the phone, or in an embedded secure element. This is not so much a separate business model as a description of how the instance managing the secure element, a Trusted Service manager (TSM), who can be a 3rd party (also called Trusted 3rd Party), the mobile network operator, a bank or the handset manufacturer defines the business rules. This applies to all the business models described above, and may be an important reason that NFC has not yet reached a broader utilization. The International Association of Public Transport quite correctly observed that "fare systems may become managed by owners of the ticketing application rather than issuers of the electronic

media” (UITP, 2007), and there are no indications that a consolidation or clarification in this field has happened.

2.4.3.3.1 The Role of the Trusted Service Manager (TSM)

The Trusted Service Manager in NFC ecosystems is a virtual role that can be held by several parties. The main role of the TSM is to manage the NFC applications in the user’s phone. This is done over the air (OTA), and appears to be automatic to the user. The next role is to manage the communication between the user and the service provider for a product (e.g. a public transport application containing a travel ticket) so that data are kept secure in the transfer between the customer’s phone, via the mobile network operator’s systems, and to the public transport provider’s systems. (HUOMO, 2009)

The TSM has control over the embedded secure element residing in the phone (internally, or in the (U)SIM card), giving the TSM provider tight control over the business platform for NFC applications. One example of this situation is that in mobile phones running Android OS, the embedded secure element is either in the (U)SIM, or if located in the phone, it is available to 3rd party TSM providers. Apple has a different strategy for their iPhone, where they keep the TSM role to themselves, securing that they can be involved in all financial transactions involving the iPhone and NFC. (Source: <https://www.bellid.com/blog/tsm-to-single-source-or-multi-source/> [Retrieved 2016.08.23])

Huomo (2009) is describing the technical aspects of TSM and NFC in excellent detail, and the technical minded reader is referred to this source for further reference.

2.4.3.4 Public Requirements and Regulations

Public transit, and especially urban public transit is a service commonly governed and controlled by municipal or county authorities. The economy of public transit is therefore offset against non-financial values like mobility for all groups of society, population patterns, traffic congestion and environmental issues. Funding of urban public transit is commonly subsidized as well. Operational costs are subsidized with an average of 50%, but with large variations from city to city. This is also a fact for Trondheim, where approximately 50% of the costs rely on public funding. (ATB, 2014, p.9) Also capital investments are often subsidized by public authorities. (BUEHLER & PUCHER, 2011; MATHISEN, 2016; ROJO et al, 2015)

However, subsidies from public authorities can be unpredictable. Authorities have many important uses for the money, and public funds are political instruments. Costs have generally risen more in this business than the general inflation rates. (UITP 2012) Where this leads is that public transit authorities and providers must continuously work to reduce costs, increase efficiency and innovate, to stay profitable. Several studies look at the issue of competitive tendering to achieve cost reductions, whether they actually do, and how this method influence other effects.

2.4.4 The public

About the public's willingness to embrace new technology and new methods for paying for public transport services, here exemplified by mobile payment.

2.4.4.1 Mobile payment

Based on the Technology Adoption Model (TAM) described by F.D. Davis (1989), the Diffusion of Innovations (DOI) model (ROGERS, 2003) and the UTAUT (Unified Theory of Acceptance and Use of Technology) model by V. Venkatesh et al (2003), DiPietro et al (2015) have formulated a new model specifically directed to the acceptance of mobile payment services, the Integrated Model on Mobile Payment Acceptance (IMMPA). The model consists of five predictors: Usefulness, Ease of use, Attitude towards mobile service, Security, and Compatibility. Of these, the Attitude towards mobile service and Security are new, whereas the other three are composed of predictors identified in the previously mentioned models.

Usefulness: The perception of to what degree the service will fulfill the users' needs. This is directly influenced by the Attitude towards mobile services, the Ease of use and the Compatibility predictors.

Attitude towards mobile services: The perception of usefulness of mobile services in general. In this case mainly targeted on functions related to public transport, e.g. geolocation services embedded in the ticketing application, online timetable alerts (real-time systems) etc.

Ease of Use: The perception of how easy the various functions of mobile ticketing are to use. E.g. buying a ticket, finding the correct fare, validating the ticket.

Compatibility: The expectation of the mobile ticketing application to be complete with regards to information on costs, timetables, alternative routes, delays etc. In addition, the interface should be easy to use (familiar) and the application should be customizable.

Security: The expectation that the mobile ticketing application is safe, and that provided card or account information is treated with confidentiality. This predictor also covers the expectation that eventual errors, refund situations etc. are properly handled so that money is not “lost” in the system.

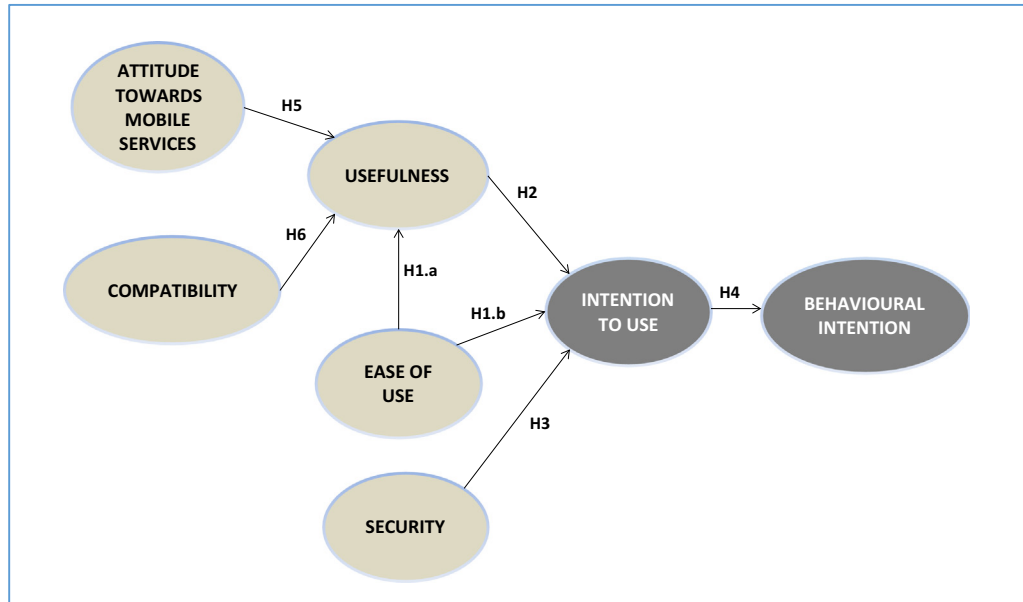


Figure 5: Proposed IMMPA model with related research hypotheses (DI PIETRO et al, 2015)

In the article, the theoretic foundation for the theory is presented along with an empirical testing in mobile payment in public transport. The results indicate that the model is well suited for predicting the adoption of mobile ticketing, although the authors argue for further testing to verify usefulness in other contexts.

2.5 Summary and Research Questions

Summarizing the literature reviewed, one can say that a lot of research has been done on various aspects of public transport, including payment and ticketing. However, the ongoing development in the area of payment systems is progressing rapidly, and it is not clear if and how the newest technology is adapted in the public transport sector. To better understand this, two cities (Rio de Janeiro and Trondheim) with presumed very different approach to the issue of public transport are used as cases. The general questions asked for this research are:

- What technology is in use today, and what is being developed for the future?
- How is this technology developed and adapted for practical use and by whom?
- Why is the development progressing the way it is?

The first question should be more or less self-explaining. The general technology trends are described in the previous chapters and this research aim to determine whether any of these are in use or under development, and if not, which technologies are used and developed instead.

The ‘how’ question is also fairly straight-forward. What is interesting is whether development is conducted internally in the public transport organization, or whether external companies have gained entry into the market. The ‘how’ is therefore expanded to include a ‘by whom’.

The ‘why’ question is more complex, as this is where it should be determined whether the theories studied are applicable to the particular case or not. To structure this, the various stakeholders will be examined for traces of the theories as follows:

- Public authorities/PTA:
 - Public Value;
 - Are Public Value issues pursued consciously or unconsciously?
 - Can any clear implementations of Public Value be found?
 - Platform-mediated business networks;
 - Are any existing?
 - Are they being promoted by the public authorities?
 - Technologies;
 - Integrated ticketing
 - Modalities and integration
- Public Transport Operators and technology suppliers/providers:
 - Financial and business models;
 - What models are used by the various stakeholders in the industry?
 - Are any new models emerging?
- Passengers/The Public:
 - Mobile payment (IMMPA model);
 - Is mobile payment services offered?
 - If so, can the IMMPA model be applied?

One ambition of this dissertation is to provide a useful overview for managers of technology providers and other who seek to approach the markets in one (or both) of the cities in the study.

Such an overview would not be very useful if it was strictly limited to the payment systems of the two cities' public transport systems. It is also difficult to explain the development of payment systems unless it is seen in a wider context. Therefore, a second research topic has been added: An overview of the public transport systems in the two case cities. Formulated as a formal research question:

- How are the public transport systems in Rio de Janeiro and Trondheim organized?

A fairly easy, and still thorough way to provide such an overview is to describe the ecosystem. This method of analysis provides both a graphic overview and an analysis of the various actors and their relations.

Dealing with the payment systems questions makes more sense after the general systems have been described. Therefore, the research questions will be organized as follows:

1. How are the public transport systems in Rio de Janeiro and Trondheim organized?
2. What technology is in use today, and what is being developed for the future?
3. How is this technology developed and adapted for practical use and by whom?
4. Why is the development progressing the way it is?

To attempt to further add to the managerial usefulness of the study, a scenario analysis can add valuable background material, mainly as a way to fill in some of all the 'soft' information gathered during the research for this dissertation, but also as a starting point for a company to form their strategy in the respective markets. Therefore, the main steps of a scenario analysis will also be provided as part of the attempt to answer research question 1.

3 Methodology

3.1 Research Type

Initially, the intention of this dissertation was to study payment systems in public urban transport. Due to the international nature of the researcher's situation by being Norwegian and living and studying in Brazil, a dual case study was chosen to address the topic, and also to show equalities and differences between very distant locations. However, studying available literature, it became clear that the organization of the public transport systems in the two chosen cities are very different, and the need to chart and describe them

became necessary as a purpose in itself, not only to understand how the payment systems function, and why they are developing the way they are, but as an intrinsic approach as defined by Stake (1995).

The situation with two cities chosen for examination, calls for a holistic multiple-case study as proposed by Yin (2009) (p.46). Separate case descriptions will be prepared for each city, and subsequently compared.

As the intention with the research was to explore and understand the phenomena of payment systems, as well as the very organization of the public urban transport, it was natural to choose a qualitative, exploratory study.

The available literature describing payment systems in public transport tend to focus on technical issues, and little has been found to explain the development seen. Also, the two studied cities have such differences in the organization of their respective public urban transport systems, that they probably can't be explained from the same framework. Therefore, the exploratory study was chosen so as to chart the existing connections and relations and seek to explain their nature as closely as possible. Some theories were explored in the literature review, and are attempted applied to the data obtained.

Data was collected from secondary data (websites, reports, international organizations' online libraries, etc.) and interviews.

3.2 Selection of Interviewees and structuring of the interviews

Purposefully selecting individuals is the best way for the researcher to understand the problem to be researched in a qualitative study (CRESWELL, 2014). In this study, the purpose was to see the public urban transport systems in the case cities as completely as possible, hence the interviewees were chosen to represent all known aspects of the industry. One important limitation is that the passenger is omitted from this study. A survey of the suitability of the payment systems in use, or the experience or efficacy of the transport system would of course need the view of the passenger as user, but as the scope of the study is to chart and describe the actual systems, and not to try to evaluate their usefulness or appropriateness, the regular passenger is not assumed to be able to contribute in a meaningful way.

The interviewees were chosen based on the following criteria:

1. Organization. An attempt was made to obtain interviewees from the following types of organizations, so as to provide a description of the topics from different

angles: Research organizations. Public transport authority. Public authorities. Enterprises providing relevant products and services to the public transport system.

2. Competence and position. Researchers, executives, technical professionals involved in development, administration of or research on transport systems and payment platforms for these were chosen.
3. Language. The interviewees had to master English or Norwegian due to the language limitations of the researcher.

Based on these criteria, requests for interviews were directed to the following organizations:

Table 4: Interview invitations

City	Institution	Type	Response
Rio de Janeiro	Secretaria Municipal de Transportes	Public authority	No response
Rio de Janeiro	RioCardTI	Public transport operator related	Positive response
Rio de Janeiro	Programa de Engenharia de Transportes - PET/COPPE/UFRJ	Research Facility	Positive Response
Rio de Janeiro	CEFET/RJ	Research Facility	Positive Response
Rio de Janeiro	Fetranspor Mobilidade	Public transport operator related	No response
Trondheim	SINTEF	Research Facility	Positive response
Trondheim	AtB	Public Transport Authority	Positive Response
Trondheim	WTW	Technology provider	No response
Trondheim	FourC	Technology Provider	Positive Response
Trondheim	Sør-Trøndelag Fylkeskommune (County Administration)	Public Authority	Positive Response

Based on the response from the invited organizations, the following interviews were performed:

Table 5: Interviewees

Participant	Name	Organization	Position
A	Carlos Silveira	RioCardTI	Director
B	Ronaldo Balassiano	COPPE/	Professor
C	Diego Carvalho	CEFET/RJ	Professor
D	Trond Foss	SINTEF	Senior Researcher
E	Tor Rune Skoglund	FourC	CEO
F	Sigmund Henningsen	FourC	Business Developer
G	Erlend Solem	Sør-Trøndelag Fylkeskommune (County Administration)	County Director of Regional transport
H	Torfinn Utne	AtB	Director of ICT

The interviewees were offered confidentiality, which were declined by all. Their names and organizations are therefore listed above.

3.3 Data Collection

The main sources of data for this project were interviews and various written data sources, mainly located online. To chart and understand the structures of the public transport ecosystems, various online sources were used, based on the websites of the main actors, their annual reports etc. Also, the library sections of the big transport associations were used. Used sources are referenced.

The interviews were semi-structured in-depth interviews, and were performed as conversations. A script containing the key issues to cover was brought to the interview, but the interviewee was mainly urged to address the topic (“public urban transport in your city, and the related payment systems”) freely, based on the competence and position of each individual. This was intended to lead to a more varied and more complete description of the

topics, in accordance with the qualitative method (CRESWELL, 2014). Follow-up questions were asked in accordance with the development of the interview and the details section of the script, unless these were covered during the conversation.

3.3.1 Interview Script

The interview script was somewhat adapted to each interview but with the same main topics in all. Country differences were observed (it doesn't make sense discussing the public transport system in Trondheim with interviewees from Rio de Janeiro and vice versa). Also some threads were expected to require different approaches. For Rio de Janeiro the organization of the bus system, and its feasibility for innovation was one. The Norwegian situation of researchers also acting for the regulators required differences in the approach depending on whether researchers or company representatives were the interviewees.

3.4 Data Analysis

The following methodologies were applied to the data gathered from interviews and secondary data:

Ecosystem analysis: Base data to construct the ecosystem graphs were collected by the author based on available online sources, mainly from the involved enterprises and organizations. The obtained data was used to create ecosystem models of the public transport systems in Rio de Janeiro and Trondheim. The ecosystems were discussed, revised and confirmed in all relevant interviews performed. The analysis of the ecosystems was performed according to the theories of Iansiti & Levien (2004) and Moore (1993). This analysis is intended to provide answers to research question 1. The graphs were prepared using the Gephi graph platform (www.gephi.org), which allows for dynamic viewing and restructuring of the ecosystems.

General description: Relevant data and quotes to describe the public transport systems in Rio de Janeiro and Trondheim, their background, current situation and expected development were extracted from the interviews with support from secondary data to provide facts and an impression of the perceived nature of the two organizations. The data were also applied to theoretical models studied in the literature review. In the general description we aim to find answers to research questions 1, 2, 3 and 4.

Platforms and Networks analysis: Applicable platform-mediated networks were extracted from the data and analyzed. This analysis is further providing answers to research question 1.

Scenario Analysis: The descriptive nature of the study, and the intention to look into the future indicates that a scenario analysis is fit to review possible futures for the payment systems, and to the public urban transport systems. This analysis aim to provide insights to aid answering research question 1. In addition, alternative development paths for research question 4 will be explored.

Extracting data from the interviews was done manually, after transcribing the interviews. Due to the interviews in Norway being conducted in Norwegian, and the Brazilian interviewees having different approaches to the English terminology for the subject, automated coding or analysis was not attempted, as such analysis would require an extensive adaptation of the recorded interviews to ensure the language used would allow automated analysis to reveal the data sought.

3.5 Limitations

Due to the lack of response from some organizations, a full “360 degree” analysis of the public urban transport systems in the two cities could not be made. However, the obtained data seem to be quite well triangulated between the interviewees and available secondary data. Also, the presumed more resourceful resources on the topic of payments were interviewed.

Some limitations arise naturally from the nature of the chosen method of in-depth interviews (GIL, 2002; FONTANA & FREY, 1994). Difficulties to understand the questions, different interpretation of the motive of the research, different knowledge base etc. all open for a difficulty to directly compare results. The variation in the positions of the interviewees and their loyalty to their organizations may also affect their ‘version’ of the truth.

Despite these possible limitations of the research method, the choice of a qualitative approach and in turn the use of semi-structured interviews is considered appropriate to obtain the necessary information.

4 Analysis

4.1 Case 1: Rio de Janeiro

4.1.1 History and background

In the beginning of the 20th century, the public transit system in Rio de Janeiro was a well-organized one. The emperor at the time was an educated man, and interested in culture and all the new inventions of the time. He was fascinated by everything European, and brought this inspiration back to Rio de Janeiro. Among these things was the early bus and tram systems. In the beginning pulled by horses, but soon electrified. However, when Brazil was turned into a republic, all the things associated with the monarchy was suddenly unwanted, and the public transit system deteriorated. (Interviewee C)

“...the last emperor he spent a lot of his time in Europe. He loved art, photography and so on, he went to Paris and so on, so he took the ideas from there and brought them back here. “Ah we have to implement a public transportation system, a well-organized, planned city” and so on. But after the breakdown of the monarchy in Brazil, everything related to his work was put away because it was a symbol of the monarchy.” (Interviewee C)

Then in the late 50's or early 60's, the system was privatized and operated completely unregulated. In nature, bus services are cheap to set up, as the investment is low, and return is fast. So a lot of independent bus companies started operation. This continued unregulated until one mayor tried to clean up in the 80's. He nationalized all bus transport in Rio de Janeiro in an attempt to bring system and control. This attempt failed, and lead to big problems with corruption and legal problems. (Interviewee C) It turned out that the bus operators also had a lot of other businesses. They ran airlines, car sales companies etc. and taking over the bus transport from them turned into severe legal issues. (Interviewee B)

After only 5-6 years, the public system collapsed, and private actors came back. The municipality kept running a publicly owned operator company, but this was weak, and could not compete with the private actors. It ended up running the least profitable routes (which the private didn't want). (Interviewee B)

One interesting thing is that among the routes the private actors didn't want was a couple of routes going from one part of the city, and then on the highway through the tunnels to another part of the city. As the highway had no stops, the private companies had no belief

in these routes, but they turned to be very profitable, as they were efficient trunk routes. So when the public company wound down their activity, these were the first routes to be taken by the private.

