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The governance of urban public transport systems: the case of Zurich (ZVV)

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Abstract

The complexity of urban systems is reflected in all network industries and in the urban transport systems in general. Our research focuses on the modelling of the governance of the public transport system as well as on the exploration of the role of intelligent systems as a means of improving their performance. The types of governance of public transport vary from city to city worldwide and are linked to institutional legacies, ownership and others more. In the urban context, public transport services need to be integrated in order to best serve the needs of users and to provide a reliable service. Such integration can be achieved by means of a regional transport authority coordinating and contracting transport operators and which is furthermore responsible for planning, operations and financing. This is for example the model of the transport authority of the canton of Zurich in Switzerland, i.e. the ZVV (Zürcher Verkehrsverbund), which serves as the case study of this research. In the case of Zurich, operations are mainly coordinated by the transport companies, whereas ZVV is responsible for the strategic planning, as well as for the financing and marketing of the transport system.

This paper will present a framework for the analysis of the governance of an urban public transport system and its impact on performance. According to this framework the transport system is

represented through the interactions of its main actors which are the following: (a) the transport authority, i.e., the ZVV which is coordinating and contracting transport companies and operators as well as financing the system, (b) public authorities, mainly the municipalities, which have service requests and are partly financing the system via ZVV, (c) the transport companies which are coordinating operations, implementing timetable requests and sub-contracting transport operators, (d) the transport operators which are running the everyday operations of the transport network and (e) the users, i.e., the passengers. The governance system defines the relationships between (a) the transport authority and the companies/operators, (b) the transport authority and local authorities and (c) the transport companies/operators and the users. A simulation model based on this framework will be developed.

In order to evaluate the impact of governance, we will focus on two types of performance: economic and operational. Regarding economic performance measures to be used include the annual deficit, but also indicators relating cost to passengers as well as to the public transport network more generally. Operational performance is divided in two broad categories: the first one has to do with the efficiency and effectiveness of the labour/employees of the transport system and the second with the quality of the service provided. Although the evaluation of the level of service is of high interest, the efficient usage of resources, such as labour, affects both economics and operations. Furthermore, it is anticipated that the type of ownership affects labour efficiency. On the other hand, it is also expected that under a private and revenue-driven scheme, network characteristics such as frequency of service will be directly related to profitability.

The analysis of the transport system in the case of ZVV will be conducted at two levels. First, the organisational structure of the transport authority or agency will be discussed, looking at the interactions between the actors involved in planning, operation and financing of the system. Secondly, the transport system will be modelled in the context of the urban or regional system in order to measure total operational and economic performance. Here, issues relevant to demand for transport will be taken into account.

1 Introduction

This work is taking place in the context of the IGLUS (Intelligent Governance of Large Urban Systems) project, a research and education project managed by the Chair MIR at EPFL and the Stevens Institute of Technology (USA), aiming to address the unprecedented challenges of and opportunities for the governance of urban networks.

Networks are inherent elements of the cities and although in the past there was no or limited need for distinction between the governance of national and urban networks, the intensification of urbanisation and the impacts of agglomeration has turned cities into global actors. Transportation is one the major urban infrastructure sectors that has changed over the years in response to this turn and as a result of technological and governance changes. Governance determines the relationships between the main agents involved in the urban transport system and these relationships need to be represented in order to understand the mechanisms that lead to better performing systems.

The aim of the project discussed in this paper is the exploration of the relationship between governance of urban transport systems and performance, focusing on the role that intelligent systems can play to improve performance by improving the level of information about the urban transport network. For this purpose an interdisciplinary approach needs to be taken in order to (a) identify and analyse the main qualitative and quantifiable characteristics and relationships of different urban transport governance systems, and (b) develop a model of these relationships and of the main processes of the urban transport system in order to be able to test and forecast the impacts of relevant changes.

The general questions we are seeking to answer are the following:

- What policies – including the introduction of intelligent systems – can improve operational and economic performance of an urban public transport system?
- How are population choices, such as mode of transport choices, affected by these policies?
- What governance structures are more efficient in implementing these policies?

Initially, the focus will be on choices relevant to transport supply and demand. Supply-related decision processes leading to transport policies will be explored through the conduction of interviews with experts and relevant stakeholders. Regarding demand, the focus initially will be on the impact of policies – including the introduction or enhancement of ICT (Intelligent Communication Technologies) usage – on mode choice decisions. In the future, we aim to address urban dynamics more comprehensively by considering location decisions and urban development-related issues.

