7. Cities and adoption of innovation in passenger mobility

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1. INTRODUCTION

The central theme of this book is the role of cities in transitions of systems towards higher levels of sustainability. In this chapter the focus will be on passenger mobility, and hence on urban mobility innovations. In most cities mobility is a domain of problems and challenges, regarding congestion, liveability, infrastructures not fitting the urban fabric, loss of economic potential by slow mobility, etc. Urban mobility is also a battleground between different stakeholders, often with conflict between citizens and the economic players in cities.

In a broader sense, the transportation sector has been a problematic domain for the advancement of sustainable development policies. Trends in transport are not encouraging as in most cities in the world motorization and private vehicle dominance are still escalating. Related to globalisation, freight transport, with long supply chains as a driving force, is booming. Transport is now the only economic sector with still growing CO_2 emissions. In response to these developments, cities are pursuing a myriad of sustainable transport policies, which often contain some innovative elements. Goldman and Gorham (2012) identified in their article 'Sustainable Urban Transport' four emerging directions of structural innovations in urban mobility: Liveability, Intelligent Systems Management, New Mobility and City Logistics.

The aim of this chapter is to clarify the conditions under which cities could play a leading role in creating innovations in mobility, and to identify which stakeholders can take the lead in these innovations. Three of the emerging directions of Goldman and Gorham (2012) will be chosen as starting points, as City Logistics is about freight transport, and the focus in this chapter is on passenger transport. For each of remaining directions – Liveability, Intelligent Systems Management and New Mobility – a number of innovations will be introduced and discussed, with a specific focus on the question what created the initial innovation. Many mobility innovations started in cities. Which conditions in the cities where the innovation has been created or initiated – physical, social, institutional – could be considered as crucial? The

conditions concerned may hold true for the creation of new innovations or initiatives to adopt existing innovations in urban mobility. Cities do not have to create or initiate innovations by themselves, as they can also learn and adopt strategies and policies from other cities in a process of diffusion. Innovations in urban mobility are travelling throughout the world of cities, with some cities being better able to pick up, and extend innovations, than other cities. We will also look at elements that are crucial for appropriate learning and introducing urban mobility innovations in practice. With regard to the methodology in this chapter, we will focus on a few important innovations in each of the three directions. In total, we present 16 innovations in mobility including a narrative of the innovation, concluding with experiences with innovation projects and literature studies. The analysis of the three directions also pays attention to their position in time.

The direction of Liveability found its beginning in the late sixties, when citizens took initiatives to diminish the dominance of private vehicle motorization in urban policies in most cities in the developed world. We will briefly introduce pedestrianism, traffic restraint precincts, traffic calming, cycling strategies and shared space concepts in this chapter. Intelligent Systems Management, taking off in the late eighties and early nineties of the last century, is essentially about systems for public transport, and about managing car traffic flows. We will briefly look at congestion charging schemes, but focus on the introduction of Bus Rapid Transit Systems over the world. What patterns of diffusion could be noticed, and which cities succeeded or failed? And finally, New Mobility is a recent area of innovation, focussing on IT-solutions for urban mobility, mainly for the public transport functions of private vehicles, related to the sharing economy, and on smart mobility in relation to data and smart cities.

Adjacent to the practice-oriented narratives, three theoretical themes or concepts related to innovation in urban mobility, will be introduced shortly. Path dependence theory is helpful in explaining why cities sometimes fail to initiate or even to adopt innovations. We will look at the concept of smart cities and its relation to urban mobility, and we will put the narratives of the innovations in urban mobility into perspective by introducing a debate on innovation capacity of cities in general.

A whole range of transport systems have taken off in numerous cities worldwide. A short overview of these systems plus their introduction date is offered in Hidalgo and Zeng (2013). A first mobility innovation was the creation of the metro system in London, UK, starting in 1869. Now some 200 cities over the world have metro systems. In 1951, the first car free zone was created in Rotterdam, the Netherlands. Now some 400 cities over the world have (completely) car free zones. Portland, Oregon (US) redesigned its downtown core to create

space for slower modes, in 1971, and now some 450 cities have applied some sort of redesign. In 1974, Bus Rapid Transit (BRT) was introduced in Curitiba, Brazil, and now over 200 cities have BRT networks. Car sharing schemes have been initiated in 1000 cities, the first one in Zurich, Switzerland, in 1948, but wider scale adoption had to wait until three decades later. Smart cards for urban mobility (now available in 300 cities) were introduced in 1992, by Oulu, Finland, and low-emission zones (now in more than 200 cities) started their development in Tokyo, Japan, in 2003, etc. All these systems, originated in a large spectrum of cities over four continents, found their ways over the globe. In urban mobility, innovations in transport concepts or in infrastructural orientation spread along networks and institutions. Cities differ in their capacities to adopt innovations and new approaches. For most cities innovations originate from learning instead of from their own original initiatives, making learning capacity an important asset of cities.

