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Organizing the multi-modal transport system

Addressing the travel-related and organizational challenges to provide seamless, multi-modal, door-to-door journeys

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Abstract

Multi-modal mobility contributes, among other things, to accessibility and sustainability. New developments in technology, sustainability and public transportation provide opportunities to take multi-modal mobility to the next level. To do so however, one faces both travel-related and organizational challenges. The travel-related challenges relate to providing what is necessary to create an attractive, pleasant and seamless journey from A to B for the traveller, using different modes of transportation. The organizational challenges are more difficult to solve as the organization of multi-modal mobility is generally spread across different organizations and departments with different interests and resources. Two Dutch regions have faced both kinds of challenges and now serve as examples in the field of multi-modal mobility. This paper will focus on how the challenges have been addressed in these two cases to draw lessons for others who want to seize the opportunities that multi-modal mobility has to offer.

Keywords: multi-modal transport system, public transportation, cycling, governance.

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1. Introduction

Urban areas are urgently exploring solutions to pressing urban problems they face such as accessibility, environmental impacts and lack of spatial capacity. Cities are becoming more attractive as a place to live and for companies to establish themselves. They are incubators for economic growth and activity and thus contain the majority of spatial development. Accessibility is a precondition to maintaining economic viability in urban areas (Van Eck, 2011). Therefore, policy makers aim to design mobility systems that are robust and prepared for increasing mobility demands, while decreasing emissions and retaining accessibility to the city long-term. Innovative solutions are required to expand travel possibilities while preventing increasing spatial pressure.

To an increasing extent, urban areas are the economic cores while rural areas face economic decay. Rural areas have to deal with population decline or stagnation and as a result, facilities are forced to close or move to urban areas. Accessibility is therefore not only relevant for urban areas and their citizens. Even more so, rural areas have accessibility demands for their population to travel back and forth to urban centres (Verwest, van Dam & Daalhuizen, 2010). Because of this, the relation between urban and rural areas deserves close attention when designing mobility systems.

Aside from growing disparities between urban and rural areas, other developments influence our perspective on mobility. There is a shift in the identity of modalities as we know them. Traditional public transport (bus/train) used to be the solution to guarantee accessibility to and from rural villages. In contemporary society, public transport is primarily relevant when used for connecting places at a larger distance. Considering cycling, we see that this mode can now bridge distances up to 20 kilometres, which has been induced by the advent of e-bikes. Furthermore, the sharing economy is growing which results in the establishment of car and bicycle sharing schemes. We see that travellers attach value to mobility, rather than possessing a single form of mobility. Usage is becoming more important than possession.

The contemporary arrival and exponential growth of sharing concepts is not coincidental. Developments in information technologies (IT) provide an increasing number of opportunities for mobility. The *Internet of Things* and real-time travel information contests our old-fashioned approach to planning for accessibility. Among these are, besides bicycle and car sharing concepts, electronic lockers at stations and integrated information, booking and payment systems. Moreover, innovative concepts such as Mobility as a Service (MaaS) are developed on the premises of the sharing economy in coordination with digital facilities. Finally, IT also offers possibilities with regard to influencing travel behaviour through which we can encourage the traveller to adjust his/her travel plan to the desired trip.

1.1. Multi-modal mobility

Multi-modal mobility is a viable solution for urban challenges. It enables the employment of (financial) resources more efficiently as every transport mode is employed for the purpose it serves best. Moreover, it offers opportunities for accessibility as it offers alternatives to exclusively traveling by car. On one hand this creates new travel opportunities, on the other, multi-modal mobility results in fewer people traveling by car and this releases pressure from the road network and improves the traffic flow. This is beneficial for both accessibility and the environment. Furthermore, when the number of cars decreases in the city it is possible to reallocate valuable public space. Parking lots can be assigned to new land uses which can contribute to the city's spatial quality and liveability (CROW, 2013c).