The analysis of the urban transport system will be based on the interactions between its four main agents namely the following: transport authority, public authorities, transport operators and users. The differences of urban transport governance systems are reflected not only in these relationships but also in the distinction of the roles of the agents. For example, when an urban transport system is fully public and operates as a department of a municipality, the transport authority might practically be the same as the transport operator. The division of the roles of the authority and the operator is the direction towards which most urban transport systems are moving. The determination of the four agents and the specification of their roles are based on the structure of the urban transport system of Zurich that will serve as the case study of this project.

2 Governance and performance in urban transport systems

Before proceeding to the presentation of the conceptual approach, we need to discuss urban transport governance and its relationship to performance. Various general definitions of governance serving different purposes and representing different schools have been given over the years. The four most common ones (Klijn, 2008) are the following: (1) “Governance as good governance or as corporate governance”, (2) “Governance as new public management, as improving performance and accountability or as market governance”, (3) “Governance as multilevel governance or inter-governmental relations” (4) “Governance as network governance”. The second and the fourth definitions are the most relevant to our approach of urban transport governance.

According to the second definition: “the focus of government should be to set goals, and not on the implementation process. Policy implementation is best left to other organizations or separate public agencies, which can be held accountable through the use of clear performance indicators and other market mechanisms. This definition of governance is similar to that of new public management, which stresses that governments should guide at a distance, using performance indicators and market mechanisms to arrange services and secure policy outputs” Klijn (2008). For this purpose, appropriate performance indicators of urban transport systems that will lead urban transport policies need to be identified/determined. On the other hand, according to the fourth definition governance is the process that takes place within governance networks and the term governance network refers to the relationships between government, businesses and civil society actors. In order to apply these definitions to explain urban transport governance, it is necessary to understand the organisational structure of the urban transport system.

2.1 Urban transport organisational models

Inherent to the organisational structure of an urban transport system are the notions of ownership and integration: On one hand, most public transport systems have been through different phases of ownership since their foundation. On the other hand, with the development of cities and wider urban areas into important economic entities and the increase of urbanisation, the integration of urban transport services (i.e. timetables, tickets etc.) has become necessary for the provision of reliable and attractive, in comparison to private transport modes, services.

Referring to the whole urban transport system and not to the various transport operators that may operate in a city, ownership can be public, private or a combination of the two and may include one or several stakeholders. The choice of the best system depends on the size, form and dynamics of the city as well as on legal, cultural and other local characteristics but cooperation between the public and the private sectors for the provision of urban transport services is becoming more common. The new forms of cooperation between private and public actors have attracted a lot of research interest in the field of governance and public-private partnerships (PPP) are considered to be “new governance forms in which more co-production between public and private actors leads to more efficient and better policies or products” (Klijn, 2008). In the case of quasi-private companies the majority of the shares belong to the city allowing control and implementation of policies that support public transport and at the same time not bounding the system by political interests. The rest of the shares are sold in the stock market through Initial Public Offerings. This model is also identified as partial privatisation model and the only recorded case is the Mass Transit Railway (MTR) in Hong Kong (Jain et al., 2008). In the logic of increasing private participation but moving more towards privatisation, are the corporatization models that refer to the introduction of corporations by transferring to them the operations and governance of the system (Jain and Cullinane, 2002).

Regarding publicly owned transport systems, there is large variation in the ways city transport agencies operate and Vuchic (2005) provides a good review focusing on US examples. A municipal transport agency is fully owned by the city, making the implementation of transport policies and the financing easier as money can be drawn from other sources of the city. The flip side of the latter is that transport is competing with the other departments of the city for funding. Also, transport policies are susceptible to political interests.

Urban transport systems have been changing over the years and one factor guiding the changes is urbanisation. The need for regional – or more centralised – transport agencies can be the result of the need for integration of services as cities grow and merge with neighbouring areas to create large metropolitan areas. There are several cases where regional transport authorities – or centrally regulated transit systems – operate the entire transport system, including planning, financing and operations, such as the Transport for London in UK, the Washington Metropolitan Area Transportation Authority and the New York City Transit (in New York there is also the Metropolitan Transportation Authority with jurisdiction over the New York City Transit, the Long Island Rail Road, the Metro-North Railroad, the Long Island Bus and the Metropolitan Transportation Authority Tunnels and Bridges) (Vuchic, 2005).