The privatized system did not function well, and the private operators turned into mafia-like organizations. The lack of regulations led to problems on the ‘borders’ of the system, where routes with marginal profits were not served well. The lack of a proper network and proper planning also caused problems. (Interviewee C)

In 2010 the mayor of Rio de Janeiro reorganized the bus system. It was divided into 5 regions, of which 4 were divided into concessions, that should serve the 5th region (the city centre) jointly in addition to their own territory. The operation of the four concessions, InterNorte, InterSul, TransCarioca and Santa Cruz were awarded to four consortiums in a tender process, and given the concessions for a period of 20 years. The consortiums are organized in the RioÔnibus syndicate, which is the major part of Fetranspor.

Today, the Secretaria Municipal de Transportes is governing the bus transport, setting the rules of operation for the syndicate-consortium-operator matrix. The Secretaria is working to implement the bus network properly and to implement the backbone routes.

“So they are working. I don’t know how it will be, because the real problem is the political system that we have here, and those enterprises, they give a lot of money for the politicians, so...” (Interviewee C)

4.1.2 Ecosystem

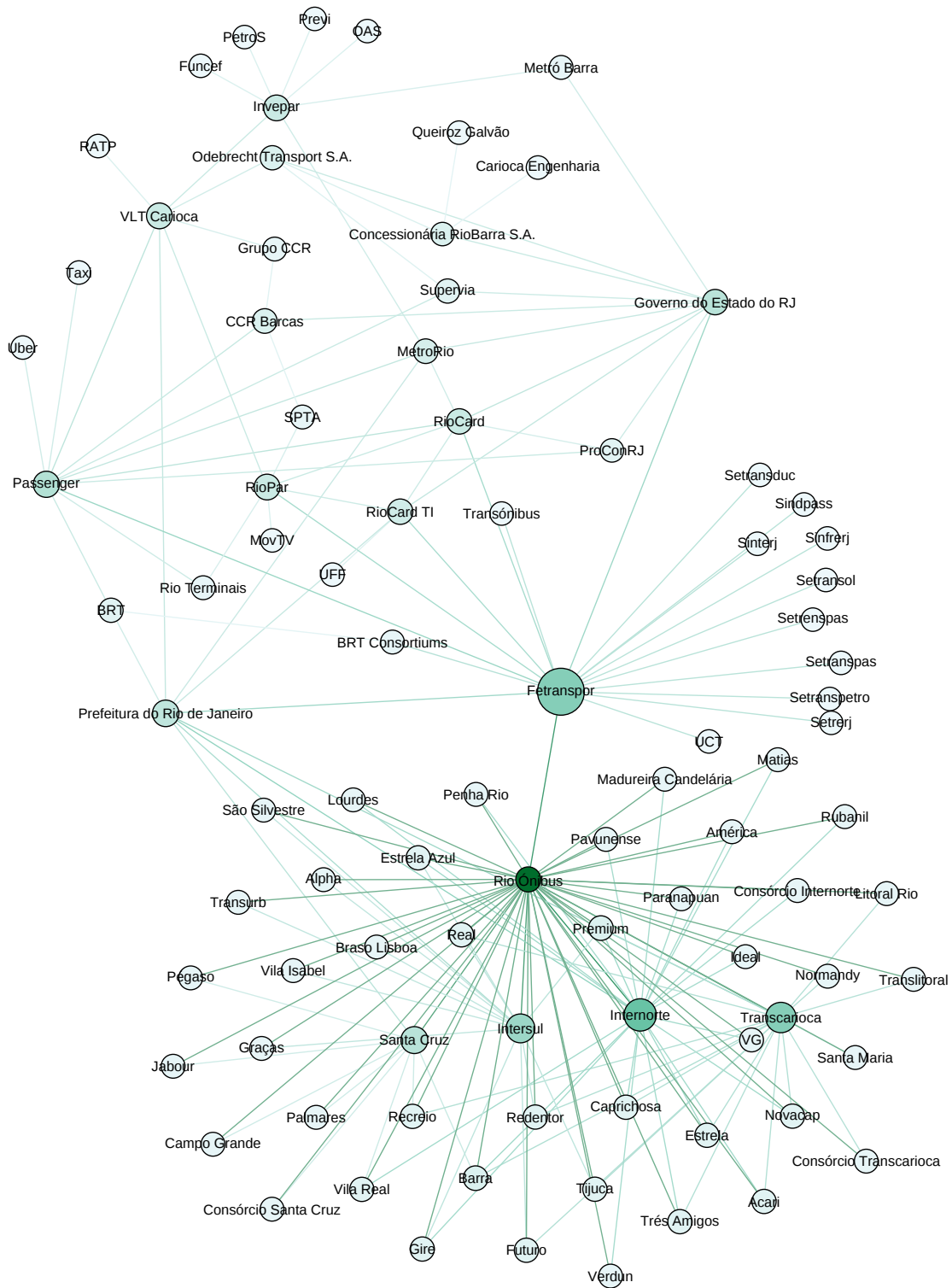


Figure 6: Rio de Janeiro Public Transit Ecosystem (Prepared by the author based on online sources from the involved organizations.)

4.1.3 Ecosystem Analysis

The Rio de Janeiro public transit ecosystem is multimodal. All the common modalities are well represented: bus, metro, VLT, BRT, ferries and trains operate on a daily basis moving about 3,5 million people into the city center and back again (Interviewee C). The total number of daily travel instances (every time a passenger boards a vehicle) on all modalities are about 9 million (Interviewee A).

4.1.3.1 Major Actors

4.1.3.1.1 Fetranspor

The Fetranspor is short for “Federação das Empresas de Transportes de Passageiros do Estado do Rio de Janeiro” (Federation of passenger transport enterprises in the Rio de Janeiro state), and it is the federation of all bus operators in The Rio de Janeiro state. It is a powerful organization that controls all urban bus transit in Rio de Janeiro city and also in the rest of the Rio de Janeiro state.

Since 1987, Fetranspor has held the concession for providing Vale-Transporte in Rio de Janeiro state. (SECRETÁRIO DE ESTADO DE TRANSPORTES, 1987). See separate chapter on Vale-Transporte.

The Federation owns RioPar Participações S/A who in turn control RioCard and RioCardTI and hold shares in the VLT Carioca and CCR Barcas enterprises. (FETRANSPOR, 2016)

Owning RioCard and RioCardTI gives Fetranspor control over all payment processes, and also all money paid for transport, including the Vale-Transporte.

In the ecosystem, Fetranspor can't be seen as anything other than a dominator. The extensive vertical integration, controlling everything from the individual bus companies, the payment system and all payment transactions, up to the institution educating drivers and other officials in the public transit system, the Universidade Corporativa do Transporte (UCT) is a clear indicator. The resistance to entrants into the Rio de Janeiro public urban transit market is another.

“(Q: So in the question of any new stakeholders, perhaps coming from the outside, you don't see anything like that happening here?)

They tried. A big company in Sao Paulo dealing with buses, they tried to come to Rio. But these guys [Fetranspor] are very strong, and they could stop their entrance in Rio.” (Interviewee B)

One could always discuss whether or not the Fetranspor should be considered a keystone instead of a dominator. After all, it is an organization of operating companies, and as such not really vertically integrated. Also, the Fetranspor is providing the ticketing integration service to the rest of the ecosystem. However, looking outside the circle of member companies and owned subsidiaries, the willingness to share value is very limited. Not letting outside companies into the bus transit part is one thing. Another is that the Fetranspor is seeking to expand its reach into the other modalities operating in Rio de Janeiro, like the VLT and the ferries. The entrance of the French company RATP in the VLT consortium can be seen as an attempt from the politicians (in this case the mayor of Rio de Janeiro) to limit the power of Fetranspor (Interviewee B and C).

4.1.3.1.2 RioCard

RioCard is organizing and handling all payment for the public bus transport in Rio de Janeiro. Through the Bilhete Unico, they keep control over payments not only from the bus transport, but also from other transport modalities that accept this payment instrument.

RioCard has 29 stores and more than 1400 charging points to provide travel cards (the only electronic ticket medium used in Rio de Janeiro) and charging opportunities. Recently the possibility to recharge the card via internet has also become possible.

In the ecosystem analysis, RioCard must be seen as a sub-instance of Fetranspor, as it is fully owned by them through the RioPar holding company. It is controlling an important niche in the ecosystem, namely the payment system.

4.1.3.1.3 RioCardTI

This is the technology division of RioCard, responsible for acquiring and maintaining the necessary software and hardware for the payment system to function. They also make the decisions on hardware and software to be used in vehicles and by operators. According to interviewee A, 9 million transactions are processed daily, with a demand to uptime of the systems approaching 100%. Calculation of share of the fares between operators for multi-modality travels are also the responsibility of RioCardTI.

A section in RioCardTI is dedicated to exploring and analyzing new technologies within payments, and whether and how these might be introduced in the Rio de Janeiro transit systems.

In the ecosystem analysis, RioCardTI must be seen as a sub-instance of Fetranspor, as it is fully owned by them through the RioPar holding company. Operating the Trusted Partner systems of the payment system for the whole of the integrated transit system, the RioCardTI is occupying another important niche in the ecosystem.

4.1.3.1.4 Prefeitura do Rio de Janeiro

The Secretaria Municipal de Transportes de Rio de Janeiro is the official authority regulating all public transport in the municipality of Rio de Janeiro. In 2010 the Secretaria divided the municipality into 4 concessionaries (InterSul, InterNorte, Transcarioca and Santa Cruz), which are operated by consortiums with the same names as the concessions, formed by companies in the Fetranspor organization. The four consortiums operate under the RioÔnibus syndicate. The contracts are valid for a period of 20 years with an option to prolong for another 20 years as long as stated demands are met by the consortiums.



Figure 7: Municipality of Rio de Janeiro consortiums (<http://www.rioonibusingforma.com.br/quem-somos/>)

In addition to the regular bus system, the Secretaria Municipal de Transportes is governing the VLT and the BRT transit systems.

The Prefeitura is, through the Secretaria Municipal de Transportes the official, public regulator of the ecosystem together with the SETRANS (see below). However, one can ask how efficient and powerful this regulator is, as both independent interviewees (B and C) indicate that the Fetranspor have a lot of power to influence any decisions made.

4.1.3.1.5 Governo do Estado do Rio de Janeiro

The Secretaria de Estado de Transporte (SETRANS) is the governing organ on state level. Responsible for governing the Vale-Transporte program.

SETRANS is governing the operations of the Metrô (subway), the SuperVia (local trains) and Barcas (passenger ferries operating in the Guanabara Bay), as well as intermunicipal bus routes. All are operated through concessionaries. The new extension of the Metrô to reach Barra da Tijuca is governed under a separate concession.

The SETRANS also have a governing role in the ecosystem. The biggest volume of the public transit in the state of Rio de Janeiro is in the urban bus system in the city of Rio de Janeiro, which is regulated by the Prefeitura, the effective power of the SETRANS is limited, according to the independent interviewees (B and C).

4.1.3.1.6 Passenger

The passenger is an indispensable actor in the urban public transport ecosystem. After all, the passenger is providing the foundation for the very existence of the ecosystem. The demographic of the passengers is leaning to the poorer classes, with all that implies.

“The question is, the number of the people who use the system today, is about 9,5 mill people [travels]. Per day. Of course they are not A and B class people, right? They are C and D.” (Interviewee A)

Transit passengers, while being indispensable to the transit providers, are mainly from the lower classes, which means that they are poor, poorly educated and not organized. Therefore, they have little power to influence the operation of the public transit.

An exception occurred in 2013, when huge protests broke out over a 50 centavos raise in the bus fare. Lots of people took to the streets, and the mayor and the state senator had to reverse the decision and keep the fares unchanged. However, these protests were also influenced by other factors, not related to public transport but to the Brazilian society in general, and as such not an issue for this dissertation.

4.1.3.1.7 MetroRio

Rio de Janeiro's subway system. It is operated by a consortium called Invepar. The Fetranspor has no owner interests in this consortium, as it is owned by four large pension funds. The concession for the Metrô is given by the Secretaria de Estado de Transporte,

SETRANS. At the time of writing, an important extension to the Metro is about to be finalized. That is the Linha4, extending the Metro network to Barra da Tijuca. The Linha4 is to be operated by a different concessionary, the Concessionária RioBarra S.A. Invepar is not involved directly in this concessionary, which is owned by Queiroz Galvão, Odebrecht and Carioca Engenharia, all three large contractors operating in Brazil and internationally, and within a number of industries.

Payment in the metro is organized by own electronic tickets on standard plastic card medium. RioCard's various bilhete unicos is also accepted.

MetroRio is occupying a niche in the ecosystem, providing transport services the same way as Fetranspor, but with a much more limited operation.

4.1.3.1.8 Supervia

The SuperVia provides local train transport between Rio de Janeiro and the closest municipalities. The SuperVia operates 4 lines going north and east. The SuperVia is owned and operated by Odebrecht TransPort under a concession from the Rio de Janeiro State.

Payment on the SuperVia is made by the Superivia card or the cards offered by Fetranspor (Bilhete Único and Vale-Transporte).

The Supervia is a niche player in the ecosystem providing an important of the transport infrastructure, connecting the city of Rio de Janeiro to the surrounding municipalities.

4.1.3.1.9 CCR Barcas

Passenger ferries operating in the Guanabara Bay between Rio de Janeiro and Niteroi and also serving the islands in the bay. There is a separate division operating between the mainland and Ilha Grande in the south of Rio de Janeiro state.

Payment is via own ticketing or bilhete unico.

Although they are partly owned by the Fetranspor via RioPar and the holding SPTA, the CCR Barcas are operating as a niche player in the ecosystem.

4.1.3.1.10 VLTCarioca

The new prestige project of the Prefeitura for the 2016 Olympic games. It is designed to reduce the need for buses to enter the city centre, as well as transport for visitors and tourists to the newly refurbished dock area.

“... for example, for the VLT in the center, many many bus routes are getting out of the center. But, if the VLT does not operate well, those buses will come back. Because of public demand.” (Interviewee B)

The VLT is owned and operated by a consortium whose main owners are Invepar, RioPar, Grupo CCR, Odebrecht TransPort. It is interesting that RATP (the French rail operator) has managed to enter with a small ownership, as most consortiums in Rio de Janeiro are made up of Brazilian interests.

“ But, when the mayor, because of the opportunity of having the Olympic games here, he said, ok, now we have in the center of Rio the VLT. The first thing they[Fetranspor] have done, ok, “we want to be with you”. So they enter here ([the VLTCarioca consortium], and there is this consortium with RATP from France, Odebrecht Transport etc. and you have them, the RioPar. Ok, we are together here.” (Interviewee B)

The VLT consortium also has some other small owners.

The VLT is another niche in the ecosystem, but it is a very interesting project, as it is also an attempt from the politicians to take back control from the Fetranspor. The current VLT is part of an old project developed by the BNDES 10-15 years ago. The original project was more extensive, forming three circles around the city center. Although the VLTCarioca is in all a different project, it is based on the old plans, and if successful, might very well be the beginning of an expansion at the expense of the bus transit in and around the city center.

4.1.3.1.11 BRT

The BRT network in Rio de Janeiro is seeing a great expansion for the 2016 Olympic Games. The two existing lines, the Transoeste and the Transcarioca will be joined by the Transbrasil and the Transolímpico. The lines are operated under different Concessions, and different concessionaries have interests in the different lines.

The role of the BRT in the ecosystem is also as a niche player.

4.1.4 Interviewees' aspects

4.1.4.1 About the Fetranspor

According to both interviewee B and C, Rio de Janeiro is different from other cities in that the real power in public transport questions lies with the Fetranspor, and not with the Secretaria Municipal de Transportes.

“But when we have the private sector with the force that we have here in Rio de Janeiro, we will always have a deformed solution. Not the best for the municipality. And it is a public service. We have to provide the best thing.” (Interviewee C)

Even though the Fetranspor is a very strong organization, the trust between the members is low, and inhibiting development and innovation. For example, in the BRT stations, each of the operators have their own ticketing booth, even if they sell the same tickets. This is a means of keeping control over the number of buses and passengers boarding.

“... they are operating the BRT from Santa Cruz to Barra de Tijuca. It's a corridor. So 2 bus companies that are in this consortium here, they share this corridor. When you go to a station, one of the ticketing boxes is from one company, and the other is from the other company. Because they don't trust each other. If they are both there, they both know exactly how many buses are passing, how many passengers are boarding the bus and okay, this guy is not going to cheat me.” (Interviewee B)

Also, the buses, the metro, the local train and the ferries all have individual payment platforms working only in their own modality. In addition the RioCard Bilhete Unico is accepted by everyone, as this is also the medium for the *Vales-Transporte* (see below) and the *Gratuidade* (see below).

4.1.4.2 Vales-Transporte (Employer-paid transport for workers)

In Brazil, there is a law saying that the employer shall provide transport services to and from work for his employees up to a certain salary level (Leis nos 7.418 . de 16 de dezembro de 1985, e 7.619, de 30 de setembro 1987). This is called *Vales-Transporte*, and is normally organized in such a way that the employer buys a special bus card for the employee,

which is valid for one travel in each direction per day (home-workplace-home). Each month the employer prepays the travel for one month. If, however, all trips are not used, there is no reimbursement, transfer to next month or similar

“...you give the ticket for your employee, and in the end of the month, instead of, for example 30 trips, he only travel 25 trips. The 5 trips in the card are lost. All these lost trips come back to [RioCard]. This is another source of revenue.” (Interviewee B).

The right to handle the *Vales-Transporte* was granted to the Fetranspor in October 1987, with no clause on renegotiation or other time limitation (Secretário de Estado de Transportes 1987).

The *Vales-Transporte* is securing the worker’s possibility to get to work also over great distances, which enables people from the poor districts far from the center to keep jobs there. As a social measure this clearly fit into the Type A (VEENEMAN ET AL, 2006) and Social Inclusion (CARLI, 2011) categories of Public Value frameworks.

4.1.4.3 Gratuidade (The rights to free transport)

The elderly, the disabled and students up to a certain level are entitled to free public transport in the state of Rio de Janeiro under a regime called *Gratuidade* (governed by several laws, among them “Constituição Estadual, de 5 de outubro de 1989 – Art. 14 – Gratuidade”, “Lei complementar nº 74, de 10 de setembro de 1991 – Regulamenta o art. 14 da C.E. e seus incisos”, “Lei nº 4.510, de 13 de janeiro de 2005 – Gratuidade”). Ensuring mobility for the otherwise unable fit into the Type A (VEENEMAN ET AL, 2006) and Social Inclusion (CARLI, 2011) categories of Public Value frameworks.

Whether intentional or not, this in reality the method for paying subsidies to the bus operators, as the gratuity is reimbursed by the municipality. (Interviewee B and C) In contrast, the view of Interviewee A, is that the bus transit system is operating without any subsidies of any kind. This is one example of the very different world views the inside (RioCard/Fetranspor) and the outside (the universities) have on the issue of the urban public transit in Rio de Janeiro.

The reimbursement is based on travel data from RioCard/Fetranspor. This way of subsidizing is unfortunate, as the subsidies go to the operators with more traffic of gratuity passengers, not to the ones on the most marginal routes. According to Interviewee C there is no system for distributing these subsidies within the Fetranspor, and he claims that smaller

operators on the borders of the system (running the less profitable routes) are going bankrupt as a result of this practice. This raises a lot of challenges in the operation and governance of the concessions.