Also for rural areas multi-modal mobility offers a solution for accessibility issues. As public transport operators are forced to stretch their lines to warrant a profitable business case, the average distance to a stop is increased. When the chain of modalities is connected smoothly, the traveller originating from a rural area is still offered a full trip from A to B. Moreover, stretched lines with fewer stops in combination with proficient access and egress transport are more attractive than the outdated connections with numerous turns and stops. This ensures mobility for rural citizens and accessibility to facilities.

The combination of the trends described above, give rise to new approaches to mobility systems and the way they should be organized. Together they offer the opportunity to drastically transform mobility systems and seize the opportunities that multi-modal mobility has to offer. When speaking of multi-modal mobility, this refers to using multiple modes of transport to complete the journey between A and B. A multi-modal trip could for instance include the use of public transport as well as cycling.

In the Netherlands, a growth of cycling in access and egress transport to and from train stations has been witnessed

in the past years as shown in figure 1. It has become apparent that combining the bicycle and train is a viable and attractive solution to travellers. To encourage the growth of multi-modal trips, we have to design a multi-modal transport system in which the various modes of transport are synchronized to an optimum situation through offering quick and convenient transfer opportunities (Van Eck, 2011). Multi-modal mobility itself is not an innovative concept. People in the Netherlands have already been cycling to (and from) train stations for years. Also, park and ride concepts have been embedded at city borders. At such locations, travellers switch from car to bus to reach their destination within the city.

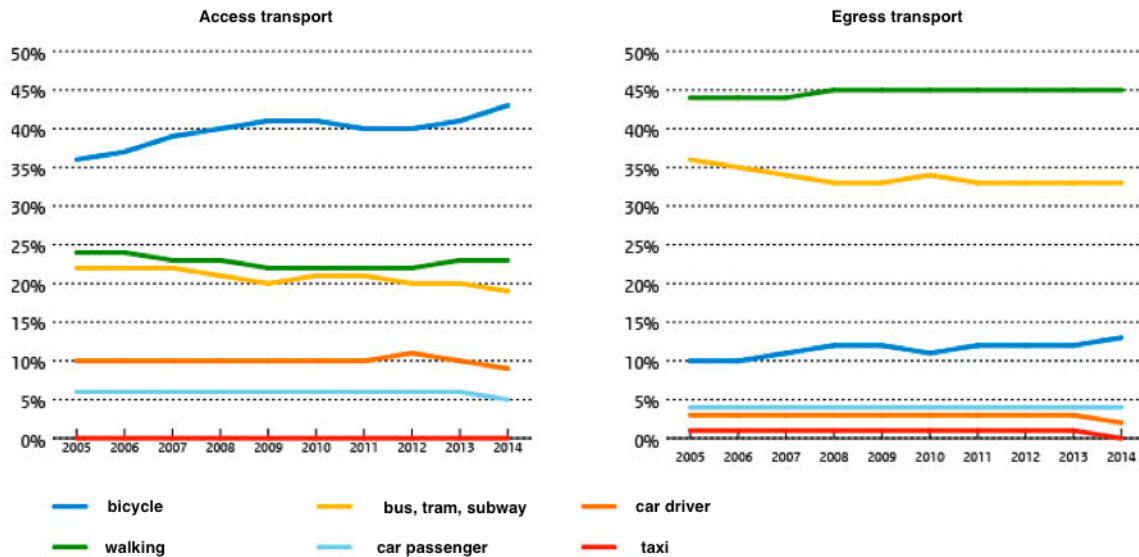


Fig. 1 Cycling to and from train stations in access and egress transport (Knowledge Institute for Mobility, 2016)

1.2. The innovation

However, planning for multi-modal mobility brings a number of challenges. Guaranteeing an improvement in travel time for example is not the only condition for travellers to prefer multi-modal transport. It is proven that travel experience is equally as important as travel time (Van Hagen & Bron, 2013). The innovative aspect is captured in the organization and planning of an integrated multi-modal transport system on a regional scale that makes optimal use of technological developments to make multi-modal journeys more pleasant, seamless and attractive. This will be expounded on thoroughly in paragraph 2.