On the other hand, when more companies operate in the urban transport system two common forms of integrating services are: tariff associations and transit communities (Vuchic, 2005). The first one has to do with contracts regarding joint fares and tariffs and with the distribution of jointly collected revenues. The second one goes further to coordinating routes and schedules. A full integration of all aspects and services provided by different actors can take place under a transport federation, the name of which has its origins to the German Verkehrsverbund; this is the case of Zürcher Verkehrsverbund (ZVV), which coordinates and contracts transport operators and is responsible for planning, operations and financing.

2.2 Governance and performance

The relationship between organisational form and performance has been the subject of several studies. Most of them look at a specific mode rather than the whole urban transport system and focus mainly on the differences between public and private ownership; they compare a number of transport systems categorising them according to organisational types and use a number of performance indicators to estimate efficiency.

For example, Jain et al (2008) analyse the relationship between ownership structure and technical efficiency by applying Data Envelopment Analysis (DEA). 15 urban rail transit systems are compared and the general conclusion is that privatisation has a positive impact on efficiency. Ownership levels are divided in three categories: private, corporised and public. The inputs are labour – measured either as the total number of staff employed in railway services or as total labour hours –, capital in terms of goods and material such as total rolling stock –measured by the number of train wagons and electric multiple units in service – and line, which is the total length of tracks or the total network length. The outputs are passenger trips and train car kilometres.

Also, Pina and Torres (2001) compared the efficiency of the public or private provision of urban transport services in the area of Catalonia, Spain. The study is using DEA, multiple linear regression and logit and cluster analysis. The results showed that private management of urban transport services is not more efficient than public. The input indicators were fuel/100km, cost/km or cost/traveller and subsidy /traveller. The outputs included productivity indicators such as bus-km/employee and bus-km (year)/bus, service level indicators such as bus-km(year)/inhabitant, quality indicators such as accident rate and frequency and size indicators such as population.

Other applications of DEA to evaluate transport schemes include: Cowie (1999), Viton (1997), Yu (2008) and Chu (1992).

The econometric models used in these studies provide a macroscopic point of view and do not represent the decision making processes that vary among the different governance systems. In order to evaluate the governance of urban transport systems and to explore the impact of changes and of transport policies, we will focus on transport supply and demand decision making processes. The conduction of interviews with the relevant stakeholders will give an insight to the processes leading to decisions about frequency of services, information systems, number of employees, fares etc. Then, the mode choice model will represent the reaction of users to different policies. Finally, performance indicators will be used to reflect a range of impacts on the urban transport system.

A weakness of the aforementioned studies is that they use only a limited number of performance measures. In this project we are particularly interested in performance measures relevant to operational and economic efficiency taking into account their responsiveness to policies to be tested. Performance measures of interest include the following (this is not an exhaustive list):

- Quantity measures such as network coverage area (by mode), number of stations and stops of the entire network and of each commune separately in order to find average and distribution and number of passengers or annual number of trips.
- System and network performance measures such as intensity of network service and labour efficiency or productivity of different modes.
- Transportation work measures, which is the number of transported objects multiplied by the distance over which the objects are carried, such as annual vehicle km, annual space km and annual passengers.
- Efficiency indicators such as vehicle-km/vehicle per year, passengers/vehicle-km per year, number of total or operating employees per year to measure efficiency of labour use or labour productivity, vehicle-km/KWh to measure technical energy efficiency of a vehicle depending on technology, design, performance, operation etc., space-km/KWh to measure energy efficiency of service, passenger-km/KWh to measure actual energy efficiency of utilized service or performed work, revenue per seat-km or vehicle-km, revenue per vehicle-hour or train-hour.
- Consumption rate measures (the reverse of efficiency ratio, given by the ratio of resource quantity expended over output quantity produced such as energy consumption, average cost per trip and cost of service per unit.

3 Case study

The Zurich case was chosen because of the potentials of transport federations as organisational structures and because it can demonstrate very interesting interactions and distribution of roles among the involved actors.