Another challenge is fraud. According to RioCardTI, the fraud related to the *Gratuidade* is as high as 32%, meaning that almost 1/3 of all passengers using a gratuity card are not entitled to. What is common is an old person giving (or selling) their card to a teenager. (Interviewee A)

4.1.4.4 RioCard

RioCard is comprised by the companies RioCard Cartões and RioCardTI and are filling a very important role in the Rio de Janeiro public transit system. They handle all transactions of payment for every unit of transport performed on all buses, and all transport on other modalities paid for with the Bilhete Único (“Sole Ticket”).

The Bilhete Único is Rio de Janeiro’s most important effort for integrating all modalities of the public transit. What is confusing is that the meaning of “Bilhete Único” is that it is accepted on all modes, not that it is a single way of paying. So there are many different products under this brand. According to interviewee A as many as 52 varieties are in use.

“I use to say, because they call it the unique ticket, bilhete unico, and I say that this city is the only one in the world that have one hundred bilhetes unicos.” (Interviewee B)

Particular versions of the Bilhete Único are used for the *Vales-Transporte* and the various *Gratuidade* programs. Also there are different versions for use within Rio de Janeiro Municipality and between municipalities within the state.

One of the most important tasks of RioCardTI is the handling and processing of multi-modal travels. When a passenger changes mode, for example from bus to boat, then to metro and finally to bus, he is only charged once if the travel is completed within a certain timeframe. The payment is then divided between the various operators that provided the transport.

“RioCardTI is a company and we have here the whole IT organization to collect the money, and give the money to the right person [company].

This is simple if you have one mode only. It is becoming complex when you have several integrations in between. Important. So we say the modes have multiple legs. What that means: From Niteroi I take one bus, so I have the ship, then I have a second bus, then I have a subway, then I go to Barra, I have another bus, then I have the BRT, then I go to Santa Cruz with a sixth bus. “

(Interviewee A)

4.1.4.5 About Automatic Fare Collection (AFC) and the use of cash

Rio de Janeiro was early in adopting a modern contact-less electronic system. However, just like in Norway, law requires cash to be accepted as payment. And it is an important issue for including more people of the lower classes in the transport system.

“The question is, the number of the people who use the system today, is about 9,5 mill people. Per day. Of course they are not A and B class people, right? They are C and D.” (Interviewee A)

“The tariff today is 3 reais, 80 centavos. You should have 3 reais and coins. When I put coins to collect money. 40% of the people who has public transportation in Rio make charge for one tariff only. So they just pay one tariff. They came to Rio, pray, have money to feed, and back home. They don’t have 10 reais to load the credit. 40%. They do one unit. Charge per day. So they need to have 2 directions, but they buy one. So they have in their pockets less than 5 reais. So the challenge when you think about how, so you say oh it’s almost impossible. Who do not have 10 bucks in their pockets? Answer: A lot of people.” (Interviewee A)

In Rio de Janeiro the price must be the same for cash customers as for card customers. (In Norway, there is a large price difference to incentivize the use of electronic ticket media.)

“The tariff is the same, so there is not a different tariff, as the law says that the tariff with credit card, the Rio Card is the same that you have with cash.” (Interviewee A)

This is a huge cost, and requires a big administration to ensure provision of change, and of course the collection and handling of the cash. With a ticket price of R\$ 3,80 at the time of writing, many of the cash transactions requires change of R\$ 0,20.

“But they have 4 reais, so we give 0.20 back. It’s not 0.25, its 0.20. So I need to provide change. To all the machines. So the price to have coins, to machines, to load coins, to give change for that charge. So if you think the whole chain of problems for small change is amazing. The total cost to load. So how many trucks with coins I need to have to charge, to collect, and give money back to that people.” (Interviewee A)

4.1.4.6 Payment system

In most transit systems, there is a public authority that is handling and governing the cash flow. Transport operators are operating their routes based on a variety of passenger payments and subsidies that are all payed back from the transport authority after certain rules stated in the individual contract or concession. This way the local government has control over the money in the process. In Rio de Janeiro, the process is different. All fares are distributed to the operators without any deductions. So a passenger paying R\$ 3,80 will result in the same amount being paid to the operator. It is then up to the operator to cover all his costs, among them the costs of the RioCard and RioCardTI companies. (Interviewee A)

The cash flow in the system is described as follows by interviewee A:

Passenger -> RioCard Cartões -> Fetranspor -> Operators

1. The passenger charges his card with credits, and pays in an ATM or another point of sale. The information of the credits loaded to the card is recorded with RioCardTI.
2. The money paid goes to Fetranspor.
3. When the passenger uses his card to travel, the information from the validator is recorded with RioCardTI.
4. Every day, RioCardTI calculates the amount of fare money to pay back to the operators. Single travels are easy. Multi-modal travels are divided between the operators.
5. Based on the information from RioCardTI, the Fetranspor pays back fare money to the operators.
6. The operators pay Fetranspor for their services (a “membership fee”).

The *Gratuidade* travels are different, as they represent money not yet in the system of Fetranspor. These travels are reported to the Prefeitura (the Secretaria Municipal de Transportes), and reimbursed on a monthly basis. (Interviewee A)

4.1.4.7 Development of the payment system

The current payment system is based on contactless cards and validators following the MIFARE[®] standard⁵. Current version is MIFARE[®] Classic, but an upgrade to MIFARE[®] Plus is ongoing. A challenge in the maintenance and development of the systems towards the buses is that many of the 24000 validators in use are very old and basic. As much as half have a memory capacity of less than 256 kB. (Interviewee A)

Another issue is the management of the Fetranspor. Today the payment system is completely prepaid (with the exception of the *Gratuidade*). Because of this, transport is never offered unless the money for the fare have already been paid. The Fetranspor being very conservative, altering the business model to post-paid systems is not going to happen. Any new initiatives in technology or otherwise are required to meet clear demands to

- Return of investment
- Total cost
- Risk

Development initiatives are currently focused in the following 4 categories (Interviewee A):

1. Improvements towards the General management
2. Improvements to the card system
3. Improvements towards the bus operators
4. Fraud reduction

The General Management: The initiative is meant to give the general management better and more detailed information about the passengers. The idea is to identify every passenger in the system, using a personal key like the CPF or similar. Today the primary key in the system is the card number, and every card can only hold one product. Changing the primary key to the passenger opens a lot of new possibilities, among them loading several products in one card. For the passenger, several (unspecified) benefits can be added.

“With this project I need to give to the card holder the benefits to be identified.” (Interviewee A)

⁵ MIFARE[®] is a registered trademark of NXP Semiconductors (<http://nxp.com>)

For the management, possibilities like load management, route planning etc. will be greatly enhanced and it seems that the main motivation lies here.

“For you with a card, I can have information about where you get in, where you get out, the number of kilometers that you have every day, the normal positions that you will get out, you know, everything related to the density, for your transportation utilization as a person, not as a card.”

(Interviewee A)

However, the change is bringing the payment system into the future, as this means that the system will be fully ID-based.

“Q: Does this mean that you are turning this into an ID-based system?”

A: Yes.

Q: Are you then also going to open for the use of different [ticket] media?”

A: Yes. Yes. This is the future! Our challenge today is this. Big challenge! Huge! Because all the systems that we have today, they use the card number as the primary key. Everything has that primary key. And as an IT guy, you probably know how difficult it is to put all the systems to use other IDs.” (Interviewee A)

Interviewee A is clearly interested in developing the system further, but the technical challenges to transform the base systems to enable them to be modernized is a work that will take a long time: *“...so we have a roadmap for that” (Interviewee A).*

For the card system, the primary target is to make it easier to load credits into the cards. It has been expanded to the use of the internet, but more modes are being developed. Allowing other media than the plastic cards is not currently considered, only as a future option. One challenge is that the individual bus operators own the card validators, while RioCardTI provides the systems to run on them, thus having the challenge of operating and maintaining equipment owned by someone else.

Towards the bus operators, the RioCardTI is working on developing systems for monitor and controlling the operation of the buses with driver management systems, fleet management systems, fuel and vehicle management systems etc.

Fraud reduction: At the moment, this is a project related to fraud in the *Gratuidade* system. As this represents money not in the Fetranspor system, but money that has to be reimbursed, it receives special attention. The objective is to implement biometry scanning of the bearer of the *Gratuidade* cards to ensure that the person traveling is the one entitled to free travel. The latest tests have shown that the level of fraud is at 32% of all *Gratuidade* travels. At the same time, this is part of the project to switch to personal key identifier.

4.1.5 Platforms

The situation in Rio de Janeiro is characterized by one very strong operator with a very conservative business mentality. However, one platform can be located (and is rather obvious), which is the Bilhete Único, connecting passengers and transport providers.

The Bilhete Único is offered by RioCard, and is accepted on all transport vehicles of all modalities in Rio de Janeiro. There are some limitations in the cross-municipality travel, as this requires different versions of the Bilhete Único, but this is a minor detail.

The reason this network is so effective is the award of the *Vales-Transporte* and the *Gratuidade* to the Fetranspor, effectively creating a monopoly for multimodal ticketing in Rio de Janeiro. In other words, the transport operators have no choice but to join the network, as they are required by law to offer *Vales-Transporte* and *Gratuidade*. For the passengers, the Bilhete Único offers a great advantage in providing multi-modal transport for a single fare. (It is possible to pay on all transport vehicles, but no mode transfer is offered without the Bilhete Único.)

Treating this as a platform-mediated network is not quite correct, though. The fact that regulations force one side of the network may be more of an inhibitor of alternative platforms to form than the network externalities in play. Also, the platform provider, the RioCard company, is part of the Fetranspor organization, in which also the bus operators, a major part of the transport operators in Rio de Janeiro are organized. In sum, this means that other effects than the regular network effects as viewed elsewhere are playing an important part in the success of the described platform.

4.1.6 Public Value

Being an important model in the study of public organizations, this model was expected to help understanding the organization and development of the organizations studied.

In Rio de Janeiro, few similarities were found, and probing of the interviewees provided no response to indicate that these models have any conscious place in the government of the public transport. Not that no matches with the concepts of Public Value are found. The frameworks of Veeneman et al (2006) and Carli (2011) seem to have some resemblance with the priorities, but a clear pattern could not be detected from interviews or materials studied. The social inclusion of challenged groups (elder, young, and disabled) in Rio de Janeiro through the *Gratuidade* have been mentioned.

4.1.7 Mobile Payment

As Rio de Janeiro have no mobile payment possibility for public transport, there are no data to compare.

4.1.8 Rio de Janeiro Scenarios

The scenarios in this study are developed according to Garvin's framework. As mentioned in chapter 3, the full analysis is divided into 5 stages, which will be described in more detail below.

4.1.8.1 Stage 2: Trends

Fetranspor is in general little interested in change and development: All interviewees indicate (or say directly) that the Fetranspor is acting as an inhibitor for changes to the system. Only when change is unavoidable, it is endorsed (e.g. when the VLT project was decided, the Fetranspor decided to join in on the owner side (Interviewee B)).

The government is getting more active in governing the public transit: The main example is the VLT project. Previously, the concession system was implemented to attempt to regulate the industry. Among other indicators are a revision of the routes to avoid congestion of buses and increase passenger load and new BRT lines owned by different consortiums.

Changes to the payment system are characterized by incremental improvements to the existing system. Innovations that could radically change it have low priority and must answer to rigid demands to return on investment, risk and cost (Interviewee A). The organization of the Fetranspor, the syndicates and the operators is very risk averse, and work as inhibitors to change (Interviewee B and C).

4.1.8.2 Stage 2: Key Uncertainties

1. Government strength, the ability to implement a proper PTA and take control over the cash flow in the public transport: One of the major uncertainties seem to be the power of the Secretaria Municipal de Transportes to take control over the public transport in Rio de Janeiro. The independent interviewees in Rio de Janeiro don't seem to see any imminent change, and Interviewee B goes as far as indicating that the Secretaria is following the command of the Fetranspor. However, the initiative of the VLT is an opportunity, as the Fetranspor only has a minority share of ownership in the operating consortium. There are also other initiatives working to reduce the number of buses in the streets, restructuring the routes etc. The question is how much of this is "allowed" by the Fetranspor, and how much is really enforced. Interviewees were not clear on this. Stronger government control could lead to higher standards in the buses, fewer accidents, more efficient routes, entry of new enterprises to provide real competition, alternative solutions and innovation in the system, but most importantly, control over the cash flow and more transparency.
2. Entrance of new actors in the operations or financial sectors strong enough to force a development in transport pattern and/or payment system development: In the operational sector, new entry would probably be dependent on the power of the government as the current organization is very protective against foreign entries (Interviewee B). In the financial sector, however, the international picture is one of extreme change and previously unseen initiatives. New and innovative products and services here could circumvent the defensive organization of the Fetranspor and the other organizing powers currently in position. In both sectors, the entrant would need considerable power, both financially and politically.
3. Level of ridership from the middle and upper classes: With the opening of the new metro extension, the new BRT lines and the VLT, the urban public transport options for these classes have been much improved and the intention from the government is clearly that much of the traffic from Barra de Tijuca to the city center shall move to the metro. The question is whether these new passenger groups will start to use these new offers. If they do, and if the operators prioritize these passenger groups, considerable change could be seen coming to the whole industry in Rio de Janeiro as these passengers are higher educated, demands more

convenient service and better products. Innovations like mobile payment could be driven by this development.

4. Traffic congestion: An increase in the congestion problems already imminent in Rio de Janeiro could afflict the public transit system. According to Interviewee C, building roads to resolve the situation is not easy considering the topography in Rio de Janeiro. Around the time of writing, the difficulties in the petroleum industry and general recession tendencies in Brazil led to somewhat lighter traffic, but this picture is subject to change. New growth in the economy, globally, national or regional would lead to a new increase in the transport demand, increasing the load not only on the roads, but on the public transport system as well.

We see that key uncertainty 1 and 2 are connected to each other, as the entrance of new actors to compete with the incumbent enterprises will be easier with a government that has strong control over the structure of the system and the participants. Also, the key uncertainties 3 and 4 are not completely independent, as the participation of the higher classes in the urban public transport will ease the congestion. Also, congested traffic will induce more people from the upper classes to use public transport. For our further analysis we will therefore use key uncertainty 1 and 3 to develop our scenarios.

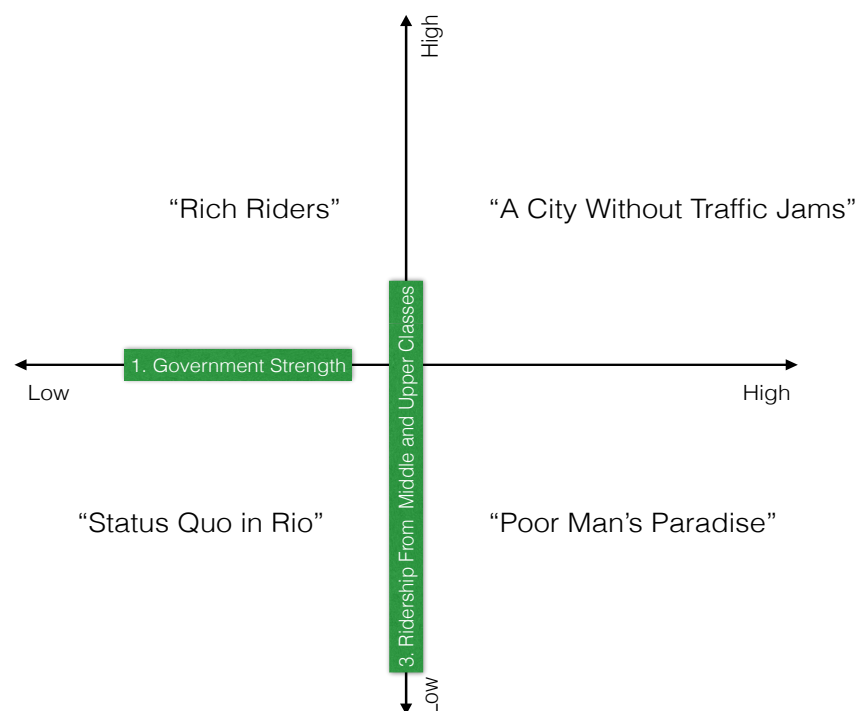


Figure 8: Rio de Janeiro Scenarios (Author)

4.1.8.3 Stage 3: Scenarios

The scenarios are developed in a 5- to 10-year timeframe. Choosing the perspective is not an easy task, as the world in general is changing ever faster, and some of technologies involved here more than ever. The fact that a technology like the smartphone was exclusively used by businessmen 10 years ago, and the picture we see today of extreme connectivity is even younger. On the other hand, cycles in the bus transport industry tend to be long, as contracts are usually made for periods of ten years or longer. This gives the industry some stability, as shifts in technology tend to come later and less frequently. Based on these trends, the timeframe for the scenarios were chosen as wide as they were.

4.1.8.3.1 “Status Quo in Rio”

After the Olympics, the world’s focus on Rio de Janeiro and Brazil softened, and after a while disappeared almost completely, as the political situation continued to be unresolved for a long time. The eventual impeachment of President Rousseff did little to stabilize the situation, and the elections held just after complicated matters further. Now, congress and senate are spending most of the time on internal affairs and power struggles, and few new initiatives are made.

The economic recession became worse than expected with the end of the Olympics. Real-estate prices dropped dramatically, and many investors took great losses. Unemployment rates rose critically. Fortunately, the recession was soon eased by a marked rise in oil prices, and the long-time effects of the crisis were limited for most people. Some real-estate operators went bankrupt and the large entrepreneur enterprises had to restructure, laying off a lot of employees. The increase in oil price has since led to rise in employment rates, and the unemployment rate is now at around 7% (depending on the source, it is lower (government) or higher (political opposition), but 7% is the realistic figure). This number, although not extreme, is aiding in keeping salaries low, and thus also the general cost level.

In the months after the Olympics, public security was severely compromised. Income problems for the city that had led to problems paying public servants in the months preceding the Olympic games escalated, leading to strikes in the police, the fire brigades, among the teachers and other public agencies. Several of the initiatives, started years before in the communities around the city were discontinued or drastically reduced. Along with the increase in unemployment, this led to a marked increase in crime all around the city. Robberies, assaults and killing saw a huge rise. Rio de Janeiro returned to the lists of the

world's most dangerous cities. As the oil industry helped reduce the unemployment rate and increase public income, crime rates dropped. The state and city managed to route resources to be able to pay salaries, and thus improve the security level somewhat. The Mayor's office is running several initiatives to improve security, especially in the wealthier parts of the city as a means of attracting more foreign capital and business to Rio de Janeiro. Among these initiatives, one is not connected specifically to the south zone (the wealthy part) of Rio de Janeiro. In collaboration with Fetranspor (actually, the initiative came from the Fetranspor) a project with security personnel on the buses are improving the situation for the passengers. Before the project was started, security in buses was so bad that ridership was down by over 25%. Robberies and violence happened several times per day in most of the bus routes. People found other means of transport or simply stayed at home. The project is working so that the city is providing a number of armed security personnel to ride along on the buses. Salaries are paid by the city, and Fetranspor is organizing the operation so that all routes and all districts are covered. The new project has brought passengers back to the buses, but only from the poorer areas of the city. Those who can afford it still use personal modes of transport. In the BRT lines, security issues threatened to break the whole operation. Another project to increase security in the BRT was started, this time as a collaboration between the concessionaries and the Mayor's office. It saved the BRT, but the demographic of the passengers is still mainly in the lower classes.