In this paper, a method for organizing a multi-modal transport system effectively with support of all stakeholders involved will be presented. To do this, firstly, the multi-modal challenges concerning the travel-related and organizational challenges will be elaborated on. Next, we will illustrate a method that will enable regions to tackle the multi-modal challenge. This method will be explained on the basis of two Dutch example regions. The two regions deal with varying circumstances but strive for comparable goals. The paper concludes with a plea towards the continued implementation of multi-modal transport systems in the future.

2. The multi-modal challenges

2.1. Creating pleasant, seamless multi-modal journeys

The multi-modal chain should be attractive to customers to ensure a shift from car use to multi-modal traveling. Therefore, planners should understand what travellers value during their journey. The Dutch National Railway organization has developed the so-called client's wish pyramid to understand and depict the client's desires, presented in figure 2. This pyramid is based on Maslow's hierarchy of needs and Herzberg's theory of motivation. These theories have been integrated and transformed into travel needs in the client's wish pyramid (van Hagen & Bron, 2013).

Similar to Maslow's initial explanation of the hierarchy, the client's wish pyramid anchor is safety. If the modalities are not safe and the traveller does not feel secure on stops, they will not make the journey. In the high end of Maslow's pyramid, one's recognition for the environment is presented. This is equal to the client's wish pyramid where experience of the built surrounding and ambiance on transfer stops are covered in the pyramid's top. Maslow's line of thought is integrated with Herzberg's two-factor theory of motivation which distinguishes satisfiers from dissatisfiers. For any given activity, dissatisfiers represent the criteria that have to be met to not be dissatisfied with the activity. It equals the expected situation when these criteria are met. Satisfiers are the criteria that can make an experience a positive one. Satisfiers that are fulfilled result in a positive evaluation of the activity. For satisfiers to be fulfilled, all dissatisfiers should be met.

Likewise, the client's wish pyramid allows us to explain the travellers' experience during a journey. It suggests that a traveller also distinguishes dissatisfiers from satisfiers during his/her travel. The dissatisfiers, represented in the base of the pyramid, are the components that equal the travellers' expectations. In case of not meeting the dissatisfiers, the client cannot attach value to the satisfiers. For example, there can be a beautiful bus stop with a lot of facilities (satisfiers). However, if the bus does not show up (dissatisfier), the experience will still be a negative one. The dissatisfiers are reliability, travel time and convenience: the bus should arrive on schedule, a traveller should have a seat and so forth. These are all experienced and influenced during traveling. In other words, completing the trip as the traveller expected to, is crucial for a traveller to be satisfied with the journey.

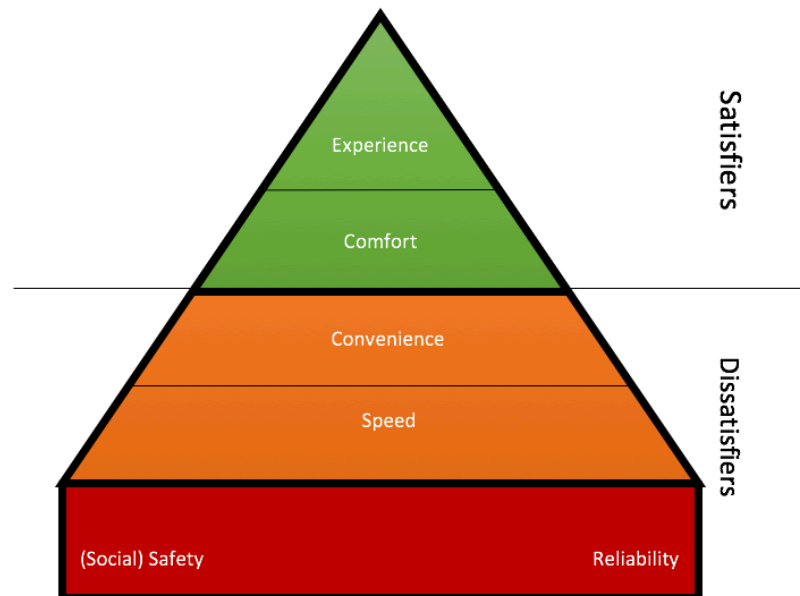


Fig. 2 The Client's wish pyramid (Van Hagen & Bron, 2013)

Once the bottom of the pyramid is positively experienced by a traveller, the top of the pyramid becomes relevant. Comfort and experience (satisfiers) can make the traveller happy about his/her experience and attach extra value to the journey. Important factors are comfort and experience.