The Zurich transport system is governed by the ZVV transport federation since 1990. ZVV is a public authority under the governance of the Canton of Zurich. It is operating as a holding company as it fully finances the 8 transport companies (Figure 1) and the transport system in the area. Around 60%

of the financing comes from revenues (around 90% of the revenues are from tickets and the rest from advertisements in stations etc.). The rest (i.e. the deficit) comes from the canton and the municipalities: 50% from the canton and 50% from the municipalities. The municipalities' contribution is based 20% on the commune's financial strength and 80% on the level of service offered. The latter is calculated by multiplying the number of departures of a mode of transport from each commune by a predetermined value index. If the municipalities want to increase or intensify transport services they have to increase their contribution (ZVV, 2010).

Figure 1: The eight transport companies in the canton of Zurich

ZVV is the coordinator of the transport system and not actively involved in the implementation of policies. As ZVV fully finances the system, the operators are not driven by profit. The income of companies and operators is determined by contracts but companies have control on their revenues, e.g. when they sub-contract transport operators.

In 2010 51 transport companies were involved in the operations of the Zurich transport system: the 8 transport companies responsible for the 8 areas in which the canton of Zurich is divided, 11 major transport companies and 32 transport operators (ZVV, 2010). 3880 people were employed in the Zurich transport system, excluding the SBB personnel. There were 391 lines out of which 28 S-Bahn lines, 9 S-Bahn nightlines, 13 Tramlines, 7 connections by boat, 4 mountain rails and 330 bus lines including 47 night-bus lines. The length of the network was 4080 km out of which 800 km is the length of the network of night services. There were 2685 stops and stations out of which 210 in areas

out of the borders of the Canton of Zurich. From the 1281 vehicles in total, 732 were tire vehicles, 260 trams, 256 railways (trains), 25 boats and 8 mountain trains. Finally, there were 140 staffed ticket sale-points out of which 3 in areas out of the borders of the Canton of Zurich and approximately 1600 automatic ticket machines; in most cases of regional buses, tickets were also sold by the bus drivers (ZVV, 2010).

4 Conceptual approach

The urban transport system will be analysed through the relationships between the following agents:

- The transport authority, which coordinates and contracts transport companies and in the case of Zurich also finances the system
- The public authorities including central and regional government, and municipalities
- The transport companies, which manage and operate parts of the transport system
- The transport operators, which run the everyday operations of the transport network
- The users, i.e. the passengers of the transport system

For the Zurich case the main agents involved in the urban transport system are the following:

- ZVV
- Canton of Zurich
- 171 communes plus the communes from the surrounding cantons that participate in ZVV
- 8 transport companies
- Transport operators
- Passengers/users

The key relationships to focus on are those between:

- The transport authority and the transport companies and operators
- The transport authority and the public authorities
- The transport companies and operators and users

The relationships between the agents of the urban transport systems will be represented in terms of money, information and travel flows. In Figure 2 money flows among the main actors are represented. ZVV is collecting the money from tickets, public authorities and other sources and is financing the transport system by contracting transport companies and operators. In some cases the transport companies are subcontracting transport operators.