The mobility projects only concluded just before the Olympics, took a hit after the games ended. The expected extension of the VLT has not been initiated, and the lines opening before the Olympics have had huge operational problems. Bus routes previously changed so as not to enter the city center have since been extended, and are operating much as before, but also covering new routes in the port areas. Both the VLT and the Santa Teresa tram has suffered because tourists have been fewer after the Olympics, and the security issues scared those who came to use taxis and chauffeured cars. The security project in the bus routes were not extended to the VLT and the tram. The official explanation from the Fetranspor were that the capacity of the security officers commissioned was already stretched thinly trying to protect the buses, and including the VLT and tram would not be possible without an increase in the number of security personnel. Most people did not believe in this, though, and expect that the real reason is that the Fetranspor wants to reinstate the bus as the main mode of public transport in Rio de Janeiro.

The metro managed to keep security high, and saw an increase in ridership. The new line connecting Ipanema and Barra de Tijuca suffered continued problems with ingress of

water under the channels it crossed. The expected shift from the use of private cars to the metro for people living in Barra de Tijuca and working in the city center did not happen, partly due to the operational problems of the metro, partly due to the security issue with the BRT line intended to connect the condominiums of Barra de Tijuca with the terminus of the metro.

Internally, the Fetranspor saw a consolidation especially within the RioÓnibus syndicate. Due to an internal policy in the federation of awarding marginal routes to the smaller companies, the more powerful operators grew, and there are now less than 10 operators left sharing the four bus transport concessions.

Large parts of the BRT concessions, mostly owned by large entrepreneur companies were acquired by Fetranspor when the previous owners ran into financial problems in the recession, and had to liquidate assets.

In all, the picture today is that the Fetranspor is an even stronger organization, with considerable political influence. In all, Fetranspor has an effective monopoly on bus transport both in the Rio de Janeiro municipality area, and in the rest of the state. The focus in the organization is on profit maximization. Passenger-friendly initiatives are few and far between, with one important exception: All buses controlled by Fetranspor in Rio de Janeiro state are now air-conditioned.

The payment system has seen some development. A change to more secure travel cards have been implemented, but without adding any benefit to the passengers. What has added some benefit was the registration of the cards to the bearer's id. This was enforced in a major change of the system two years ago, when the permission to store rider information was issued by the state government. Now all cards must be registered to a passenger id (CPF number for residents, passport number for foreigners). This change has led to a decrease in fraud and a reduced number of lost travels, as a lost card can now be replaced. This was previously not possible. Also, the passenger can access the system from a computer and see an overview of all travels he made the last week, month or year. For the Fetranspor, this has led to the possibility of making a proper passenger flow analysis and has led to radical changes in the routes, improving the capacity utilization of the vehicles and increasing revenue significantly for the operators. This change has not necessarily been beneficial for the passengers, though. Due to demands for higher utilization, several routes have been removed, joined with other routes, or have less frequent schedules. Average walking distance from home to the nearest bus stop has also increased.

There is still no option for post-paid products, and credit cards or other payment institutions are not allowed to take part in the system.

Other ITS initiatives have been implemented. Systems for fleet and driver management are now installed in all vehicles. The driver pattern can now be monitored closely by the transport operator. Data on fuel consumption, speed, acceleration and brake patterns etc. are registered. This has led to several drivers being fired, and a lot of pressure has been put on drivers to increase the economy level of their driving, while still keeping the schedules. The Fetranspor can get data from the systems to monitor the keeping of the schedules, time in bus stops, speeds etc. to aid their route planning and optimization.

To summarize, the power of Fetranspor has increased. This power has been utilized to implement changes that mainly serve to increase revenue for the operators, and thus, to the Fetranspor itself. These changes have led to an increase in ridership numbers, but a decrease in the passenger satisfaction. This has been possible because the demographic of the passengers is more and more in the poor end of the population, mainly among people that have no other option get to work and back.

4.1.8.3.2 Rich Riders

Several Brazilian successes in the Olympic Games helped change the political climate in Brazil in the following months. The impeachment process of President Rouseff was delayed so much that new elections received more attention. The new government focused on reforming the economic situation, making several changes to attract foreign investments and -businesses to Brazil. These initiatives mainly favored the already rich, although a rise in the economy also favored the poorer classes as more jobs were created.

The new, business-friendly government was beneficial to the business climate even as the world's attention diminished after the Olympic Games ended. Investments and business establishment increased in spite of a continuing low oil price. Several of the many restraints to Petrobras' business abilities were removed, and because of this, many foreign companies returned to Brazil and Rio de Janeiro to join in the development and exploitation of the oil fields outside the coasts of Brazil.

The new government prioritizing the economic benefits for businesses and the upper classes, resulted in deep discontent within the poorer classes. Initially, unemployment was high and these factors led to an increase in crime and violence. The government responded

with increased funding of police forces all over the country. In general, the increased police presence was not beneficial to the people. Violence in the poor areas increased, much due to police brutality, and discontent with the government increased. Crime rates in the wealthier parts of the city decreased though, and the initiative was seen as a great success in the media and by the government. As the economic reforms were allowed to work, employment rates rose and contributed to reduced crime rates. More people had jobs to go to, and needed security in their neighborhoods, leading to an increase in the resistance from ordinary people against criminal gangs and drug cartels. Police initiatives to increase security in public transport in the south zone were implemented after the Olympics. The idea was to reduce the mobility of the criminals, and easier contain gangs in specific areas. This was part of a cynic policy to reduce violence outside the gang areas, and also to limit the exposure to the gangs for ordinary (wealthy) people. Regardless of the intention, the buses and trains, also those going into the suburbs became safer, and general ridership increased. The big difference was made in the wealthier parts of the city, where crime and violence in the public transport vehicles dropped to almost zero.

The Olympic games introduced a shift in the passenger demographic in the Rio de Janeiro public transport. During the games, a combination of traffic restrictions and special ticketing products led to an increase of higher-class people in the public transport. After the Olympics, the demographics were returning to normal, but new initiatives from the operators and Fetranspor managed to keep most of the higher-class passengers and eventually to increase the number. These initiatives included large-scale promotion of the new BRT-metro combination from Barra da Tijuca to the city center, newer and more comfortable vehicles from the other parts of the south zone to the city center, security improvements and new payment products and options. Also, some of the “Olympic” lanes on the main roads, lanes reserved for official transport during the Olympic Games were continued reserved for public transport vehicles to improve the transport speed.

The introduction of the new VLT just before the Olympics was a great success. Originally the concession to operate the VLT was awarded to a consortium where Fetranspor through the RioPar holding, Invepar, Odebrecht TransPort and Grupo CCR held equal shares of 24,88%. Now, the consortium’s main owners are RioPar and Invepar with equal shares of 48%. Odebrecht and Grupo CCR have only contained small shares of about 1% each. The new control of the VLT has led to a rapid expansion of the lines, now covering most of the city centre and the new business district created in the port area. Bus transport in the centre is

almost history, but very efficient transfer terminals have been created to move passengers from the buses, the ferries and the metro and onto the VLT.

The BRT system is now operating in six lines, with new connections directly from the international airport, Galeão to the Ipanema/Leblon region and from Galeão to the city centre. These two lines have greatly enhanced ridership from the higher middle class living in the Ipanema/Leblon area, as well as business travelers between the city center and the international airport. Ridership from the lower classes on these new lines is very limited, except for some travelers from the district around the airport going to the center and to Ipanema/Leblon. The two lines have decreased the mean travel time to/from the airport with almost 20 minutes per passenger and is considered a huge success.

The buses operating in the south zone have been upgraded to promote the increased ridership from the wealthier regions in this zone. Newer, more comfortable vehicles and new, better organizing of the waiting lines at the bus stops have added a lot of wealthy passengers. The transfer between the bus and the other modalities, like the BRT, the metro and the VLT have been improved, and is now very efficient with almost no waiting time, and only short walking distances. The previous issue of security is now eliminated by strong presence of police and armed security personnel. The flip side of this is that the older vehicles are now operating almost exclusively in the north and west zones and between these and the city center. As these are the regions where the lower classes predominantly live, the discontent is high with this policy. However, the transport alternatives in these regions are few, and ridership has not decreased significantly. Nevertheless, the political pressure against the Fetranspor to alter this discriminating practice is building as the elections get closer. The question is whether the political system has become transparent enough to force a change. However, lot of incidents from the previous elections, both national and in the state indicate the opposite.

The Fetranspor is increasing its influence. Through the RioPar holding company, shares of the Invepar company holding the concessions for the Rio Metro have been acquired from some of the four pension funds that formerly each held 25% of the shares in Invepar. The same is happening with the BRT consortiums. With the increase of the share of the VLT to nearly 50%, Fetranspor is becoming the central operator in all public transport in Rio de Janeiro.

Through this increased influence, the Fetranspor has managed to extend the participation in the public urban transport to the middle and upper classes, and thus created a lot more revenue. The fact that the increased ridership is releasing the pressure on the roads

must not be forgotten. Even with the redistribution of lanes on several of the main roads to public transport lanes, the general tendency is that there is less congestion in Rio de Janeiro now than before the Olympic Games.

To further attract the higher classes, an option of mobile ticketing was introduced two years ago. It became an instant success, even though the product options are limited, the option requires a smartphone, and no discount is given. The main difference in the physical organization is that passengers paying with their mobile phone have a separate line at bus stops and are given boarding preference. The validation is currently a two-phase operation. First the ticketing application snaps a QR-code on the bus door. Then a valid-sign is displayed on the screen, and must be shown to the driver, who releases the gate manually. Experiments with NFC are ongoing, but the reader equipment in the majority of the buses have limitations that make the use of Apple iPhones impossible. The ticket price is equal for all regardless of ticket medium and payment instrument, and regulated by the government. Therefore, the introduction of ApplePay, credit cards and other external payment providers have been discouraged by the Fetranspor due to the cut of the ticket price these operators charge. Instead own apps have been developed introducing an account with RioCard, that can be filled directly from the passenger's bank account (Brazilian accounts only). For foreigners, the option of using an international credit card is offered, but these customers get a fee added separately on the credit card bill.

The option of paying cash on board the vehicle has finally been discontinued, but an option of purchasing a single ticket for cash has been distributed to a number of kiosks and convenience stores spread all over Rio de Janeiro. The operation of this cash option is still costly, but compared to the cost of keeping the cash option in the vehicles it is very small.

The introduction of personalized travel cards, and the registration of passenger data (as described in the first scenario) was initiated, but soon discontinued when the success of the mobile payment option in the middle and upper class passenger segment became apparent. The mobile ticketing platform offers even more opportunities of personalization, travel optimization, route planning etc. The current focus of the Fetranspor has moved to providing better services for the wealthier travelers, and these predominantly use the mobile ticketing app.

Other ITS initiatives have been postponed as the opportunities offered by the mobile ticketing platform have been explored. The data capture from the applications is very rich, and in addition to the passenger data (name, age, etc.) and the travel patterns, the GPS and accelerometers in the phones have been utilized to provide surprisingly accurate maps of

speed, acceleration and braking zones, driver behavior etc. Data have been transformed into driver directions on which are the faster lanes to choose on certain stretches, braking advice etc. A special app dedicated to the drivers is considered to provide updated feedback from the system and giving real-time directions to optimize speed, lane choice avoid dangerous points etc.

In summary, the public transport system has become two systems; one for the rich and one for the poor. The power of the Fetranspor is important in keeping this policy operational. The inclusion of the wealthy in the public transport system has led to lighter, more efficient traffic in the city with less congestion. The cost is that all initiatives, all innovation is directed to the wealthier passengers at the cost of the lower classes.

4.1.8.3.3 Poor Man's Paradise

To the surprise of most, the impeachment of President Roussef was rejected by a narrow majority and the governing party, PT continued their reign until the next election. This election led to an unprecedented victory for the PT and their supporters. The years after this election were dominated by the removal of political opponents from federal government, and also among the bureaucrats. A stronger regime with tighter control of the powerful industrial and entrepreneurial enterprises was implemented. This also led to a stricter regime in the state-level public transport.

The instability created by the PT-dominated government has been damaging to the economy. Investments are decreasing, capital is expensive and hard to find. Foreign investment and business establishment has almost stopped completely. Unemployment have reached unprecedented levels. One exception is the oil and gas/subsea industry, where new field developments have initiated some activity. However, government control is even tighter than before, and new regulations and taxes are passed to all arenas of business.

The increases in social support for the poor have to some extent led to a relief in crime, but unemployment is still soaring. Drug use is rising, providing the drug traffickers with new markets, and giving rise to new crime problems. Police presence is increased, and is helping protecting from robberies and assaults. The state economy is not in a good shape, and police forces are not paid well. This has led to increased corruption in the police forces. In sum the security situation in Rio de Janeiro is complex, and difficult to predict. In the public

transport, robberies and assaults are common. Usually a band of youths enter the vehicle and robs the passengers at gunpoint. Violence is not common, but occurs frequently.

An important achievement of the new government is the enforcement of a nationalization of the transport authority. This has brought the real power of public transport authority in under the Secretaria Municipal de Transportes and the SETRANS. All money transactions, deposits, payments and fare distributions are now controlled by the new Rio de Janeiro PTA office, which is a joint venture of the Rio state and the Rio municipality. This was achieved simply by taking over the RioCard and RioCardTI operations from RioPar. Unfortunately, the takeover process did not secure the key personnel from RioCard and RioCardTI, and the transit was so problematic the whole project almost collapsed. In the end, certain officials were brought over from the Fetranspor and the new PTA managed to gain control. The Fetranspor still has a lot of influence though, but by securing public control of all money handling, an important step has been taken towards an optimally functioning public transport system.

The new PTA Office has also taken control over the route planning. Now the focus is shifted towards providing mobility also for the marginal groups in sparsely populated areas, building a proper network with backbone routes, hubs, etc. Many of these changes are still being opposed by the Fetranspor, but with solid support from the city, state and federal governments, changes are enforced in a rapid tempo.

In conjunction with the takeover of the money transaction system, the subsidy regime was also changed. Offering gratuity to passengers of certain categories are still mandatory, but now they are not directly reimbursed. Instead a system of base costs and general subsidies has been implemented. This has been a great help for the many small bus operators struggling with marginal routes. As a result of the change in subsidy policy, the service level in the outskirts of the system has increased considerably, making life easier for many people, and also giving relief to some of the pressure on more central living areas.

Due to the problematic economic situation, the VLT system has not been expanded beyond the lines built for the Olympics. The system is functioning fine, though, providing mobility in the central parts of the city center. The same is the situation with the renewed Santa Teresa tramline, providing transportation for tourists and locals alike.

The BRT lines have been extended, and now cover several residential areas, among them on the Ilha do Governador. The BRT lines are providing backbone transport for many people between the poor areas in the north and west and the south zone and city center. The

security on the BRT stations have been prioritized, and it has become very popular as it provides fast and safe transport for a lot of people in the poorer regions.

As the revenues are now distributed by the public, incentives for keeping the vehicle fleet up to date are easy to implement. This has led to a significant improvement in the reliability of buses, comfort issues like air conditioning etc.

The Fetranspor has become marginalized after the PTA was established. It is showing signs of breaking apart, as many of the less influential operators seek to deal directly with the PTA, and thus get more favorable conditions. The transfer of the financial transactions away from the Fetranspor network has also revealed practices that are currently being investigated as corrupt. The main issues with the Fetranspor these days are the legal issues embedded in the conglomerate of deals and contracts regulating the relationships among the individual operator companies and towards external suppliers and the public.

Early plans to modernize the payment and ticketing systems have been postponed due to the struggle to capture control of all financial transactions. The system is virtually unchanged since the days of the Olympic Games. The ideas of implementing an ID-based system with user accounts is being developed due to intense pressure from the rest of the financial world. During the last few years, Brazil has undergone a revolution in payment technologies, and most private actors now offer ID-based payment towards centralized accounts. A change in the banking laws have increased the number of people with bank accounts with millions, now also including many from the poorer classes. Nevertheless, the political part of the city and state governments are having problems leaving the substantial amount of cash flowing through the system untouched. This money and its use has become subject to political debate, which is endangering the whole system. Because of the lack of transparency in the old, private system, it is difficult to calculate the amount and how to predispose what seems to be surplus revenue.

The ITS technologies that have been implemented so far are mainly systems intended to increase safety and security for drivers and passengers. Driver management systems detecting erratic and unsafe driving have been implemented, and a real-time system to advise passengers of actual arrival and departure times is currently considered for acquisition. However, it's difficult to cover the costs required to purchase and install such systems because the new regime have placed these investments under political control.

In summary, the strong political control has opened new possibilities by breaking the powers of the Fetranspor. However, the government has many different agendas, and the public transport system is easy to use as a political instrument. This would not be beneficial to

the system, as it needs long-term dedication and planning to work optimally. Shifting political interest is already disturbing this picture.

4.1.8.3.4 A City Without Traffic Jams

The first election after the impeachment of President Rouseff provided a government intent on reforming the economy in Brazil. Although much of the regulations governing the public transport system is formed on the municipal and state levels, federal support to the state and municipality of Rio de Janeiro provided the necessary political strength to bring the public transport authority in control of the system. This was done by bringing the Secretaries of transport on both municipal and state level together with the Fetranspor and the Invepar to form a new organization operating under public control, but with substantial minority owner interests from the two private organizations. New demands of transparency were also enforced, giving grounds of investigation of some of the more prominent leaders of the Fetranspor.

Among the new, business-friendly government's first decisions were reforms in the laws regulating foreign investments, import/export and establishments of foreign companies in Brazil. Revisions in the labor and pension laws further eased the process of starting and running businesses in Brazil. These early reforms sparked a boom in investments and new businesses and unemployment fell rapidly. The currency stabilized and within a year, most negative prognoses were turning positive.

These rapid changes did not go without problems, though. A surge of inflation resulted in protests and strikes. Laws hastily passed to regulate the use of strikes as a legal protest resulted in more strikes. Police forces were brought in to clean up, and eventually it looked like the whole reform project was going to fail. Negotiations between government and unions finally found a way forward, and from that point on the curves have pointed upwards for Brazil.

The security situation deteriorated rapidly in the early days of the new government. The police went on strike and an already unstable situation threatened to get out of hand. Social initiatives from the federal government aided to contain the situation, but real decrease in crime only came when the employment rose.

The new, public control over the transport system allowed for the use of police forces to improve security on board buses, in BRT stations and so on. A huge program was

established under the control of the new PTA and robberies and crime in the transport system dropped to all-time low values.

As problems with crime dropped, it became evident that one of the major factors keeping middle- and upper-class passengers away was exactly this. The new express lines of BRT and metro built for the Olympics soon became the preferred mode of transport for the majority of people living in Barra de Tijuca and working in the city center. The VLT in the city center became very popular, and soon began to replace buses. Since the inauguration before the Olympics, new lines have been added, and transfer capacity from buses, metro and the new BRT line coming from the north have been increased. All to provide hassle-free public transport into and out of the city center. For tourists, the connections to visit the major sights of Rio de Janeiro have been greatly improved. An extension of the VLT to RioSul and Urca is considered, both to improve the business connections, the mobility for students at the university campus and for tourists visiting the Pão de Açúcar.

The BRT lines have established important backbone lines, and with capacity increases the last few years, several bus lines have been discontinued, passengers being referred to use the BRT. Transfer centrals, or hubs have been established, and the bus routes have largely been altered to serve these.

The metro system has been modernized, and extensions and new lines are considered. A new line to cross from the south zone, going north to connect the districts of Tijuca and Grajaú and continuing to the international airport is expected to improve travel time from Ipanema to the airport by more than 30 minutes. Also, workers going to the Ipanema region from the north will have a much improved way to and from work.