Research shows that the transfers are the biggest stress factor for a traveller (van Hagen & Bron, 2013). As people need to switch the next transport mode, they are often afraid to be late. As long as a traveler is stressing about whether or not he/she will be on time for the bus, he/she will not be able to enjoy the comfortable benches and the beautiful surroundings. This example also shows that the client's wish pyramid is applicable in every part of the multi-modal journey: it takes into account both travel and transfers.

2.2. The organization of the multi-modal transport system

A multi-modal transport system is a linked set of modalities. Access and egress transport should be carefully connected to the main transport mode for the traveller to experience a convenient journey. The majority of the chain's elements are already in practice. However, the components are currently not functioning as an integrated system for multiple reasons. First of all, a multi-modal trip tends to cross geographically determined borders as it usually happens on a regional scale rather than inner-city scale. This implies that institutions of different geographic areas are involved, each contributing to a minor part of the trip. These parties all have different policies and their own approach to execution and finance. They may pursue different, possibly contrasting views, on mobility.

Secondly, when planning a multi-modal transport system, several policy disciplines are involved. Some are mobility related and some focus on for example health, social equity and urban planning. Even the mobility-related disciplines might have different policies (cycling, public transportation).

Lastly, public and private institutions are responsible for different sections of the system. Access and egress transport such as bicycle parks or sharing systems are generally a public issue while public transport is executed by private companies. These are the main factors for discontinuity in a multi-modality transport system. Not only from an organizational point of view, but more importantly, the travellers experience the process as a series of unrelated transportation segments rather than a continuous journey, while we have learned from the client's wish pyramid that convenience is an essential factor to be satisfied with the journey.

Questions arise on how the chain of multi-modal mobility should be organized and who should take the lead. This evokes a discussion on governance. Governance refers to a set of styles of governing where the line between public and private institutions are blurred (Stoker, 1998). A governance network is understood to be self-organizing (Klijn, 2005) as stakeholders position themselves strategically towards the others and deliberate about the policy of concern. However, the current multi-modal transport systems do not represent the optimal situation for the traveller. The involved stakeholders do not experience an incentive to strive for an integrated transport system and therefore we could say that self-organization is not desirable. Intervention is necessary: the governance network should be governed. This is also known as *metagovernance* which exceeds the regular concrete governance network (Sorensen & Torfing, 2009). A similar term for metagovernance is network management (Klijn, 2005). Sorensen & Torfing (2009) point to public institutions as the bodies to manage governance networks to ensure its democratic aspects and efficacy. There are different methods to be distinguished to shape the metagovernance (Sorensen, 2006; Sorensen & Torfing, 2009; Thuesen, 2013) as shown in table 1.

Table 1. Types of metagovernance

Type of metagovernance	Relation to involved actors	Key words
Network design	Limited interaction with the governance network	Framing policy and resources; limited interventions
Network framing	Limited interaction with the governance network	Storytelling; strong intervention
Network management	Strong interaction with the governance network	Supporting and facilitating the network; limited intervention
Network participation	Strong interaction with the governance network	Participation in the network; strong intervention

The methods vary in level of public intervention in the self-organizing governance network. Network design and framing are especially relevant in a starting phase where actors are gathered and the base for the network policy is determined. Depending on the network's function, a public institution could decide to increase their participation with the governance network (Sorensen & Torfing, 2009). The governance network's assignment is to determine the level of participation.

Usually, policy issues closely related to the core tasks of the government, such as warranting the rule of law and protecting public health, demand strong interaction (Sorensen & Torfing, 2009). Generally speaking, mobility issues are dealt with by means of fewer interaction and thus network management is required. However, the missing links in a multi-modal transport system might demand a stronger interaction where the public institution responsible for metagovernance is strongly interacting with the network.