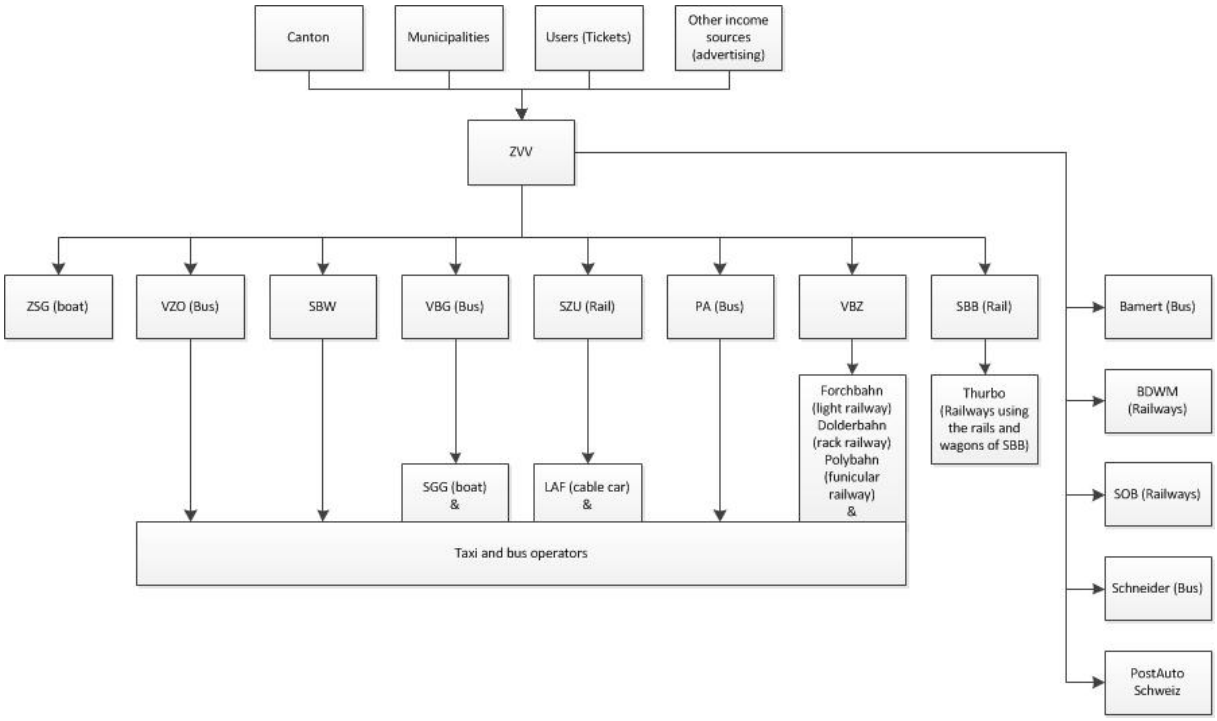

Figure 2: Financial flows in the Zurich transport system (reproduced from a diagram by ZVV)

The relationships between the agents and the impacts on performance are outlined in Figure 3 providing a comprehensive representation of the urban transport system including issues relevant to the operation of the transport network and to modal choices. ICT are included as a means of improving information about the network (impact on attractiveness of the public transport system). ICT's impact onthe level of participation of users in decision making will be explored in the context of the discussion with the relevant stakeholders.