The increase in ridership from middle- and upper classes, the establishment of backbone routes, using the BRT lines and the metro to their full potential and the optimized routes based on passenger flow measurements have all added to a significant reduction of the private car traffic in Rio de Janeiro. Congestion is reduced to almost nothing, and traffic jams rarely occur unless there has been an accident.

The big reorganization have left Fetranspor with far less power than before, as all economic transactions and cash flows are now handled by the new PTA. It is not completely marginalized though, as the RioPar holding company holds about 30% of the shares in the PTA. The former companies RioCard and RioCardTI are now divisions under PTA, and operate more or less unaltered, but with a new era of transparency.

As gratuity transport has now been mandatory without reimbursement, subsidies are distributed on a gross contract base. Routes are awarded the operators based on competitive tendering, and the income responsibility has been taken over by the PTA.

The Fetranspor's main function these days is to perform the route planning on the behalf of the PTA.

New laws passed by the federal government removing a lot of obstacles in the banking system, and at the same regulating the banks to provide incentives for people from the poorer classes to enter the regulated economy, starting with bank accounts and card products suited to their situation. In addition to reducing the costs of simple tasks like salary payment to employees, these reforms have opened new possibilities for payment and ticketing systems in the public transport. When 'everyone' has a bank account, the way to implement ID-based ticketing systems was short. The ticket media mostly used are the actual bank issued debit card, which now are equipped with NFC capabilities. A simple online registration is everything that is required for the passenger to access public transport. The *Vales-Transporte* system has also been greatly enhanced, as the employee's ID is simply loaded with the number of credits in the PTA ticketing clearance system.

Initially, problems with fraud were frequent, as the NFC system implemented on the debit cards allowed small transactions without other confirmation. An already initiated project from the RioCardTI was applied though, adding biometric verification of the bearer's identity. The biometry data are provided in the bank when the customer is applying for the account and card. Technically, the biometric signature is stored in the NFC chip in the card. A camera in the bus reads the passenger's face and compares the biometry parameters to those stored in the presented card. The system is ultra-fast, and functions offline, although the latter is less of an issue as buses now are online 99,95% of the time.

The old law requiring transport operators to accept cash payment on board the vehicle was terminated shortly after the new government came to power. However, the process of transition from cash to electronic payment methods have taken time. A large part of the passengers had no bank account, and no intention of getting one unless this was incentivized. Therefore, an increase in the price for cash payments along with generous discount packages for passengers switching to electronic ticketing were needed. This, however required the altering of another law, saying that ticket prices should be equal for all passengers regardless of payment method. Changing this law took some time, as the government by then were in other troubles over the labor laws, and incentives had to be implemented to facilitate the switch. Among these were several versions of offering volume discounts, but the one that

made the huge difference was the offering of deferred payment for up to five trips. In other words, the user could travel five times without money or credits in the account.

When the cash on board was finally terminated, a way to pay cash for a single trip was still needed to cater for the ones still unable to get a bank account and visitors from out of town or abroad. As many of the points of sale for the now obsolete Bilhete Unico were in kiosks and convenience stores, these were converted to sell single travel cards for cash payment. After some initial fraud problems that were solved by system upgrades, this system now works fine for travel, although some unexpected effects have arisen. Being a plastic card valid for transport in one year at the value of 5 R\$ (the current price), the cards have become an unofficial currency in the communities and serves as payment instrument for small items and services. This is not a problem as such, except for the demand for cards, that is much higher than the transport use indicates. Also, some issues of expired cards (more than one year old) being attempted used for transport have caused problematic situations for the drivers. After labeling the cards with expiry date as they are loaded at the point of sale, this problem has been eliminated.

The new regime of the PTA handling financial transactions revealed revenues much higher than expected in the system. Rather than reducing subsidies accordingly, the government (city and state) have initiated a program to implement the most modern ITS system in the world in the Rio de Janeiro public transport system. A base platform installed in every vehicle serves to connect and integrate a number of systems on board. These communicate with numerous systems centrally, and along the routes. Among the systems is a real-time information system providing information of arriving and departing buses, connections, delays, accidents, passenger load etc. All this information is available in a smartphone app. Selections of relevant info are also displayed on panels in the vehicles and on some stops and stations. This system allows the passenger to plan his travel, and to alter the route based on real-time data.

For the operators, a fleet management system is implemented, providing the operator with sensitive data like fuel consumption, vehicle state, errors and system failures, etc. Implementing this system was difficult, as much of this information is seen as trade secrets. Not only between operators, but also towards the PTA. A regime of encryption and trusted partners were agreed upon so as to provide the information to the operator only. The Fetranspor and the PTA can only read out certain parameters along with general statistics. A driver information/management system is providing the driver in each vehicle with useful information based on real-time data coupled with statistics. Among the information is lane

selection advise, traffic information, etc. Information about the driver performance is provided back to the PTA and is used for monitoring, and controlling the driver, but also to provide and improve driver training.

In conjunction with the real-time system, an infotainment system is also installed, providing news, weather information, entertainment and advertisements on monitors in the vehicles. All metro cars and all buses have been fitted with these monitors. The content is fed wirelessly to the buses and due to the advertisements, the system is providing positive revenue to the PTA.

To summarize the situation, one can say that the public transport system in Rio de Janeiro has been instrumental in transform the traffic in the city from one of the most congested in the world, to one of smooth flow and reliable transfer times. The cleanup of the bus transport business has also been important for the new regime, that is building its credibility on a wave of transparency and changing the bad habits of old.

4.1.8.4 Stage 4: Strategies

Creating strategies requires a viewpoint. For the sake of illustration, we have chosen the Norwegian company FourC as a potential entrant in the industry in Rio de Janeiro. The core business of FourC is a technology platform offering the ability to integrate all onboard ITS systems in buses on a single computer, with one remote interface via Wi-Fi or mobile network. The platform also opens for the integration between different ITS systems. It is called “Cities in Motion”.

For the different scenarios, the strategies could be like this:

4.1.8.4.1 “Status Quo in Rio”

This is the scenario differing the least from the situation at the time of writing. Due to the strength of the Fetranspor, this and the RioCardTI company is where the attention should be directed. The secretaries of transport in municipality and state are less important.

A strong focus on complementing the systems operating, and reducing risk and cost in the operations should be the strategy for selling the Cities in Motion platform. Teaming up with good providers of fleet management, vehicle management and driver management systems will increase possibilities.

4.1.8.4.2 *“Rich Riders”*

Should this scenario come true, a subsidiary in Rio de Janeiro would be the best option to get in business. A focus on the use of the platform for functions useful for the passengers will be a good strategy. Integrating with the ticketing system to optimize the operation may be a key. The focus should be on RioCardTI and Fetranspor.

4.1.8.4.3 *“Poor Man’s Paradise”*

In this scenario, the big question is whether to try to enter into the market at all. At least financial commitments inside Brazil should be avoided. Entering in a close relationship with the Secretaries of transport in city and state is necessary to achieve anything, and should be the first priority. If possible, the platform should be installed and maintained from Norway as a Software as a Service operation.

4.1.8.4.4 *“A City Without Traffic Jams”*

Both RioCardTI/Fetranspor and the transport secretaries should be approached to build an understanding of the concept, and to create a package that appeals to the ones who end up with the decision power. Working with suppliers of ITS systems to create a complete solution for Rio de Janeiro would be a good strategy. Opening a subsidiary or joint-venture with one or more ITS companies is advisable.

4.1.8.5 *Stage 5: Early Warning Signals*

The early warning signals to look for in Rio de Janeiro are:

- Of course the outcome of the impeachment process against the sitting president. Depending on the result, the business climate can be very different.
- Corruption hunts. Should these start targeting industries operating public services, like the public transport system, changes in the organization can be the result.
- The general economic situation in Brazil, hereunder unemployment rates.
- The oil price. Foreign investments depend highly on this. Related to this, the state of the main industry engine, Petrobras, will be an important indicator. If Petrobras is allowed to operate as a regular industry player, investments and activity can be expected to rise. If it continues to be used as a political tool, the opposite may very well be the issue.
- The crime level in Rio de Janeiro.

- The development in payment methods used, especially mobile payment. Should this become common in other facets of daily life, the public transport might have to follow.

4.2 Case 2: Trondheim

4.2.1 History and background

Trondheim is one of the oldest cities in Norway. Officially it was founded in year 997 by the king Olav Tryggvason, but it is believed that people have lived in city-like patterns far longer. During the middle age, the city was the northernmost arch bishop's seat in the Catholic Church, and to this day the world's northernmost cathedral, Nidarosdomen is one of the city's main landmarks. Modern Trondheim is Norway's technology capital. The University of Science and Technology (NTNU) is located here, housing world-leading research environments in various disciplines, among them petroleum technology/deep-sea technology, material technology and medicine. Two Nobel laureates have had their research base at NTNU. One in chemistry and one in medicine. Naturally, much of the industry and business in Trondheim is centered around the university, especially the technology sector. Being a university city, Trondheim has approximately 30 000 students, mainly coming from other parts of the country.

In 2009 AtB AS was created as a company owned 100% by the county (Sør-Trøndelag Fylkeskommune). The company was created “... to secure a coordinated, efficient, attractive and environmentally friendly public transport service for Sør-Trøndelag county.” (ATB, 2011)

The reason to create AtB was to execute the national demand for tendering in the public transport industry. This demand coming from the EU through the Norwegian association in the EEC.

“It is a demand that public transport contracts must be subject to tenders. That is according to EU rules. So there was a deadline for the counties to implement a structure for this.” (Interviewee H)

Before this, the public transport was organized by private companies with a cooperation, the ‘Trafikanten Trøndelag’ towards the county administration.

“The role of ‘Trafikanten Trøndelag’ [company name] was as clearing house for EBIT, the ticketing system. That in turn was a joint effort between all the operators in Trøndelag, and should handle the settlement

between the operators. At that time, they had net contracts, and every operator had their own revenue responsibility.” (Interviewee H)

In 2007 the electronic ticketing system was introduced in Trondheim. The system was ordered in 1997, and took more than 10 years to develop. When development was finished, the system was immediately introduced. The electronic ticket media was a MIFARE® card of the DESFire category. One of the conditions when placing the order was that it should be a standard system. Even so it took ten years to develop.

“What we say is that we shall never be the first mover. Let others move first, and we can be a strong second. So we didn’t develop something brand new. We were very focused on the system being ‘off the shelf’ when we bought the FARA system [electronic ticketing system]. Even so we ended up being first there, and that was probably because they claimed the system to be ready and ‘off the shelf’ and not because of the real state of the system at the time.” (Interviewee G)

This introduction happened almost at the same time as the introduction of the electronic ticketing system in Oslo. However, that system took 20 years to develop.

“They spent 20 years there. In 1989 they said that they should create the most advanced ticketing- and payment system in the world. In 1999, ten years later they had spent ten years and an unknown number of millions of NOK for the 3 transport companies in Oslo to agree on a platform. The next 10 years from -99 until they released in 2009 they spent 600 million NOK to develop the solution.

So they spent ten years to agree on the technology- and platform choice, then they spent another ten years developing. 20 years. From 1989 to 2009. In between we got the Internet! A technological revolution beyond compare! And all that time they spent developing a system. Clearly then the technological development was faster than the project development. So these systems... – In Trondheim we wrote a contract requiring a standard off-the-shelf system, and even so it took us 10 years.” (Interviewee G)

Almost immediately the service was extended to include a SMS-ticketing option, and in 2011 a smartphone app was introduced. Both technologies were originally developed for the local tramline, which at the time was operated separately from the bus system.

“We launched [the mobile system] as SMS ticketing system in 2007 and as an app in 2009. That was isolated to Gråkallbanen [the tram line]. Then AtB took over the systems in 2011 and developed the app to have AtB design and so on.” (Interviewee G)

4.2.2 Trondheim Ecosystem

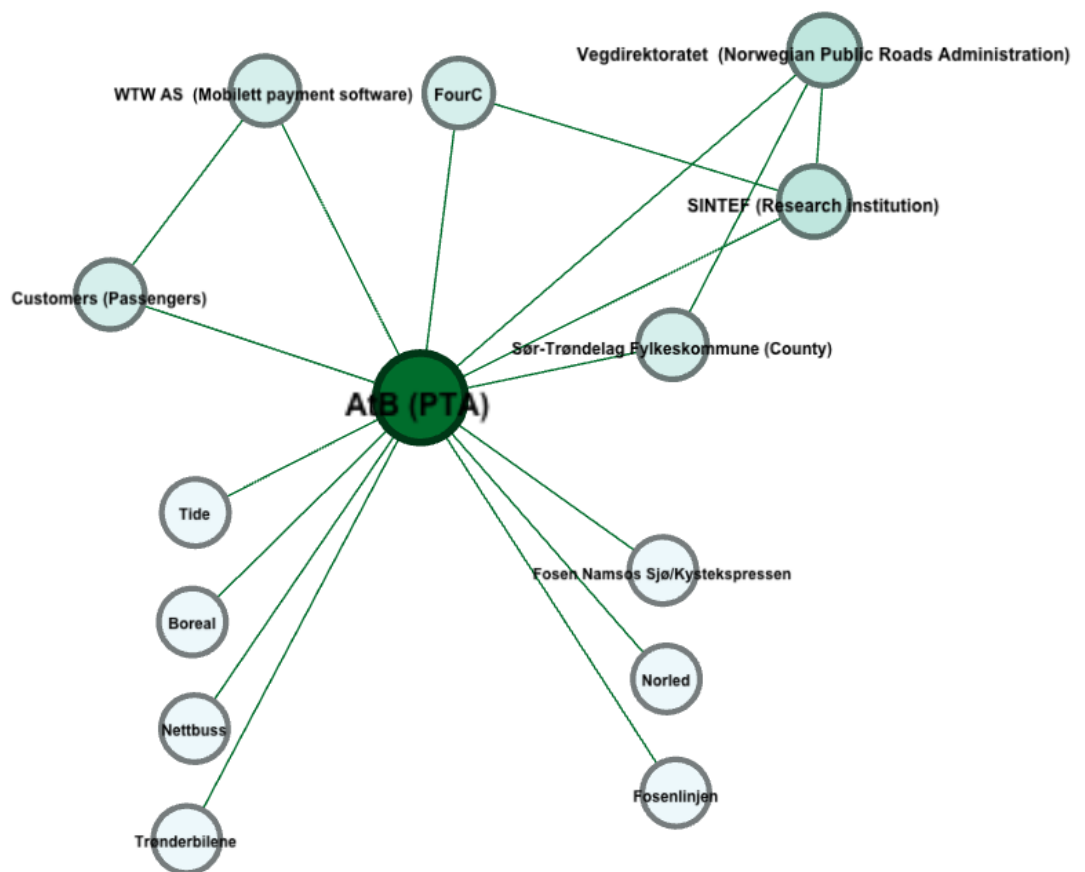


Figure 9: Sør-Trøndelag county ecosystem (Prepared by the author based on online and interview sources)

4.2.2.1 Ecosystem Analysis

The public transport system in Sør-Trøndelag is organized on the county level, not differing the municipality of Trondheim from the rest of the county. The system is multi-modal in that the city has a tramline in addition to the buses. Also the regional high-speed passenger ferry systems and the national train operator (NSB) are to a certain extent integrated in the ticketing and route systems. (AtB 2016)

A differing factor in the various levels of integration of PTAs is the revenue responsibility. In all bus transport in Sør-Trøndelag, AtB has revenue responsibility and all operators have gross revenue contracts. In some of the ferry operations, and the local train, revenue responsibility is lying with the operator, and a fare distribution systems are implemented into the electronic ticketing system EBIT. AtB is also involved in some public transport initiatives in the neighboring county, Nord-Trøndelag. Here the revenue responsibility is lying to the operators with net revenue contracts, and AtB is responsible for the revenue distribution. (AtB 2016, Interviewees D, E, F)

An important difference in the public transport systems of Norway compared to most other countries is that in Norway only ungated systems are used. The public acceptance of gates in the public transport is low, and experiments with implementing such devices have generally failed (Interviewee E). Because of this, the number of passengers not paying for their travel (sneaking) is quite high. Today it is estimated to ca. 1% in Trondheim, but is expected to rise with new more automated ticket media. (AtB 2016, Interviewee E)

4.2.2.2 Major Actors

4.2.2.2.1 AtB

AtB is the Public Transport Authority (PTA) in the county of Sør-Trøndelag. It is organized as a publicly owned company, and tasked with operating the public transport in the county. This includes the ticketing and payment system, the operations and route planning, passenger relations, publicity etc. AtB is contracting with a number of Public Transport Operators (PTOs) to operate the bus, tram and ferry lines.

AtB is the keystone in the ecosystem, as it is laying the foundation for several other companies to offer their products and services. Because this ecosystem is being controlled by the government, the keystone position is not earned as such, but nevertheless fits the

description given by Iansiti & Levien (2004) in that they both create and share the value of the ecosystem. Partly by organizing the public transport system platform, and giving access to 3rd party suppliers, and partly in a literal way, as subsidies are paid from the county administration to AtB, and distributed to the operators through gross revenue contracts.

4.2.2.2.2 Sør-Trøndelag Fylkeskommune (County Administration) (STFK)

The County Administration is the public authority regulating the public transport in the county. AtB is given its mission as PTA from the County Administration and the political level in the county.

“AtB is on the operational side, they don’t plan far into the future. They run the current systems, and update them when needed. Their perspective is to the end of the current tender period. We (STFK) have a longer perspective. We provide the long-time strategies, financial framework and infrastructure. We also own all physical infrastructure, ticketing machines, centrals and so on. We own the infrastructure and AtB provide the transport. But also: AtB owns the customer, and provide all customer relations. So the ticket solution and all related belongs to AtB.

We can provide guidelines and constraints for AtB. E.g. they have said that we need a new ticketing system. AtB will have to provide the documentation that this is correct and important, but we will give the go-ahead in the end.” (Interviewee G)

In the city of Trondheim, a huge project called Miljøpakken⁶ aiming to limit the use of cars and improving the public transport system with the objective of securing a more environmentally friendly person transport, and also avoiding traffic congestion problems that were about to arise at the start of the project and expected to become a problem in the coming years. An important part of this project is the development of the urban public transport system, including buses and infrastructure for buses, bicycle lanes, and a new “superbus” initiative which is meant to be a variety of BRT system.

⁶ <http://miljopakken.no> (Norwegian only) A joint project between the municipality, the county administration, the PTA (AtB), the Norwegian Public Roads Administration and the toll road operator Vegamot. The mission is to improve the mobility, road quality, public transport availability, the environment and the situation for bikes and pedestrians in the Trondheim region.