3. Facing the challenges in two Dutch regions

The public transport authorities in the Netherlands, responsible for the strategic planning of public transport, realised that the self-organizing element of a multi-modal transport system did not result in a smoothly connected and functional system. An intervention was required to encourage the network of the multi-modal transport system to design an optimal system. Mobycon was consulted to assist two public transport authorities (OV-bureau Groningen-Drenthe and the province of South-Holland) in structuring, organizing and developing the multi-modal transport system in two regions. In these particular cases, the focus was on multi-modal journeys that involve the bicycle and public transport. The public transport authority OV-bureau Groningen-Drenthe is a collaboration of the provinces of Groningen and Drenthe, two sparsely populated provinces in the northeast of the Netherlands with the city of Groningen (± 200.000 inhabitants) as the most important city in the region. The other region is the DAV (or Drechtsteden, Alblasserwaard and Vijfheerenlanden) region. This region is located in the south of the province of South-Holland (which also functions as public transport authority) and consists of a densely populated part (de Drechtsteden) and a sparsely populated part (Alblasserwaard-Vijfheerenlanden). The region borders to the larger cities of Rotterdam and Utrecht. In both regions, the public transport authority took the initiative to seize the opportunities that multi-modal mobility has to offer.

It is logical that the public transport authorities stepped forward to orchestrate multi-modal travel from A to B. First of all because they have an interest in high quality first and last mile solutions to extend the public transportation network and therefore feed public transport. Also, because the scale on which they operate is relatively large compared to municipalities and these public transport authorities have experience in creating an efficient transport network thanks to their experience in public transportation planning. We can conclude that, in the Dutch institutional context, the public transport authority generally is the right party to orchestrate multimodal traveling. The next question is then how a public transport authority should handle this.

To answer this question, it is important to know how public transportation is organized in the Netherlands. Regional public transport in the Netherlands functions according to the franchise model. This means that public transport authorities (provinces or city regions) organize public transportation through public tendering. The delivery of the service is then done by private companies while subsidized by the regional government. This means that the strategic planning is carried out by the regional government while the tactical planning and the operational planning are carried out by the public transport operator. In this model, there is significant freedom of choice for the regional governments. They can decide on the distribution of responsibilities like the responsibility of revenue and the types of transport that are included in the tender (Van de Velde, Eerdman & Westerink, 2010).

In deciding who is responsible for what, there is a tendency between giving space to the market to stimulate innovation and therefore improve the quality of the public transportation and between setting standards that limit the freedom of the market but ensure a certain service level.

4. Approach

4.1. The aim

Although the public transport authority appears to be the right party to orchestrate multi-modal mobility, the challenge to reduce organizational fragmentation remained.

To deal with this organizational fragmentation, it was imperative that all parties were involved during the entire process (from creating a collective vision to implementing measures). The approach had to result in a multi-modal plan by means of determining a common vision and embracing shared interests as a sustainable and accessible region. To begin, a vision has been formulated about the future of multi-modal mobility in the regions. Afterwards, the vision was worked out into concrete measures. An external and independent consultancy firm (Mobycon) coordinated this process to ensure a level playing field.

During the process, the existing organizational structures and processes have been respected to ensure a seamless connection to the existing policies of parties involved and therefore improving the efficiency of the process.

4.2. Formulating a collective vision

The first step in developing a perfectly functioning multi-modal transport system is to formulate a collective vision for each region. Ensuring every stakeholders' participation and contribution to (and therefore their support for) the vision guarantees a process in which stakeholders feel responsible to co-operate and feel the urge to attain the goal. This was guaranteed by using state-of-the art ICT tools and methods that made sure every participant provided input on an equal base. By starting with a vision, the focus was on common interests and stakeholders found that they could all benefit from better multimodal mobility without being faced with the practical obstacles of everyday, as the vision did not entail specific responsibilities.

4.3. Developing the vision and measures

On the basis of the commonly developed vision, the two groups of stakeholders then conceptualized the vision in further detail and devised concrete measures. This was again done without discussing responsibilities and obligations. This step-by-step concretization of how multimodal mobility would be improved in the regions led to a feeling of shared interests, shared goals and shared challenges and this is what made the eventual assigning of responsibilities possible. At the end, stakeholders really wanted to solve challenges together and were more willing to 'pay their share'.