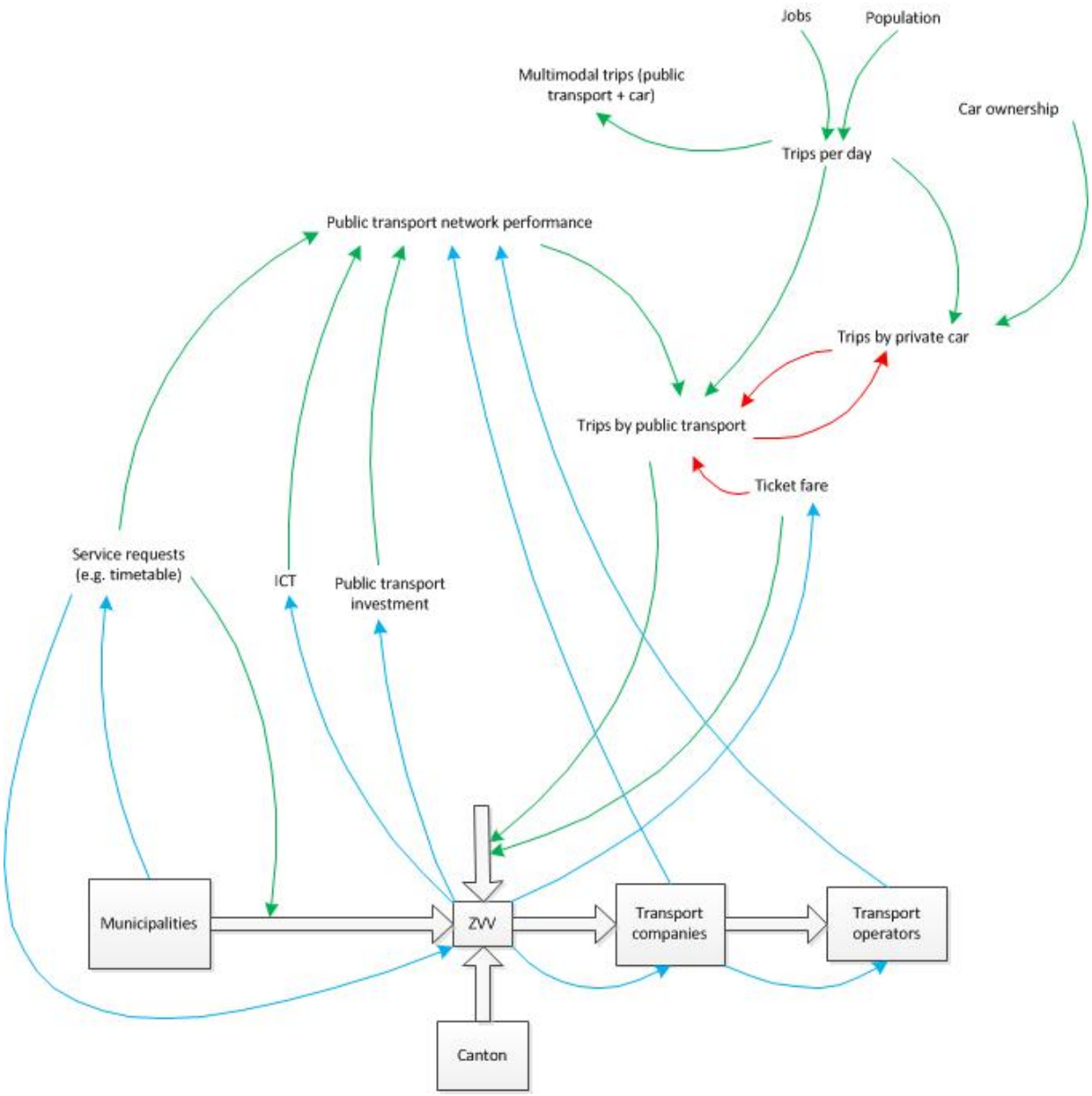

Figure 3: Interactions in the Zurich transport system

At the lower part of the diagram, in boxes, all the agents of the urban transport system but the users are shown. Transport companies and operators cover transport supply. Municipalities can affect performance, i.e. travel time, accessibility, service frequency etc., through timetable-related requests to ZVV, but this will affect the municipalities' economic contribution. Transport companies are the ones who actually implement any timetable related requests made by the municipalities.

The two-dimensioned arrows represent money flows and the rest interactions. The arrows from and to the boxes (light blue) represent information flows from and to the actors of the transport system. Green arrows represent positive impact and red arrows negative.

In Figure 4 the impact on travel time (as a measure of operational performance) is represented in more detail. Total travel time is broken down to: on-vehicle time, waiting time, transfer time and total number of transfers in order to make the relationship to municipalities and ICT clearer.