4.2.2.2.3 Norwegian Public Roads Administration (NPRA)

The Public Roads Administration is the national authority giving regulations for all aspects of Norwegian road-based transport. As part of this, a special series of regulations, or Handbooks are issued to regulate the public transport and its ticketing and payment systems. The handbook regulating electronic ticketing is number V821. (NPRA 2014) This handbook is built from 25 sections covering all aspects of electronic ticketing in great detail. A problem is that the topics are covered based on existing and already implemented technology, and because of the very specific requirements, new and innovative products have difficulties entering the market. (Interviewee E)

“The NPRA ensure that the technological platform is the same [in all parts of the country], and that everyone move in the same direction. But they are not forerunners. Somebody else always have to do that. So when we created the SMS ticketing system they said no, we could not implement that because it was not according to handbook 206 [the old version of handbook 821]. But then we said that handbook 206 is regulating electronic ticketing. The SMS system is not an electronic system; it must be considered a cash system. So we had a discussion regarding this, and in the end the SMS system was to consider as a cash system. So they had to create specific handbook for that. [A part of handbook 821]” (Interviewee G)

4.2.2.2.4 SINTEF

SINTEF is a large, independent research foundation supplying research products in a wide variety of technology-oriented disciplines. Among these are public transport and public urban transport, and SINTEF is used as technology partner in the development of central regulations, and researchers from SINTEF are involved in the handbooks regulating public transport and ticketing. (NPRA 2014)

In the ecosystem, SINTEF occupies a niche, but really fills two different roles. One as a technical expert body for the NPRA, instrumental in creating the technical parts of the handbooks forming the regulatory on road building and operation in Norway. The other is as a provider of research services on various public transport issues to PTAs but also to private enterprises. According to Interviewee E, this role can be problematic.

4.2.2.2.5 Passengers

Sør-Trøndelag county does not have the diversity in class, education and income level that we see in Rio de Janeiro. Much like the rest of Norway, the society is very egalitarian, without large differences in social class, income etc. This reflects on the use of public urban transport as well. In Trondheim, most bus passengers have the option of using a private car, and the factor mainly influencing the choice is convenience. According to the Miljøpakken project, 100 000 out of a total of 523 000 daily car trips are less than 3 km. If using a private car is no longer an alternative due to restrictions, lack of parking etc., walking the same distance takes about 30 minutes. (miljopakken.no) Safety and security is not an issue in Trondheim, but weather conditions are. However, to compete with the car, bicycle and walking, the bus has to offer convenience and speed. Because of this, an important priority for AtB as PTA is to increase the comfort, speed, reliability and easiness of using the urban bus system. (ATB 2014)

4.2.2.2.6 AtB (Public Transport Operator)

In Sør-Trøndelag county, AtB is administering the bus transport operators through gross value contracts, meaning that the revenue responsibility is lying with AtB, not the operator. The transport operators are contracted for periods of up to 10 years based on competitive tenders administered by the PTA. (ATB 2014)

The AtB is 100% owned by the County Administration, and is the organization responsible for the tendering of the route packages, contracting the operators and maintaining the contracts. Also, the ticketing system and all passenger relations are responsibilities of AtB.

“We have a framework agreement with our owner with the horizon of a few years. Then we have annual agreements that are more specific on tasks the coming year and the main projects we are running in addition to the regular tasks. They provide a budget, and based on that we plan our services to provide the best possible offer to the public. Ultimately we receive missions based on political issues that are being decided in the County council, so the politicians can influence this both through the mandate and not the least through fare regulations, as they are the fare regulating authority. We have a small flexibility to adjust to the budget, but the fare regulation authority lies with the County council. So any bigger

changes are based on political decisions. We can of course provide advice in those cases, based on our experience and competence.” (Interviewee H)

4.2.2.2.7 Technology suppliers

Important technology providers in the ecosystem are the companies FARA AS⁷, WTW AS⁸ and FourC AS⁹.

FARA: Provider of the electronic ticketing system since 2008. (AtB 2016) One of the major Norwegian companies within public transport payment systems.

WTW: Supplier of the “Mobilett” payment app used for bus transport in the county. The company also has other payment apps for various sectors (<http://www.wtw.no/>). The Mobilett app has been operational on county level since 2011. Before this it was used locally on the tram line only (AtB 2016, Interviewee G). Mobilett is in use in several Norwegian counties. The contract with AtB expires in 2018.

FourC: Startup focusing on mobility services through their “Cities in Motion” platform connecting the transport operators and suppliers of other ITS products and services, e.g. infotainment systems, ticketing systems etc. In addition, an own passenger flow analysis functionality is offered on the platform, and more functionality is planned for the future. (Interviewee E,F)

These are the main companies within payment and ticketing, and fill important niches in the ecosystem.

4.2.3 Interviewee’s aspects

4.2.3.1 About AFC and cash payments

Moving to a fully automated fare collection system is inhibited in Norway because like Brazil, the rights to use cash for payments is regulated by law. There are two laws governing this: “Sentralbankloven” (The Central Bank Law) (LOV-1985-05-24-28) and “Finansavtaleloven” (Law of Financial Agreements) (LOV-1999-06-25-46). According to these laws, the customer has the right to pay with cash for products or services.

“Q: Do you see a change of these laws coming?”

⁷ <http://www.fara.no/en/>

⁸ <http://www.wtw.no/>

⁹ <http://www.fourc.eu>

A: Yes. They are really being challenged. Several industries have voiced serious objections. So it is becoming – it will not last much longer.”

(Interviewee G)

However, most Norwegians nowadays pay with cards or through mobile services, and cash is mostly used by the very young and the very old.

“We have also discussed with AtB the consequences of making public transport free for children under a certain age and similarly for elders over a certain age. If we exclude everyone under 10 and above 80 from the payment system? Then we remove a major part of the ones that today are unable to use the automated ticketing systems. And then a very small fraction will remain that will have challenges if we completely

automate the system.” (Interviewee G)

The challenge of the few that will always be without bank account and payment cards can also be resolved by creating points of sale where cash can be used.

“And of course you could have agreements with stores so that the few affected could purchase tickets. And then you could fully automate the

rest.” (Interviewee G)

Removing the cash from the vehicles will facilitate a fully automated fare collection system. This will in turn raise new questions, as we shall see.

“And then the question is whether to use electronic validation on board, or if it should be a manual control.” (Interviewee G)

4.2.3.2 Gated vs. Open Systems

In Norway, the only gated public transport system is the airport express train “Flytoget” from Oslo to Oslo International Airport Gardermoen (Interviewee G). All other bus, train, tram and metro systems are open, which means that the passenger doesn’t have to pass barriers to enter the vehicle or in the vehicle itself. Validation of the ticket is based on trust and fear of controls, which traditionally have been few and far between. (Interviewee G)

Especially in Oslo there have some attempts to implement gating and control mechanisms. An initiative to place validators with bars at the entrance to one of the major subway stations in Oslo failed in long queues and disgruntled passengers. Several million

NOK was spent on validators that were used for a week. (Interviewee E) In general, the Norwegian public is negative to gated systems.

“I’m not sure, but I think it is a cultural thing. We are probably a bit gullible and naïve, and we don’t want those ‘hard’ systems. There has been some discussion on the topic, and the result has been that softer lines are preferred. Plus, it is costly to set up such systems [gated validation]. If we had it from the beginning, when there were few buses and few stops, then it would be ok, because you had developed the system over time. But as we didn’t do that, it will be difficult to achieve in retrospect.” (Interviewee G)

To avoid passengers travelling without paying, two strategies are pursued. First, a control regime is implemented. Uniformed controllers board vehicles and inspect tickets. If the passenger doesn’t have a ticket, or if it is a mobile ticket purchased within the last two minutes (i.e. when the passenger discovered the controller), he will be fined. Studies from Bergen indicates that at least 2,5% of all passengers must be controlled to obtain good effect. (ATB 2016) Second, the work is ongoing to make paying for the ride as easy and convenient as possible. The general view in Norway is that passengers want to pay if the service is good and affordable, and the payment process is simple. (ATB 2016).

4.2.3.3 Mobile Payment in Norway

“You have such a huge part of the population that is so advanced users of mobile systems, and also, in Norway we are completely fearless in using the mobile phone to pay, and to place our ID in the phone. If this had been Italy it would have been impossible, because they believe, or they are convinced that their authorities will cheat them if they do. Here we are completely relaxed in this matter.” (Interviewee G)

According to the Danish Payments Council (2014), Norwegians are at the top in Europe of online shopping. The fear of fraud or other ‘cyber-crime’ does not seem to affect us. According to Interviewee G, this is one of the major reasons that mobile payment solutions have become so popular in Norway. And not only for public transport. The peer to peer (P2P) payment service Vipps¹⁴ app has been downloaded by approximately 2 million Norwegians, and is in daily use, especially by the young. In fact, a new Norwegian verb “å

¹⁴ <https://www.vipps.no> , a service provided by DNB bank (<https://www.dnb.no>)

vippse” (“to vipps”) has become a reality, meaning the transfer of an amount of money between two persons using the Vipps app. “DNB [a Norwegian bank] has come a long way when their service has created a new verb.” (Interviewee G) At the time of writing two more solutions are competing for the market leadership as well. A generic mobile payment solution based on NFC was recently discontinued. It was an initiative from Norwegian telecom giant Telenor and the largest bank, DNB and aimed to introduce contactless payment based on a standardized solution.

“A lot is happening within payments. It was a pity that TSM Nordic, or Valyou couldn’t continue. The board discontinued the company. That has made all the proprietary solutions we see now pop up.” (Interviewee E)

For the development mobile payment in public transport, this situation is difficult. A situation with several products with proprietary solutions are difficult to implement in the vehicles. (See chapter 0 for more information on the competing solutions.) An important issue in public transport is boarding speed, and having to choose between several payment modes will slow down the boarding process, as well as potentially cause errors.

“In public transport this is an interesting dilemma. You can have a [card] reader that will read one or the other, but you can’t have five different readers when you board the bus, and then wonder where to hold your – medium. So it is a setback that there are so many actors that cannot agree there. Say that you board the bus and wishes to pay with mCash. Then the terminal in the vehicle show a QR-code. But that terminal doesn’t know beforehand that the next passenger wishes to pay with mCash, there you have a problem. Are you required to press something on the terminal to choose mCash? Simply having to press a button will cause a delay. And you can’t start transmitting a Bluetooth message that now someone is arriving wishing to pay with MobilePay, because then everyone with the phone in their hand will be eligible to pay [because the Bluetooth handshake will launch the app on their phone]. So it is not easy for public transport.” (Interviewee E)

This unresolved situation combined with the long horizons and contract periods of the public transport industry means that none of these solutions will be adopted into the ticketing and payment systems of the public transport in the near future.

“Q: How do you think it will turn out? Do you think the transport authority will choose one provider for the mobile payment?”

A: No I don't, because I think they will stay out of this as long as they can because they see that the solutions are too slow and the situation too unresolved. In Buskerud (another county), for example, they said that while ApplePay is not available in Norway, they will not make any choices.” (Interviewee E)

“In any case it is a technology contest. What is hard is if one will have to choose. It has been hard for decades, as one didn't know on which technology platform to base the system. When the electronic payment system was introduced it was also a choice between different card solutions and so on. And then came the choices between different mobile solutions with NFC, or visual validation, and now with QR- or bar code, and there are Bluetooth solutions available also...” (Interviewee G)

4.2.3.4 Development of the Payment System

Payment- and ticketing systems in public transport is being transformed in Norway. The ticketing system in Trondheim was purchased in 2008, and according to AtB it is due for replacement, and the process of preparing the tender has already begun.

“The most important principle to establish is whether the passenger must validate their ticket every time they board the bus, in other words show in one way or the other that they have a valid ticket, or the opposite; that what is important when you board is that you have a valid ticket, but you don't have to do anything. Only if there is a control you show it. Then we can use the mobile solution and cover 90% of the passengers. Then there is the small group that can't use a mobile, or don't have a mobile, tourists and so on, and children of course. We must establish a system that covers everyone, but without spending a lot of money on the last 10 percent. In that there are some ... – ideally you wouldn't need hardware in the bus at all. That would be the best, but it will probably not be possible. – maybe in the next tender process.” (Interviewee H)

The question of openness of the ticketing system is a challenge even beyond the principles, as the access to good systems may be limited.

“We have to explore the market a bit deeper to see what the suppliers actually can deliver now. Open ticketing is quite controversial. Most places have a form of validation, and the larger the cities, the more rigid the systems. So we have to find out more about what is possible and at what costs. Then there is the political aspect in all this. Securing revenue vs. simplicity for the customer. They are contradictory.” (Interviewee H)

Recent developments in mobile payment (discussed in chapter 0) is also complicating the preparation for purchasing a new system, but not so much for the extra opportunities the inclusion of any of them could provide, as the fact that very important players are not yet participating, and that the picture in this market could very well change completely in the next few years.

“As we see it, those services don’t provide any added simplicity for the user. [...] You must take another step forward. It has to be so simple that you don’t have to type, don’t have to log in if it is supposed to give something extra to the user. At least the way the card usage pattern is in Norway. [...]

Ruter [The PTA in Oslo] include them with the reasoning that they want more payment options in their app, so that if one should fail, you always have two or three others. For new customers used to ‘vipps’¹⁵, to use such a phrase, it might be a plus. But this is a market where a lot is happening, and I don’t think it looks the same way in five years. That would surprise me. The drawback with Vipps and the others is that they are Norwegian solutions. What we are thinking around payment methods for the coming years is to use the bank-issued card the same way you can do in London. That you can create a transaction without communicating with a backbone system. That you save that waiting time for verification with a server. [...] So we’re thinking that an ID-based ticketing solution where the bank-issued card can be the most used ID. That would be very simple for the customers. [...] A revolution is ongoing that is going to further

¹⁵ The new Norwegian verb created to describe the use of the P2P payment service Vipps. See chapter 0 for a closer description.

change the market, I believe. ApplePay has not arrived [in Norway] yet, and other heavy players may enter [from abroad] and change the picture somewhat. [...] The advantage with international solutions is that you can travel, and still keep the same functionality. So in the long run the services that operate internationally will prevail. I believe.” (Interviewee H)

Even so, the possibilities for development are several. Especially if you think in the direction of separating the ticket further from the payment system.

“Yes, they could maybe have some payment service in there [in the route planner app] as well, right? Maybe you free the ticket from the payment system so that you can have a cloud service where anyone could purchase a ticket and show it in their app without that app being Mobilett. Then you have freed the ticketing from the payment... I think this will happen eventually.” (Interviewee E)

In Trondheim, however, the start of the electronic ticketing and payment system was a bit different:

“[When we] originally developed the electronic payment system, or ticketing- and payment system, our biggest mistake for us, and for them [FARA, the supplier] that we saw ticketing and payment systems as one discipline. And it is two completely different technologies. Engineers build ticketing systems; economists build payment systems. In hindsight that was our biggest mistake. We were so unexperienced that we didn’t understand that. We thought that ticketing- and payment system was one technology. One discipline.” (Interviewee G)

Separating the ticketing system completely from the payment system opens up for some interesting new possibilities as well.

“And then you can use an API to purchase the ticket, receive it, and present it in your app. Then it will be up to you as an app developer to make a presentation of the ticket that is accepted by the transport operator.

And then Mobilett, why should AtB pay for using Mobilett? When everyone soon could have their own presentation of the ticket in the phone.

Q: But then you move to a solution where the app owner takes a cut of the ticket price?

A: Yes. Just pay the price of the ticket to AtB, and it is ok.

Q: So, you mean that AtB charges – say NOK28 – per ticket, and what the app owner can sell it for is not an issue for AtB?

A: Yes, or you have a popular app, so you have a potential for commercials in the app. Eventually, travelling is free for the passenger because so many use the app, that one of the big chains is willing to sponsor the trip because it goes past one of their stores.” (Interviewee E and F)

As a natural consequence, the development in the ticketing and payment ‘sector’ goes towards what is called ID-based payment or ID-based ticketing, but this requires a shift in how the providers think about the ticketing process.

“But you get a clearer distinction between ticket and payment. A ticket is then just..., well, you receive an ID. You have an ID bearer, and then you have a system in the background, where the ID gives you a right, or a ticket. And then you have a payment solution in there. But it is the ID bearer and the handling of it that is the challenge, because that is what you carry with you while the ticket and the payment lies in the background in the cloud.” (Interviewee G)

4.2.3.5 From Public Transport to Mobility

In the literature, mobility can mean different things depending on the context. In this setting, we think of the difference between transport and mobility as the different approach where transport is merely bringing the passenger from a to b, whereas mobility is the offering to solve the full transport needs of the passenger.

“[...] what we see today is that we are leaving the idea of transport, where you travel from station to station, maybe only by train or bus or tram. We are now talking about covering a need for mobility, where you during on journey maybe have two or three different modalities. Where you go from home to the station by bike, then you take the tram to downtown, and then the bus to the university campus. Then you have three different modalities. In the traditional transport philosophy, you have to get from your door to the station, and then from the next station to the door of your destination. What we are moving towards now is the idea of mobility, where we help you, take you from door to door, and where you can shop different travel alternatives with one single booking medium and a single payment medium.” (Interviewee G)

This philosophy would include more than merely integrate the various modalities of public transport available in Trondheim. Other modalities, like cars and bikes should be included into one seamless functionality for transport.

“The next generation ticketing- and payment system for public transit might cover both city bikes, car-sharing and car-pool arrangements in addition to the public transport; bus, train, taxi, tram, all the modalities in the city that you can use. And you have one payment solution to cover it all. Helsinki have said that within 2025, owning a car in Helsinki should not be necessary. They plan that you can pay a certain amount per month, and subscribe to all the services. Then the public have bikes, taxis, bus, subway, tram. You purchase a right to travel, and then you have one or more service providers that cover you needs. And then you can shop around among the available solutions, and you have one single ticket. One payment solution.

We have just launched a project to develop this, that is why the Helsinki situation is familiar to us.

And then we believe that at one time, autonomous solutions will be available, i.e. driverless vehicles, that would be very well suited to this kind of ticketing solutions. We want to start taking the first steps over there.

From transport to mobility.” (Interviewee G)

Even if the majority of journeys in Sør-Trøndelag are made in the city of Trondheim, the districts play an important role for the public transport. And the regional public transport system in Sør-Trøndelag is not well suited to the task.

“We see that population in the districts is becoming smaller and smaller. People are moving, and the urbanization leads to fewer and fewer [passengers] and more and more expensive to operate. It is really hard to operate public transport in the districts. We seem to have only one type of vehicle, and that is 50-seat buses. And people live scattered, and they don’t travel every day. And the vehicles are large and expensive and not suited neither for the roads, nor for the market. But it is ‘one size fits all’, that’s how it has been traditionally.” (Interviewee G)

To remedy this situation, the mobility idea is suited, going from fixed transport options to flexible offers based on the actual travel pattern of the population. However, finding a solution that will actually solve the problem without being too costly is a challenge.

“We in the public administration have eventually figured out that one way or another we have to go from fixed routes in the regions to some form of transport by demand. More like a taxi service. But operating a transport on demand system for individual transport is extremely expensive. And in the region the distances are long, so we have to catch parallel travel needs in such a way that these can be covered with one vehicle. Then we have this idea of adapting the size of the vehicle to the need. If a single person orders, it is small, then for growing need, a larger vehicle, and if fifty people need transport, a bus will arrive. We have had a desire to develop such a system for a long time. A few years ago we tried a solution with a central for people to call in advance and notify if they were going to travel. It was a very expensive solution that few used. So we discontinued that and decided to spend the remaining funds granted to develop a proper solution for them.” (Interviewee G)

In Sør-Trøndelag the idea is to move in steps to improve the mobility for the regions as well as the city. The way the public transport is organized with tenders for contracts of up to ten years, make this approach possible, but it is important to keep a long-term plan of what to achieve.