4.4. Implementation plan

The direct result of this process is one '*chain plan*' per region. *Chain* is used to capture the idea of connected modes of transport. Within this implementation plan, all organizational problems are dealt with. The plan accommodates measures to improve the hardware and software and to form co-operation between all the stakeholders. The chain plans and the processes that led to them are more or less the same in the two regions. The same goes for the mapped services and facilities that are necessary to create seamless, pleasant multimodal journeys. However, the results on the organization differ in each region due to the contexts. In the next section, we will describe what we found to be the necessary services and facilities to enable multimodal traveling and in section 6 we will explain how the two regions have organized this.

5. Results

5.1. Travel-related result: services and facilities that enable multi-modal traveling

The result of the first phases, during which a common vision has been developed, is an overview of what the multi-modal transport system should consist of. Figure 3 depicts the chain from start to end in case of a bicycle and public transport chain. In the preparation phase a traveller wants to use one app to plan his/her journey. This includes issues like the availability of bicycles in egress transport. In this same app, the public transport operator provides information on the up-to-date schedule. When the journey starts, all physical infrastructure including bicycle parks should be in place. Then, a traveller passes a transfer point. This transfer point is optimal when it not only facilitates the transfer but also offers multiple facilities such as picking up a package, shopping or Wi-Fi to work during the journey. The public transport trip should be quick, frequent and reliable. After the bus or train trip, the journey proceeds from another hub where bicycle sharing assures the completion of the last mile.

All these facilities should be smoothly connected. The group of stakeholders realized that the delivery of these facilities is reliant on open data management, participation of travellers, residents and companies. Above all, organization of this chain is essential.