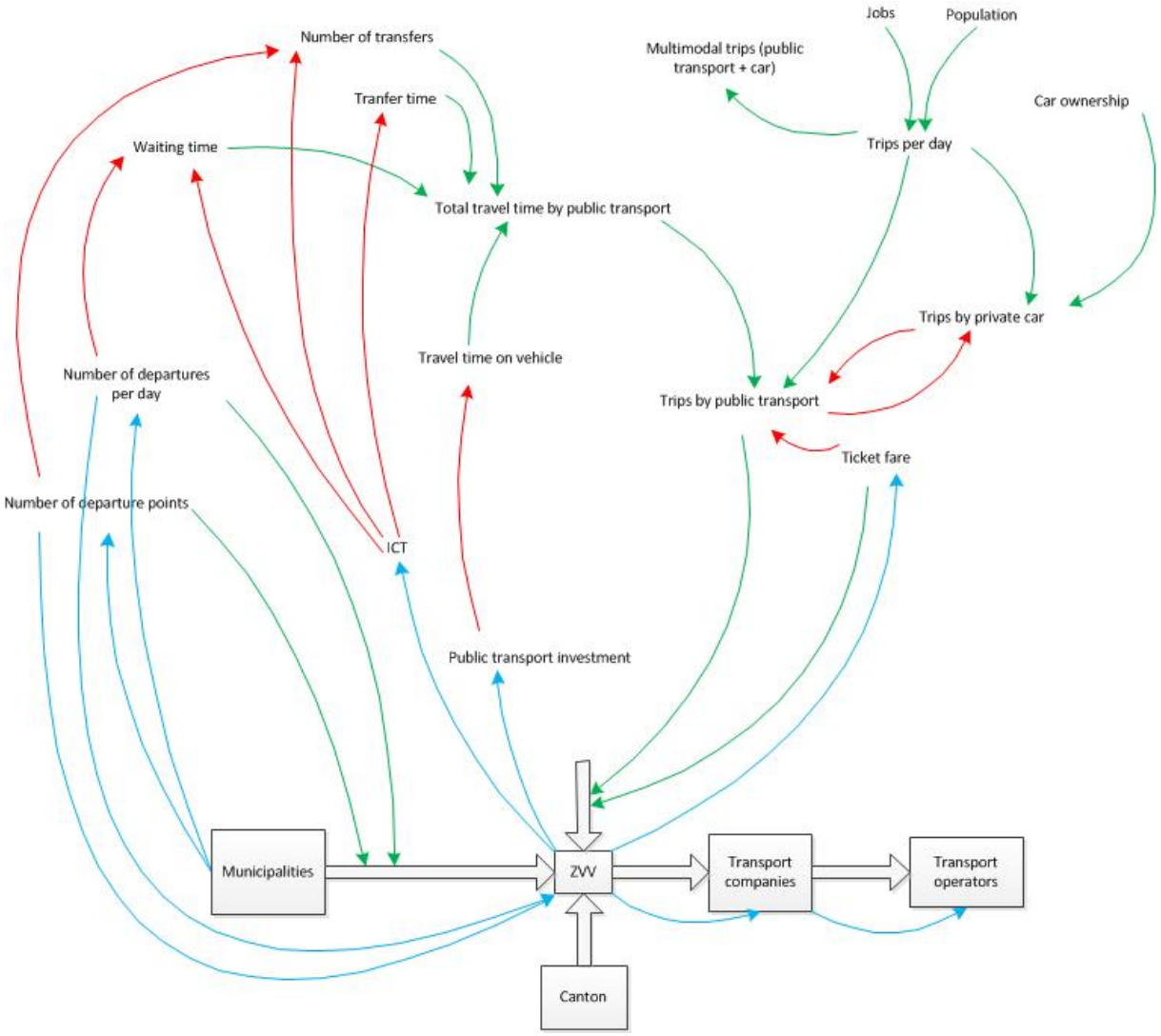

Figure 4: Interactions in the Zurich transport system-travel time processes

One important link not represented in the diagrams above is the one between municipalities and population and jobs: People as residents are paying taxes to the commune and contribute to its economic strength, which is taken into account in the calculation of the commune's contribution to cover the deficit. However, the issue is beyond the scopes of the next stages of this project.

The complex processes relevant to modal choice are represented in Figure 5 where the focus is on the attractiveness of public and private transport and on the interactions among the factors affecting the choice between private and public transport modes.