“[...] a system where you have to order in advance and notify when and where you are travelling, and then the system is combining parallel transport needs. And then we want to make it so that the system also decides the capacity of the vehicle. And on this system we want to base the next round of tenders for the regional transport. So that it isn't a tender for bus transport, but a tender for transport. Not the full mobility vision, we won't be able to get there yet. But a situation where the one who is best suited to calculate, or deploy large or small vehicles depending on the demand will win the tender, and not only the one who can offer the most buses, or the lowest price for the buses. So that we combine the vehicle with the demand for transport.” (Interviewee G)

In the philosophy of the full mobility offer, the system to order, coordinate and pay is central. Developing this system is not a task easily undertaken, and implementing the complete solution in one step will almost certainly not work.

“[...] but such mobility systems will still be first-generation. And I don't think we will get to good 3rd-generation systems unless we have many actors testing out suboptimal first-generation solutions. We have to accept the need for trial-and-error from different environments to find the best from many, and so to end up with a good solution in the end. [...] And I think it is wise to move step by step and not implement everything at once. So if we can start with one system, and then keep adding new functionality, I think it is the best way to proceed.” (Interviewee G)

Regarding the possibility to actually create the ultimate mobility system, it is frequently seen in most countries that politicians and administrators at times are more occupied with ‘monument-building’ than actually creating the best solutions for the public. The real challenge then is probably not technology or competence but the ability of all involved parties to cooperate and work towards the best solution for all.

“Then someone have to take the risk of being first, the cost of being first, and the wear it brings, both internal and towards the customers. I am convinced that we have the competence and the technology we need to make such a system here in Trondheim. Of that I have no doubts. So we have knowledge and technology. What depends is whether we have the attitude to

combine and develop together. [...] But that requires that everyone – there is a bit of competition between the different authorities and the different actors, which have to be avoided to make this happen. And then I think it is the ability and willingness to cooperate that is the barrier to overcome.”

(Interviewee G)

4.2.4 Platforms

From the ecosystem analysis section, we saw that the PTA, the publicly owned company AtB is functioning as a keystone in the Sør-Trøndelag ecosystem. As keystone, AtB offers the public transport system as a platform for third party providers of products and services. And also providers of new platforms.

The simplest platform is regular advertising in the vehicles, offering the platform to connect advertisers and customers.

The ticketing system was extended with a mobile application called Mobilett in 2011, thus providing this as a platform as well. Today, the electronic ticketing system operates parallel with the mobile application. The latter can in turn be viewed as a platform connecting transport providers and passengers.

Furthermore, the company FourC is offering a platform for the buses that will allow all other ITS systems to run on a single computer on board the vehicle. The platform is meant to connect the transport operator or the PTA with providers of various ITS systems like real-time systems, driver management systems, fleet management systems, vehicle management systems, infotainment systems and so on. This is a B2B (Business to Business) platform connecting the PTA and other product or service providers. On top of this platform other providers can build new platforms among others interacting with passengers, connecting them to product- or service providers of various kinds, and also to the PTA.

If we look to the borders of the public transport industry, we see a classic platform war with a likely winner take all outcome being fought in the mobile payments industry in Norway. Three services, two requiring different, proprietary equipment at the point of sale (mCash¹⁶ and MobilePay¹⁷) and the third more directed at peer to peer payment (Vipps¹⁸) are currently fighting for market domain. The principle is the same for all three services: A bank,

¹⁶ <https://mcash.no>, offered by the SpareBank1 group.

¹⁷ <https://mobilepay.no>, offered by DanskeBank.

¹⁸ <https://vipps.no>, offered by DNB.

or a consortium of banks have created an app for the user, and require the merchant to enter into the agreement with special hardware, or other agreement with the bank. One solution is based on Bluetooth, one on QR code scanning and the last is a pure mobile data solution, requiring the entry of name or number of the merchant on the phone to execute the payment. In all three cases, both the user and the merchant must have an agreement with the bank offering the service. (Interviewees E and F) An important issue is that the big, international enterprises like ApplePay, AndroidPay and the EMV alliance are not present in this platform war, and a national solution without a strong connection to any of these is not likely to survive in the long run. (Interviewee H)

At the time of writing there are no indications as to who will eventually be the winner in this war and deeper study of this situation, however interesting is beyond the scope of this study.

4.2.5 Public Value

Being an important model in the study of public organizations, this model was expected to help understanding the organization and development of the organizations studied.

In Rio de Janeiro, few similarities were found.

In Trondheim, or more correctly the Sør-Trøndelag county, the situation is slightly different. First, the strategic triangle of Moore (BENINGTON & MOORE, 1995), see Figure 4. One has to look a bit wider, at the big public project “Miljøpakken” (Translated: The environment package). Here the outcomes in terms of public value have been clearly defined in quality of life, traffic density and mobility parameters. Further, the authorizing environment is secured from the National Parliament. Operational capacity is secured through a dedicated project organization as well as mandatory participation from the involved parties.

Applying the framework of Veeneman et al (2006) (see Table 2) on the project “Miljøpakken”, we see that Type A values are covered by strong mechanisms. Accessibility is governed by law, affordability by other social arrangements not limited to public transport and the availability by the regulation governing the work of the PTA.

Type B, Positive Externalities are covered by defined targets of the “Miljøpakken”. E.g. 80% of new homes shall be built inside the public transport “urban sector”, growth in the number of bus journeys, reduction in pollution from traffic.

Type C, Negative Externalities include safer roads, the removal of heavy traffic from city streets and residential areas and facilitation for walking or cycling instead of driving. All important aspects of the “Miljøpakken” project.

Type D, Functioning of the Sector is characteristics of the public transport system. Quality is secured through biannual surveys of customer satisfaction. The results of these surveys are directly influencing bonus/malus paid to the operators. Security issues in Norway are not a priority. The main issue is the removal of cash from the vehicles to avoid risk of robbery, and several initiatives are ongoing to change regulation on this field. Regularity is also a parameter influencing bonus/malus. A real-time system is implemented provided exact data on regularity.

Type E, Functioning of Government in Norway is usually limited to efficiency and effectiveness of public organizations. Transparency in the “Miljøpakken” project is high, but the involvement of several public organizations introduce a significant danger of inefficiency.

Considering the framework presented by Carli (2011), the main difference is that the Environment is added as a separate parameter. Examining the same project, “Miljøpakken” we find that this is the main objective of the project, and most of the other factors are mere means to obtain a better environment. Clear environmental parameters have been defined, like emitted CO₂, suspended road-dust etc.

Summarizing, we see a close match of the Public Value parameters proposed by Veeneman et al (2006) and subsequent Carli (2011) in the management of one of the biggest development projects that have ever been executed in Trondheim. Reversing the issue, nothing in the interviews or in the studied material indicates an awareness of this theory and these frameworks.

4.2.6 Mobile Payment

In Trondheim, or in Norway in general, the attitude towards mobile services is positive. According to Interviewee G, Norwegians have remarkably few reservations against using their mobile phones for payment purposes. According to Interviewee H, the mobile application implemented has focused on simplicity, so as to maximize the ease of use. These two factors, along with the compatibility issue are defining the usefulness of the service. According to Interviewee G, the compatibility is important, as the use of the mobile payment service made a significant surge when the possibility to purchase periodic products were added, hence increasing the compatibility of the application. Again according to Interviewee

G, security issues have never been a problem for Norwegian mobile phone users. They generally demonstrate a great trust in the security of the systems they use. Hence, all factors indicate a strong intention to use the system offered, which is translated into behavioral intention, that we quite right see, as the use of the mobile payment option is approaching 50% of total payments (Interviewee G).

4.2.7 Trondheim Scenarios

The scenarios in this study are developed according to Garvin's framework. As mentioned in chapter 3, the full analysis is divided into 5 stages, which will be described in more detail below.

4.2.7.1 Stage 2: Trends

To help organize the trends we divide them in 3 categories: Technology, public issues and governmental issues.

- Technology:
 - There is no doubt with any of the interviewees that the future in ticketing for public transport is ID-based ticketing.
 - The payment industry in general is characterized by a platform war among the largest Norwegian banks. None of the services they offer is particularly suited for public transport, even if they will be offered in some cities. A characteristic is that the big international players are not (yet) present in Norway.
- Public issues:
 - The willingness to use new mobile technology and services is high. Reservations against new payment methods is very limited if at all visible.
 - The population is generally very well educated and technologically competent. The penetration of smartphones is total, only a very few don't own a smartphone, mostly elders and small children.
- Governmental issues:
 - The development of, and control over public transport by the government is very strict. Private actors have no influence on the governance. Some exceptions in the smaller counties, where proper PTA organizations have not yet been established, but these represent a minority. Also, PTA's are expected to be in place within few years.

- The population's trust in the government and public institutions is generally very high. Fraud and corruption is generally non-existent, and whenever occurrences are uncovered, they cause changes in governance and regulations to avoid repetitions

4.2.7.2 Stage 2: Key Uncertainties

1. The most prominent uncertainty in the public transport in Trondheim that we can see from the interviews and reviewed materials is the uncertainty in the future of mobile payments. The ongoing struggle to gain market domination in a platform war with clear winner take all characteristics, along with the absence of international standard solutions is causing problems for the public transport sector where, due to the long contract periods, choosing the winning technology is crucial. The expected outcome based on the interviews is that the big international solutions will be the winner in the long term. Alternatively, one of the national solutions will manage to keep their foothold and become the standard for mobile payments in Norway.
2. The Norwegian laws on privacy protection are very strong, and the access to register personal data in computer registers is very tightly regulated. This could impede the implementation of new mobility systems that include payment and ticketing. However, if the user gives consent, any registration is allowed, as long as it is reasonably fair, and used in accordance with the terms given. In reality there are two uncertainties here. Whether the government will allow the necessary registrations to make a complete mobility system useful, and whether the customers accept these data to be registered.
3. The principles of open vs. closed ticketing can potentially cause big differences in the development of the public transport. (ATB, 2016; Interviews) The actors in Trondheim seem to be favorable to open ticketing, as this is much easier to implement, and is considered much more customer-friendly. However, revenue protection is an important issue in open ticketing, and getting approval from administration and the political level to implement this may be difficult.
4. The extent to which national standards and norms are enforced. It has become clear from the interviews (Interviewee G and H) that the national handbook regulating the public transport and the connected payment- and ticketing systems

is generally outdated, even when held up against the systems currently in use. New initiatives utilizing undescribed technology and business plans will not have a chance to be conforming to the standards in the handbook. Should these standards be strictly enforced by central authorities, innovation and new possibilities in payments and ticketing will be severely limited.

5. Some national programs and initiatives have been described by the interviewees as ‘complete madness’, as they try to combine everything for everyone in one big system. (Interviewee G) The chance of such a system to be successful is almost non-existent, and Sør-Trøndelag has opted out of this development. Should they however be forced by the department of transport to join the program, the local ideas of mobility and innovative payment and ticketing are very unlikely to be implemented.

Uncertainties 4 and 5 are closely related, as it can be expected that the one will lead to the other. Therefore, uncertainty 5 are selected, with 4 as a sub-issue. For the other uncertainty, the one that seems to influence development the most is the situation in the payment technology industry. Uncertainty 1 is therefore selected for the other dimension in the analysis.

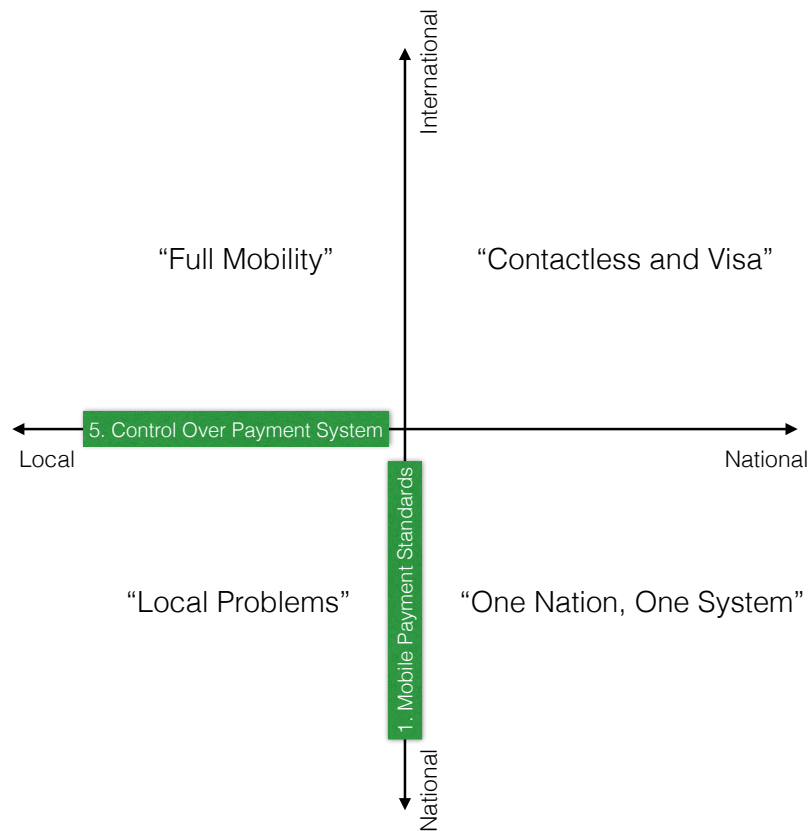


Figure 10: Trondheim Scenarios (Author)

4.2.7.3 Stage 3: Scenarios

The scenarios in Trondheim must be developed for a shorter timeframe than in Rio de Janeiro. The main reasons are the upcoming renewal of the ticketing and payment system, the standards wars in payment and the ongoing national initiatives of standardization. The first has a fixed deadline of 2019 (but with a possibility for postponement until 2021), the others can be expected to be resolved (or discontinued) within 2 to 4 years, probably less. The scenarios should therefore play out in 4 to 5 years.

4.2.7.3.1 "One Nation, One System"

Having the same, conservative government re-elected has not inflicted the economy very much. After the drastic fall in oil price in 2014-15, the land-based industry in Norway saw an upturning, as the surplus capacity in the oil & gas industry led to available labor and expertise, lower personnel costs and in general better conditions.

Although the national economy took a beating, locally, industry and entrepreneurs drove a wave of innovation and company establishments that is still ongoing. Therefore, although somewhat higher than the ‘golden years’ around 2010-11, the unemployment rate is low, hovering around 4-5%.

In Trøndelag, the neighboring counties Nord- and Sør-Trøndelag (North- and South-Trøndelag) was merged in a joint ‘Trøndelag’ in 2018, leading to a merger of all public transport administration organizations in the county. Both the county transport administration and the PTA, still called AtB are located in Trondheim.

National initiatives to improve climate-relevant factors like CO₂ continue to alter the nature of the transport vehicles, both private, cargo vehicles and public transport vehicles. The last few years, an increased effort to electrify the professional transport has led to a large number of cargo vehicles and buses operating on electricity, or hybrid solutions. Hydrogen powered cars is also becoming popular. The buildup of electric cars for personal use stagnated in 2016/17 as many of the benefits offered by the public was revoked. Now we see a rise in hydrogen-powered cars, as developments in the fuel cell technology has improved range and usability. The first hydrogen-powered buses are now operating in Trondheim.

In the mobility sector, integration of modalities, and new initiatives to increase ridership has slowed down in Sør-Trøndelag and Trondheim. The reason for this is that in 2017, participation in the national initiative to develop a travel planner and ticketing system for the whole country was enforced by the department of transport. The system is developed by a private actor, but based on input from all counties in Norway and the national railway company (NSB). Due to the demand to fit all needs on a national level, flexibility in the system is low, and local adaptations are not possible.

Since 2019, Trondheim has had a Superbus modality, which was intended to be a ‘BRT light’, operating on shared roads, but with higher frequency, out-of-vehicle ticketing and shorter transit time. The system became a success, connecting heavily populated areas with the city center fast and efficient.

Regional buses in Trøndelag continues to be an economic nightmare. Even though all routes are now administered by AtB, the wanted improvement in routes and products was postponed, and has not yet been implemented. A project run in 2016-17 to chart the situation and propose improvements was taken over by the national route initiative, and never gave any results.

AtB continues to run the route planning in Trondheim and the rest of Trøndelag county, as the national initiative still hasn’t been able to implement this functionality for the

county in a functional way. The ticketing and payment systems are poorly developed, as the national initiative has had the ticketing as an important feature, and national control has denied the local development of existing systems. The national system for travel planning and ticketing in public transport, TPT, finally came online. It took 4 years longer than promised, and the cost reached levels that no one wants to comment on. The system is still based on a proprietary card, carrying product information in the card. A mobile ticketing app has been developed based on the one used by Oslo. Integrated in the app are the two national mobile payment options, mCash and Vipps. The MobilePay initiative offered by DanskeBank was discontinued in 2017. Validation of the ticket is mandatory, also for periodic products. This means that the mobile phone must be shown to the driver for inspection, and if the travel card is used, it must be held to the validator terminal in the vehicle. No contactless Visa/MasterCard or ApplePay has been implemented, as these services have gained very little popularity in Norway. Benefits include full interoperability for travelling in different parts of the country, as well as combining bus and train journeys. The route planner also works reasonably well, but the possibility for the counties' PTAs to implement demand-based services have been severely limited, leaving Norway with a very static transport offering, that doesn't consider fluctuations in demand due to local events, holidays etc.

As mentioned, the payment scene is largely dominated by national players. The Norwegian Bank Association finally got their clearing service up and running to support modern methods, and at a very low price per transaction. The contactless Visa/MasterCard and ApplePay initiatives could never lower their prices enough to be popular among Norwegian merchants, as the custom in Norway is that clearing costs for the payment is covered by the merchant and not explicitly passed to the customer. The two remaining Norwegian payment services have been modified to fit in the public transport so that the passenger doesn't have to log in to the service every time. However, the integration in the national app, TPT is not very convenient and the payment process is considered cumbersome by users.

Other ITS initiatives are also struggling due to the nationalization of the information technology in the route and ticketing sectors. In theory, route data and real-time information is available for use by other actors, but the data are owned by TPT and access must be purchased, and the process to retrieve them is complicated. Therefore, these data are mainly offered by the TPT product.

In general, most ICT initiatives are crippled by the fact that the TPT provider is in reality a national monopolist, and their attitude is not welcoming to complementing

initiatives. The public via the Norwegian Public Roads Administration and the Department of Transportation are critical, but as the contractual terms give the TPT provider these rights, their powers are limited.

4.2.7.3.2 *“Contactless and Visa”*

Politically, little has really changed in Norway the last years. The government is stable, and the employment situation is relatively contained.

The economic growth in Norway was slowed by the oil price fall, but have since recovered somewhat. The currency is still weak compared to the US dollar and the euro, providing good conditions for Norwegian export. National interest rates have stayed low for many years. The counties Nord- and Sør-Trøndelag have been joined in one Trøndelag since 2018. The merger not leading to any dramatic changes. The public transport for the new county is handled by AtB.

The regional and local transport in Norway is still largely unconnected. The grand initiative from the Department of Transportation and the Norwegian Public Roads Administration was expected to integrate all public transport in Norway in one big, nationwide system improving the mobility for all, opening up the public transport for tourists and visitors, and simplifying travel across county borders. Nothing of this has happened. Instead, most local initiatives have been discontinued, leaving most counties without proper mode integration, route planning, or modern ticketing systems. One exception is Trøndelag, who renewed their ticketing system in 2019 as planned. However, the wanted increase in integration between modalities was never completed, due to the national system expected to do this.