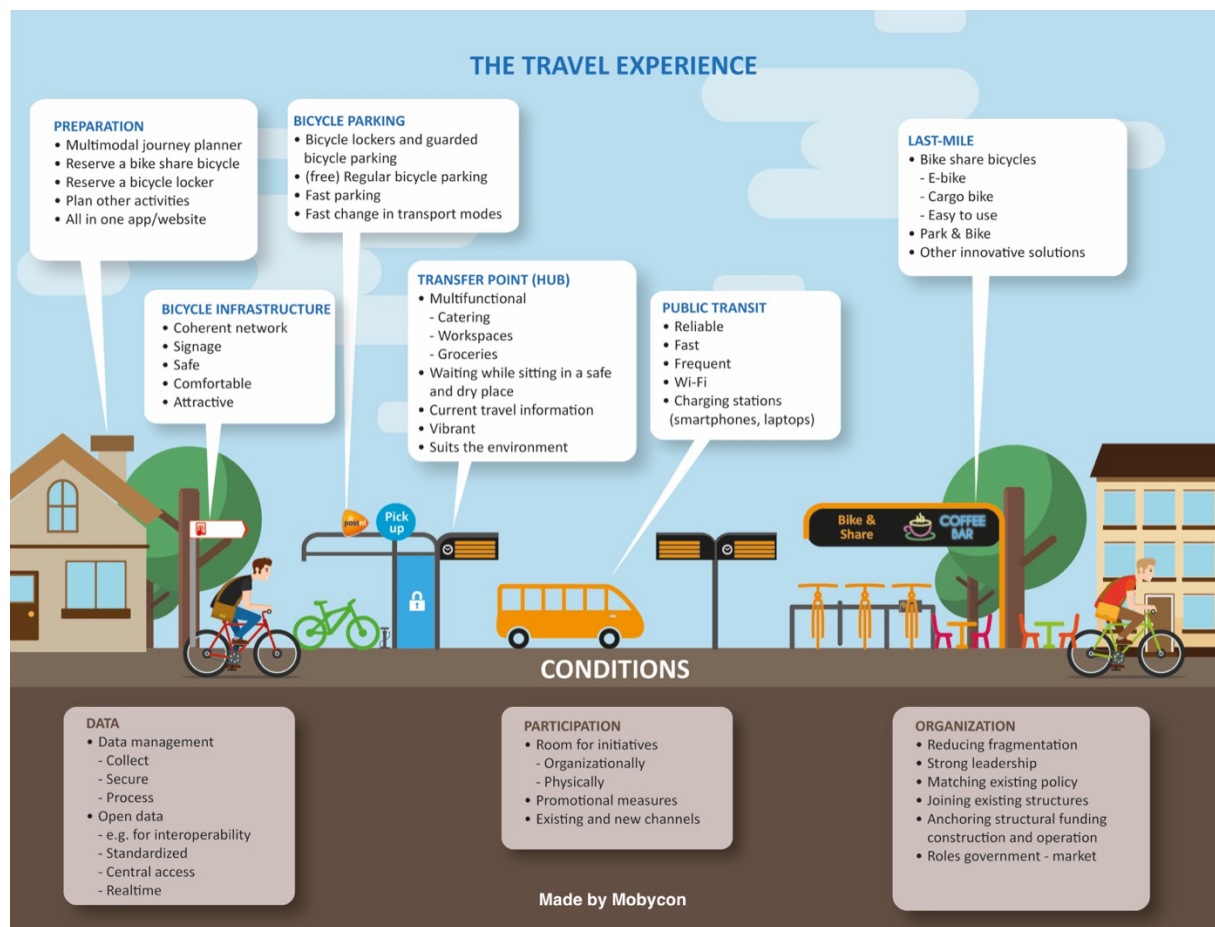


Fig. 3 The multi-modal chain (Mobycon, 2016)

5.2. Organizational result: ending the organizational fragmentation of the multi-modal journey

Both regions have developed a different strategy in optimizing the chain of multi-modal transport. The regions started off with similar objectives but ended up with different working plans due to their unique contexts. Both regions function on the same geographical scale as their public transportation contracts and it is the public transport authority that is taking the lead in improving the multi-modal mobility.

5.2.1. DAV region

The first region to be discussed is the DAV region. This area is situated in the province of South Holland and includes the Drechtsteden, Alblasterwaard and Vijfheerenlanden. The last two are sparsely populated while the Drechtsteden is highly populated. The region is located in the highly populated Randstad that also includes cities like Rotterdam, Amsterdam, The Hague and Utrecht. During the process of developing a chain plan, nine different actors have been part of the discussion, ranging from the province and municipalities to interest organizations like the Dutch cycling federation.

At the moment of writing this paper, the region is preparing a new public transportation tender. This tender not only contains the regional bus transportation, but also a regional train connection. This regional train connection has a past with chain mobility. It is one of the first trains in which people could bring their bicycles for free. The train has designated space to park bicycles. It was a huge success and caused an increase in travellers. However, you could say that the success was too big, as the large number of bicycles in the train eventually caused inconvenience. Therefore, the region is looking for solutions that keep the multimodal journey seamless and attractive whilst not having to park all bicycles in the train. Solutions include the improvement of bicycle parking and bicycle sharing facilities. At the same moment, they want to increase the mobility chain that encompasses the bus by equipping bus stops with the necessary facilities.

The stakeholders in the DAV region believe that the market can provide solutions to the challenges of organizing a multi-modal transport system. Here, the market consists of public transport operators. The new public transport tender incorporates directives for subscribers to include a plan for information provision, bicycle sharing and bicycle parking. 10% of the admitted points to subscribers assessed their plan for supporting multi-modal trips. Basically, they have decided to give a lot of responsibility to the public transport operator and therefore put their trust in these companies' capacity to innovate. The tender has closed on the 14th of September (2017) and the winning public transport operator will be announced in the end of October (2017).

Next to this, the DAV region has assigned '*node directors*' who monitor complementary requirements, developments and coherence at specific nodes. If necessary, they intervene in the area to direct spatial developments. These '*node directors*' are closely related to practice and are therefore capable of offering context specific help.

5.2.2. Groningen – Drenthe

The other case is Groningen – Drenthe. These are two of the northern Dutch provinces and they primarily consist of rural areas. To organize public transport on this scale the two provinces cooperate in the 'public transport office Groningen – Drenthe'. Together with municipalities, the region and a public-private network organization, they have contributed to the development of the chain plan. More than in the previous case, issues in this region focus on maintaining accessibility to facilities (both in the cities and in the rural areas).