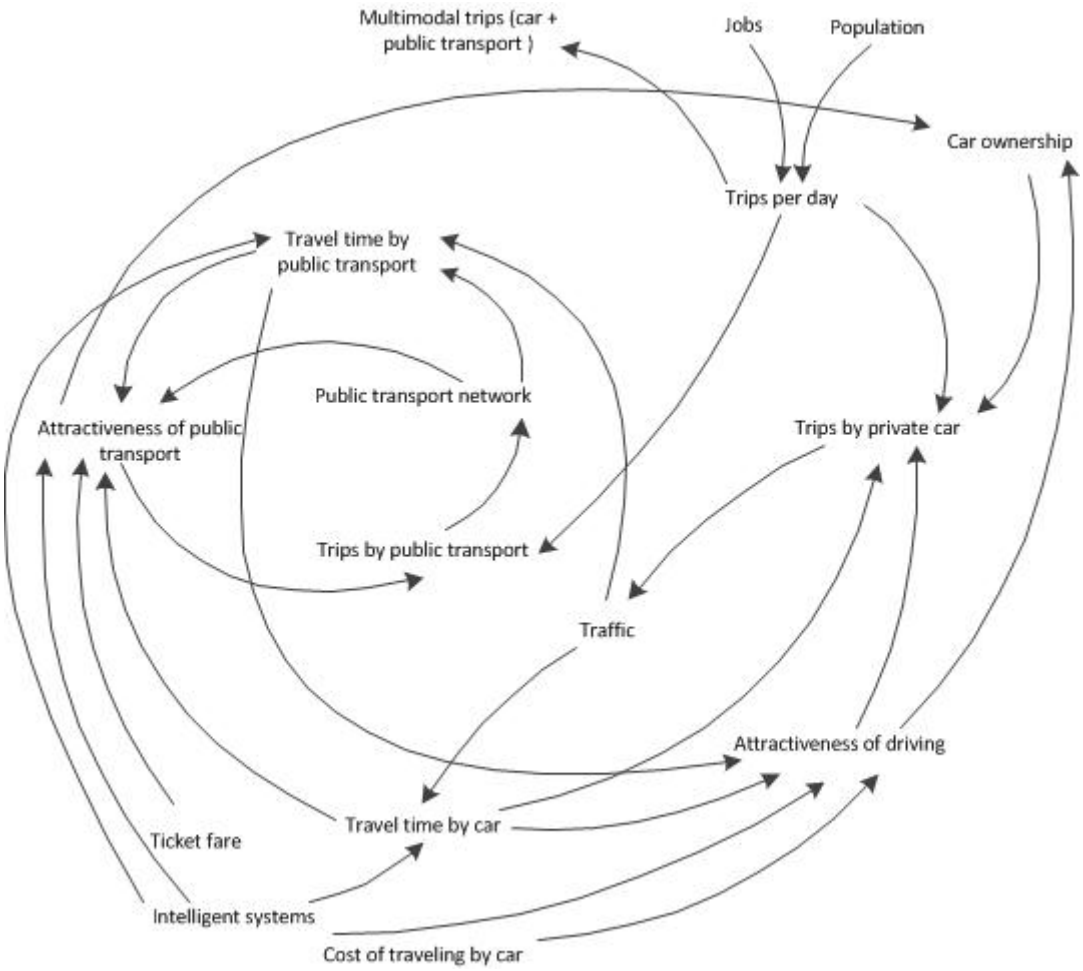

Figure 5: Mode choice decisions

5 Methods

Urban transport governance will be analysed by exploring the decision making processes of the main agents of the urban transport system, focusing on the interactions between transport demand and supply. Demand will be represented by the choices of mode of transport and supply through decisions relevant to the provision of public transport services. Finally, the impacts of transport policies on performance measures will be estimated.

The general structure of the procedure to test the impacts of changes on transport supply will be the following:

1. Determine policy change (including introduction of ICT services)
2. Identify which factors of the attractiveness of public and private transport are expected to be affected by the policy change
3. Estimate the impact on mode choice (increase-decrease of public transport use)
4. Estimate the impact on performance measures

Transport supply-related issues as well as the relationships (i.e. governance system) between the main actors of the urban transport system will be explored through the conduction of interviews

with the relevant stakeholders. More specifically we are interested in the decision processes regarding the following issues:

- Frequency of service, number of departures
- Improvement of network information through ICT
- Number of employees
- Ticket fare

Then, to analyse transport demand the impact of these issues on modal choice – at first focusing on trips to work – will be modelled. Initially, we aim to apply to the Zurich area an existing mode choice model.

For example, Vrtic et al (2010) estimated a combined route, mode and departure time choice model in the framework of a project analysing the impacts of road pricing on route and mode choice behaviour in Switzerland. The utility functions of the route, mode and departure time choice models are based on the following variables: travel time by car, travel time by public transport, fuel costs, tolls, parking costs, fare, access time, departure time-related variables, road reliability, public transport reliability, car availability, number of tranfers, headway, age, income, other personal characteristics. Also, De Palma and Rochat (2000) estimated a mode choice model for work trips to Geneva using a nested logit approach to consider the effects of car ownership. The main modes are car, bus and streetcar (tram) and the variables of the mode choice nested logit model are the following: comfort, availability, travel time, cost, years using the principal route, cross borders, flexible work hours, duration of daily congestion, frequency of congestion occurrence, frequency of late arrival to work, metro, gender, size of household, children to drop to school, age, occupation, income, non-commuting activities.

6 Summary

The main aim of the project discussed here is the development of a framework to explore, understand and model urban transport governance. In this paper we offer a first view on the conceptual approach of this framework according to which we focus on the relationships between the main actors of the urban transport systems and on the decisions relevant to transport demand and supply in order to model governance based on the Zurich case. We point out the need for an interdisciplinary approach to address the issue comprehensively: the impacts of changes on transport demand will be estimated using a mode choice model and on performance by estimating operational and economic performance indicators, but the policy making processes and the relationships between the main agents of the urban transport system need to be explored following a qualitative approach and by discussing with, and interviewing all the relevant stakeholders. The long term aim is to develop/apply a comprehensive urban model that will take into account the temporal and spatial factors of changes.

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