What was included was modern ticket media, as the system is fully ID-based. This means that any secure ID-bearer can be used to identify the passenger. For periodic and discounted products, the ID is connected to an account in the back system. Single tickets can be purchased directly using contactless bank and credit cards with NFC, as well as ApplePay/AndroidPay/SamsungPay, also using NFC technology enabling a single terminal to be used in the vehicles. The success of these systems has led validator manufacturers to include support for all of them in their most modern validators, which were chosen to replace the old ones in Trøndelag. Due to the national system, validation is required, as this was part of the regulations stated for all public transport. Later, it became clear that no useful products

would ever come from the national initiative, but the regulations had already led to limitations in the contracting of new systems in the counties.

The new tender periods just entered in Trøndelag are mainly based on traditional requirements, and little innovation in the choice of vehicles or planning of routes have been possible, again due to limitations presented by the national system.

The AtB has been busy implementing the new ticketing and payment system, connecting to new and powerful actors like Apple and Visa/MasterCard. Hard negotiations of the terms led to quite successful results regarding revenue. The Mobilett mobile solution is still maintained, but has had to share many users with the ApplePay and AndroidPay, which have become very popular in Norway. The national initiatives seen a few years back are reduced to niche operators. The Vipps service is still popular as a P2P payment option, and the mCash system is very popular in festivals and big events. As general payment methods they have become completely replaced by the NFC-driven alternatives, and none of them are used in public transport. MobilePay was discontinued some years back.

After the official failure of the national initiative, AtB has reestablished previously discontinued projects to revitalize the mobility philosophy.

Several ITS initiatives that were planned or in the process of being implemented back in 2016, have recently been reactivated. A route prediction system connected to the real time and the route planner systems is already launched. A flow management system is being evaluated, and infotainment is installed in all buses since the change of ticketing system.

4.2.7.3.3 “Local Problems”

The national government was changed after the last election, placing a coalition of labor and environmentalist parties in charge. This has resulted in a somewhat confusing mix of policies, but for public transport, the main theme is one of more initiatives and heightened focus. With the continued low oil price, the national economy is strained, and public funds for investment or development are more scarce than a few years back.

Environmental issues having become a focus of the national government, a shift in the priorities have been enforced in Trøndelag. In the city of Trondheim, the initiatives to reduce car traffic has been intensified, and the demands for an efficient public transport system increased. Unfortunately, funding has not followed the demands, and several initiatives have been put on hold.

The new payment system that was planned for 2019, was delayed, but has been implemented, although all the great plans could not be fulfilled. The idea of integrating private actors, like taxis and car sharing was put on hold. In fact, the whole booking idea was not implemented, and on demand transport is not implemented. The regional transport was out on a new tender in a couple of years ago, and in that round, the concept of adapting vehicle size to passenger load was included. However, it is a static adaption based on general figures and not on the real demand, meaning that costs are still high.

AtB is struggling with reduced subsidies, along with the demand from politicians to keep fares low. This is limiting the possible development projects, as there are no funds for investment in new technology. A lucky coincidence is that the mCash payment app have become the standard for mobile payment in Norway. This app requires a QR code to scan for choosing the product, and this has been enabled in all vehicles as a simple sticker on the vehicle door. The mCash functionality has been included into the Mobilett app, that is used to handle all fare products. The dedicated travel card was discontinued when the ticketing system were renewed in 2019, and no complaints have been made about this. Discontinuing the travel cards saves several million NOK in costs every year, and the validators on board have been removed and replaced with the QR stickers for mCash. Ticketing is now completely open in the public transport in Trøndelag, only enforced by random controls. Cash payment on board is still a requirement, causing some headache for AtB, as it is a very costly practice that is very little used. However, the law requirement is still in function, so there is no choice. To discourage cash payment, the fare for such tickets has been increased even further. These initiatives in the payment system have enabled AtB to reduce their staff with about 20%, thus saving some money, but the financial situation is problematic.

No other ITS initiatives have been established. The operators run their own fleet management systems in the vehicles, but AtB is not involved in this, and the data captured remain the property of the individual operators.

In essence, we see a public transport system that is highly advanced in some ways, but not at all developing in others. A restructuring of the regional products could help save this situation, but this requires a project, and no funds for such activities are available. In fact, the subsidies barely cover the contractual commitments towards the operators.

4.2.7.3.4 “Full Mobility”

The environmentalist party did a landslide in the last national election, and since then, everything has been about the environment. Many of the ministers leading the various departments are very inexperienced, and have a tendency to interfere in business affairs previously left to the market to sort out. This has naturally caused some turbulence in the Norwegian society. The national economy is strained, as the industry-friendly policy of the previous government have largely been discontinued. Owning and driving a car in Norway is becoming expensive, especially if you live in one of the larger cities. Here the public transport is supposed to solve all mobility needs for the population. In Trondheim and Trøndelag County, they are not so far from this target. In the city, autonomous vehicles have been introduced for transport within the city center. The Superbus initiative planned for 2019 was expanded, and instead of 3 lines, 5 were implemented. Also, dedicated lanes were created on parts of the routes. All the vehicles run on hydrogen using new, revolutionary fuel cells that are highly effective. The hydrogen is produced with a mixture of solar and wind power, supplied with hydropower.

In the regional transport, a broad range of vehicles are now used, from small minivans to full-size buses. The choice of vehicle for each route is dynamic depending on the actual demand.

AtB is responsible for all public transport in Trøndelag county. This includes information systems, that the last few years have been expanded into mobility solutions, incorporating all kinds of transport needs. This expanded system is now serving as an integrated ticketing system, where transport and entrance to events, museums etc. is included. Foreigners coming to Trondheim can download the app before arrival, register their data, and when they switch on their phone at the airport, the app will guide them through their whole stay in the city. This includes transfer from the airport, also done with autonomous vehicles. Hotel reservation, restaurant reservations and recommendations based on several of the online tourist guides, like Tripadvisor, Yelp and others. The system is also used for big events, which have become common in Trondheim. Football matches, arena concerts, big trade shows and congresses and sports events like the upcoming 2023 World Ski Championship in Nordic Disciplines. For this event, the whole guide, ticketing and transport system will be handled by AtB, and integrated in the mobility system, as it now is called. As the ticketing and guidance functionality urges the user to register, and allowing tracking of his cellphone enables numerous benefits, efficient crowd management can easily be maintained. For example can

advise be sent to spectators in one part of the arena that bus lines are favorable at certain exits, In the event of delays in the competitions, buses can automatically be rerouted to ensure that everyone get safely and efficiently back to their accommodations. On top of all this functionality, important security functions have also been included. Audience that enter regions that are off-limits can be warned, or security personnel can be dispatched to sort out the problem. These event functions are built into the mobility system, which also include ticketing. This part is completely ID-based, and several ID bearers are supported. The ApplePay/AndroidPay/SamsungPay applications are of course supported, as well as the contactless bank or credit cards that are standard issue in Norway these days. Most European countries use the same standard, making payment for tourist fully integrated. If the card is ‘beeped’ in the vehicle and no account is associated, the fare will automatically be charged to the Visa/MasterCard account.

In addition to the validators on board, a new system based on Bluetooth and beacons have just been rolled out. If you have the mobility app on your phone with a valid ticket on it, beacons in the vehicle you board will automatically validate the ticket on your phone without the need to even take it out of the pocket. If you don’t have a valid ticket, the phone will buzz, and you can purchase with a simple gesture. The system will now always give the passenger the best price available, meaning that periodic products are no longer sold. The price for each journey is calculated based on number and frequency of previous journeys.

When the new mobility system was rolled out, it was decided that elders over the age of 75 years and children under 10 travel for free. Single tickets can be purchased for cash (or card, of course) at all Seven Eleven stores in the city so tourists without neither cellphone, nor NFC enabled card can utilize the public transport system. This option is hardly ever used by anyone, even though it is the only option for traveling anonymously with public transport in Trondheim. Regional routes still accept cash on board, but this option is hardly used by the passengers.

Many of the ITS solutions implemented are available to the passengers. A live map, showing all vehicles in real time is very popular, as the transfer between vehicles can be planned based on this, rather than planned route information. Even though the drop in private car traffic has been considerable, occasional traffic jams still occur. The passenger can also see who is the driver, and provide direct feedback on driving pattern and hospitality. As a control, the accelerometers in the passengers’ smartphones are registering acceleration and braking, and these data are also fed into the driver management system along with the comments.

(The integration features in this scenario was largely inspired by Interviewee G's vision for the public transport in Trøndelag.)

4.2.7.4 Stage 4: Strategies

Again, the strategies to choose depends on the viewpoint. In this case, a company providing mobile payment services especially targeted at the public transport sector is chosen.

4.2.7.4.1 "One Nation, One System"

In this case, the best strategy would be to concentrate sales efforts in Oslo, as the nationwide system is developed there.

Regarding development strategy, creating a system that is highly scalable both in functionality and load would be wise. A system that can add value in a rural county in the mid or northern Norway at the same time as it can handle the hundreds of thousands of daily journeys in Oslo.

For a foreign company it would be wise to know about the city vs. countryside conflict that persists in Norway. Related is a 'capital vs. districts' conflict, that increases the difficulties as a system developed in the capital will be regarded with skepticism in the districts. Likewise, the needs and requirements of the districts are often ignored in the very urban capital.

At the time of writing, mobile payment is a 'red sea' with fierce competition ongoing between 3 national providers. Therefore, financial institutions in Norway are unlikely to be very forthcoming. Efforts should be concentrated with the development organization for the national system.

4.2.7.4.2 "Contactless and Visa"

In this scenario, two strategies make sense. Firstly, the failing national system initiative might be eager to implement something that could work for the members, so as to not create a national scandal (which a complete failure surely will). Also, the individual PTAs in the counties are relevant customers to approach. The climate in the payment sector would be dominated by the big players (Apple and so on), so being small and presumably less costly can be attractive.

4.2.7.4.3 “Local Problems”

In a situation where no funds are available for investments, business models involving software as a service and pay-per-use can be attractive. When defining the pricing strategy one should keep in mind that the public generally have little love for such solutions, and prefer fixed-price contracts or flat-rate subscriptions.

4.2.7.4.4 “Full Mobility”

Approaching the individual counties and applying the solution to their individual wishes is probably a wise strategy in this scenario. The national all-in-one solution will be a dead end, and should be avoided. Being able to provide integration between own systems and systems in use by neighboring counties can be beneficial, and alliances should be explored.

4.2.7.5 Stage 5: Early Warning Signals

The most obvious early warning signal that business opportunities may be appearing in Norway, and in Trøndelag is that the tender period is expiring. This information is public, and easily accessible.

The next signal to watch out for is signs of a conclusion of the payment platform wars. Either the growing dominance of one of the combatants, or the inclination to apply the different solutions for different purposes, indicating that all three may continue to coexist as niche players in the ecosystem.

The entry of the big international payment providers, like the EMV alliance or ApplePay/AndroidPay/SamsungPay.

Centralized initiatives are popular in Norway, but generally mistrusted in the districts. The failure rate is also high, and a lot of resources are often spent without any useful outcome. If the centralized route planner and ticketing system seem to be gaining traction, this is a sign that change may be imminent in the counties when contracts are up for renewal.

5 Final Considerations

5.1 Conclusions

5.1.1 Research Question 1

1. How are the public transport systems in Rio de Janeiro and Trondheim organized?

The public transport systems in Rio de Janeiro and Trondheim have been examined and described, mainly through ecosystem analysis, platform-mediated networks analysis, general descriptions extracted from interviews and secondary data. The collected data show a significant difference in the way the systems are organized, even when the expected differences due to the different size of the cities are accounted for.

The system in Trondheim largely follows the common pattern seen in many cities around the world, while the organization in Rio de Janeiro is special due to the structure where the transport operator organization is also acting as the PTA, with a very high degree of vertical integration through the whole value-chain. According to Interviewees B and C, it is also special for Brazil.

The two public transport systems are described through ecosystem analysis, general description with interview quotes, business network analysis and scenarios. The research question is considered sufficiently answered.

5.1.2 Research Question 2 and 3

2. What technology is in use today, and what is being developed for the future?
3. How is this technology developed and adapted for practical use and by whom?

Considering the difference in size and demographics of Rio de Janeiro and Trondheim, the payment systems currently in place are quite similar as experienced by the passenger.

There are important differences, the main being that in Trondheim, private companies are contracted to supply the ticketing- and payment systems, whereas in Rio de Janeiro, the system is developed by an internal organization – organized as a separate company, but fully owned by the transport operator.

The base technology currently in place is based on contactless travel cards in both cities. The cards in both cities follow the MIFARE[®] standard, although Rio de Janeiro uses an older version, which is not surprising as they have had their system operational several years longer than Trondheim. Both cities also accept cash payment on board the vehicle as this is mandatory by law in both countries.

In Trondheim a mobile app ticketing option is very popular and accounts for nearly 50% of the total sales, even though the most popular periodic products are not available in it.

In Rio de Janeiro the system is closed and gated, meaning that the passenger must validate the ticket and pass a bar to enter the vehicle. In Trondheim, validation is only required for single- and mobile tickets and tickets purchased with travel money. All vehicles are ungated.

In Trondheim, all payments go to AtB. Most of the transport operators (bus companies) are operating on gross value contracts without revenue responsibility. There are still some exceptions where some of the boat routes and one bus operator still operate on net revenue contracts that requires clearing of the paid fares, but as contracts terminate, new tenders are for gross value contracts only.

In Rio de Janeiro, the situation is different. All transport operators operate on net value contracts, and fare distribution is cleared by the RioCard organization, that also operate the ticketing system.

In Trondheim subsidies cover approximately 50% of the total costs of the public transport system. This is paid to AtB, who distributes payment to operators according to their contracts.

In Rio de Janeiro, subsidies are paid in the form of free travel for certain groups in a system called *Gratuidade*.

Both organizations point to ID-based ticketing as the future for their organizations. The practical approach is radically different. In Trondheim, the whole payment and ticketing system will (probably) be replaced when the current contract ends in 2019. In Rio de Janeiro, the change to an ID-based system is planned as a gradual change in the existing systems. When these changes will lead to new products taking advantage of the possibilities the new concept facilitates is unclear. However, from the interviews it was clear that the main objective of the development is to gain better control of the customers and reduce the level of fraud in the system.

Given this summary of the situation and the planned future, research questions 1 and 2 are considered answered.

5.1.3 Research Question 4

4. Why is the development progressing the way it is?

This third question was added to try to understand more about the motivations for how the payment systems came to be what they are. In the summary of the literature review we broke the question down into 3 main groups, which will form the structure of this presentation of the findings.

- Public authorities/PTA:
 - Public Value;
 - Rio de Janeiro: No indications of governing according to Public Value parameters.
 - Trondheim: Clear signs of Public Value parameters in the governing of one major development project.
 - Platform-mediated business networks;
 - Both Trondheim and Rio de Janeiro have tightly controlled ecosystems in the public transport. Platforms do exist, but the free network forces that we see from other businesses are not allowed to function. In Norway, the research has uncovered that a “proper” platform war in the general mobile payment industry is ongoing, but closer examination of this is beyond the scope of this dissertation.
 - Technologies;
 - Integrated ticketing
 - Integrated ticketing in the context that tickets for transport can be combined with e.g. entrance to museums etc. is not implemented in any of the cities. In Trondheim, AtB has the technology to follow up initiatives from external actors, but haven’t done anything in this area yet.
 - Modalities and integration

- Both cities have fully integrated ticketing for all modalities. In Rio de Janeiro a complex back system is implemented to clear the paid fares between the operators.
- Public Transport Operators and technology suppliers/providers:
 - Financial and business models;
 - In Rio de Janeiro, transport operators have net contracts, operating mainly through consortiums. No external companies were investigated.
 - In Trondheim, gross value contracts are used for all operators and suppliers. The only exception is the supplier of the mobile payment solution, who gets paid mainly per ticket sold.
 - Towards customers, Trondheim is following the trend in Norway, offering all major credit cards as well as bank transfers and even payment over the phone bill. In Rio de Janeiro, only payment from own bank account or direct invoice is accepted. International credit cards are avoided, as well as any payment method involving granting credit to customers.
- Passengers/The Public:
 - Mobile payment (IMMPA model);
 - In Rio de Janeiro, no mobile ticketing solutions are offered, therefore the application of these models have not been performed.
 - In Trondheim, the IMMPA model seem to fit very well with the observed results.

With this summary of the findings, research question 3 is considered answered

5.2 Contribution for Managers

The managerial aspect has been the main motivation for undertaking this study. It is the hope and belief of the researcher that the descriptions and analysis performed may be of help for any manager trying to enter the public transport industry in either Rio de Janeiro or Trondheim. None of the markets are easy. Norway with rigid, public regulations and specific national financial structures. Rio de Janeiro with a vertically integrated, complex and protective private industry. We try to shed some light on these issues, and through the scenario planning analysis to suggest some strategies that might be helpful.

5.3 Contribution for Researchers

Naturally, transport and mobility researchers in the researched cities have a good knowledge of their ‘own’ ecosystems. Others, whether they come from the outside, or if their field of research is something else, may find the structure and organization of the public transport systems confusing, especially in Rio de Janeiro, where common structures are not applicable. Providing a map of the situation, with descriptions of the actors and their relationships and motivations should therefore be a valuable help in any academic undertaking involving the public transport sector.

5.4 Limitations of the Research

The main limitation of this work is that given the size of the structures examined, some of the descriptions and analyses are somewhat superficial. Deeper analysis could uncover a richer view of specific aspects of the organizations. However, this has not been the aim of this research. On the contrary, the intention was to provide a broad view, uncovering as many aspects as possible, but not attempting to analyze them in detail.

The researcher’s command of the Portuguese language has been a limiting factor in studying secondary data for the public transport system in Rio de Janeiro. Also, the lack of response from some institutions on requests for interviews is suspected to be due to language barriers, as the requests were sent in English.

5.5 Recommendations for future research

Both in Trondheim and in Rio de Janeiro, many intriguing aspects have been uncovered that could warrant deeper examination. Some obvious examples are the influence of a new modality (the VLT) on ridership in Rio de Janeiro. The same applies to the new metro connection. Will these promote ridership from the middle and upper classes in Rio de Janeiro? In Trondheim, the development in mobility towards the new tenders coming up in 2019 as well as the outcome and changes induced by the giant project “Miljøpakken” provide many interesting aspects for research.

Most interestingly, however would be a study of mobile payment in Rio de Janeiro, and how and when it would be implemented for public transport, what groups of passengers it would attract, and whether it would affect ridership in general.

In Trondheim, both qualitative as well as quantitative studies examining the attitude towards mobile payment could be useful to complement the current view of the mobile user.

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7 Appendix A: Interview Script

Main topic	Details to cover
Introduction of interviewer	Interviewer's position and background
	The mission of the research
	Brief description of the work
Introduction of the interviewee	Background and current position
	Experience
	Fields of interest and research
The public transport system in your (the interviewee's) city?	Historical aspects
	Current organization – how is it and is it optimal for development and operation?
	Suitability to solve the task (Is the organization good?)
	How is it currently developing?
	Drivers and obstacles or inhibitors to the development?
	Are there any unfortunate connections between important actors in the system?
	Public value parameters visible? From government? From transport providers?
The payment/ticketing system	Background and status
	Technology orientation of the users?
	Technology drivers
	Inhibitors
	User adaptation of new initiatives? User's inclination to try?
	Mobile payment?
	ID-based systems, the way of the future? Why?

	Other developments in payment/ticketing?
Additional subject for technology providers:	
Your technical solutions, what are they?	Area, status, history.
	Difficulties entering the market?
	Main focus for the business?
	Innovation opportunities?
	Business inhibitors?
	Priorities?
	NFC and mobile payment?