In contrast to the DAV region, this region made the decision to keep a lot of responsibility in their tendering model. The region is responsible for the revenue of the public transportation and therefore also for making sure public transportation is attractive and efficient. Their organization of public transportation is also reflected in the organization of multimodal traveling. They decided to give the public transportation operator a minimal role in developing the necessary services and facilities for multimodal traveling as they believed that long term contracts (like the public transport contracts) would not be able to optimally benefit from opportunities that (technological) innovations will bring in the near future.

Instead the region took the lead and appointed a '*chain director*'. His/her responsibility is overseeing and protecting the chain's function. This ensures the prevention of disintegration of the loose parts of the chain. The region is now focussing on improving interchanges (bus stops, park and rides, train stations), Special attention is given to the development of hubs (multimodal nodes in the transportation network). These so-called hubs consist of everything described in section 5, from excellent (multimodal) transportation options and (bicycle) parking facilities to travel information, waiting facilities, hospitality and good cycling and walking infrastructure from and to the hubs. The first four hubs will be finished in 2017 and more than 50 locations have been appointed as future hubs.

One of the hubs that is almost finished is in the village of Zuidhorn. Zuidhorn is a village with approximately 7.000 inhabitants. The village is located on the rail line from the city of Groningen to the city of Leeuwarden (two of the most important cities in the north of the Netherlands). There are buses from Zuidhorn that serve the region as well as a bus to Groningen. The hub also has excellent cycling facilities such as bicycle lockers, regular bicycle parking spaces and a bicycle share system. There are also amenities for people who have to wait at the hub or that want to get a coffee on-route. This example shows that even small villages can become multimodal hubs with excellent facilities. There is an iterative process as a hub with better facilities attracts more travellers and more travellers cause a demand for more services.

Beyond the hubs, the Groningen – Drenthe region seeks collaboration with other parties to develop a common standard for bicycle sharing and a multi-modal travel planning application. They do this on a national scale as multimodal trips do not end at the borders of regions.

6. Imperatives for the future

Traveling by means of a multi-modal transport system is no new approach to moving around. People always look for the most efficient transport route to their ability or to their desires. However, transport system's planners have not applied this line of thought consciously, connecting all the dots for the traveller. In the contemporary society where we face environmental impacts, pressure on spatial capacity and urgency for retaining accessibility: planning for multi-modality is inevitable.

The current IT developments in relation to economic trends of sharing rather than owning a mode of transport emphasize the immediate potential and success of multi-modal transport systems. The emerging concept of Mobility as a Service (MaaS) offers opportunities to easily plan and prepare multi-modal journeys with the use of a single app on your smartphone. However, the success of MaaS depends on the mobility services that are incorporated in these apps. Besides traditional public transport, this concerns privately operated and shared mobility services, such as bike-sharing, ride-sharing and car-sharing. In case of the combination of cycling and public transport, bicycle parking facilities should be included in such an app to inform the traveller about the location, occupation and possibilities to reserve parking spaces. Good organization of the multimodal transport system is therefore essential to enhance the development of MaaS. This provides strong support for investing in the breaking down of barriers between public transport operators and other mobility providers. Geographical, financial and policy borders should be demolished.

From the two Dutch cases, we have learned that, in the Dutch context, public transport authorities are the logical choice when it comes to determining the organization which is best capable to take the lead in planning the multi-modal transport system. The primary reason here is their ability to stretch public transport lines in order to serve a larger area and their capacity to operate on a large scale.

The biggest challenge however remains the organizational functioning of the transport system. The technical abilities are available and not of the biggest concern. Our approach brings together stakeholders and thus interests and budgets and diminishes organizational divisions in the chain. The two case regions are therefore trendsetters in their efficient and effective approach to the multi-modal transport system. They have pointed out that innovation does not only have to be technological, but also organizational as they have succeeded to break down barriers and seize the opportunities that multimodal traveling has to offer in a complex system of differing needs and goals.

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