2. INNOVATIONS IN LIVEABILITY AND URBAN MOBILITY

In the late 1960s and early 1970s urban citizens began to react to the private car motorization oriented strategic plans of many cities and articulated a new approach towards urban centres. A new term was coined, the "liveability" of the city. Liveability can be defined as "the sum of factors that add up to a community's quality of life – including the built and natural environments; economic prosperity; social stability and equity; educational opportunity; and cultural, entertainment and leisure possibilities. Liveability is in essence a political term." (Jeekel et al. 2015, p. 7). Related to urban mobility, liveability is about giving all households access to a socially inclusive and sustainable transport system.

A few themes could be noticed in these citizen approaches. The first was pedestrianization. Pedestrian zones were created, often after political fights at the local level, and following the first initiative in the mid-1950s by the Dutch city of Rotterdam, with its shopping street Lijnbaan. Another theme arose from public outrage over the very high number of traffic accidents in the early 1970s. Most of these accidents were car–related, as private car mobility reached its take-off in urban areas in the developed world in the late 1960s. In some cities, a movement for traffic calming started, resulting in policy measures, but also in redesigning public spaces towards less car orientation. In the Dutch city of Delft a concept, called *woonerven* (traffic restraint precincts), was introduced. This was the start for a whole spectrum of urban design measures in European cities, all aimed at slowing down the dominant transport

mode, the private car. This "slow-street movement" found its way into policy circles during the 1980s through the application of traffic calming principles to inner-city highways in smaller Danish and German towns. There was also a redesign of urban arterials in area-wide schemes, mostly in Germany and France (Jeekel et al. 2015, p. 5). Parking was also a theme in liveability. The banning of cars from some streets, returning these streets to residents made it necessary from the early 1970s to build parking facilities at a greater scale. Paid parking was being introduced, and in this first round of parking policy, the focus was still on accommodating traffic, and not on managing and guiding the flow of car traffic.

All three themes, pedestrian zones, traffic calming areas, and parking accommodation were defined and designed as separated infrastructures and spaces. A newer concept, Shared Space, contests these "stand alone – infrastructures" (Karndacharuk et al. 2014). In Shared Space there is no street-space allocation for the exclusive use of one transport mode: all modes (from cars to walking) should be able to use the same street-space. The Dutch traffic engineer Hans Monderman developed this idea from the traffic calming design and was able to create a shared space in the Dutch city of Drachten in 1998. Shared Space, as a concept, could be seen as an extension of the work of Jane Jacobs. In her book The Life and Death of Great American Cities (1961) she explained that cities should be built on a human scale, which she argued is essential for the cohesion in urban societies.

In general, these innovations originated initially in the seventies of the last century, in a few European cities. The concepts did diffuse, with other cities adopting the innovations. What were the characteristics of these initiating cities? Or better, what were the "incubation environments" (Jeekel et al. 2015)? The initiators were almost always citizen movements in cities, consisting of highly–educated younger professionals, in the Netherlands, Denmark, Sweden, Germany or Switzerland, often in cities which are university towns. From cities like Karlsruhe, Freiburg, Basel, Zurich, Odense, Copenhagen, Delft, Lund and Amsterdam these innovations found their way to other cities in Europe.

During the 1980s and the early 1990 some new developments could be noted. At first, public policy circles integrated the innovations and measures like pedestrianization, traffic calming and parking policy in their planning and investment strategies. A network of active cities, the Polis network, was created in 1989 by city governments throughout Europe with the aim to establish a platform for cities and regions for innovative transport solutions. Secondly, cycling, often marginalised in cities since the sixties, found a second life in the eighties. New cycling infrastructure was created, and cycling was seen as fitting in with more sustainable urban mobility practices. Thirdly, the frame broadened, from relatively separate themes to integrated

approaches for managing mobility in cities. In 1999, the European Platform on Mobility Management (EPOMM) was created, and this marked the start of a paradigm shift, from accommodating traffic to managing mobility.

Cities that were active in the first period (1965-1985) as initiators, mostly remained active in this second phase (1985-2005), and more cities adopted the innovations. Important in this respect has been the European Commission, sponsoring several Europe-wide interurban programmes, of which CIVITAS was the best known. In this second phase, initiatives were more taken by municipalities and less by citizen groups. While the role of citizens groups remained important, national governments were often less supportive than the EU, and the role of private partners, enterprises and companies, was virtually non-existent.

In the last decade, the liveability agenda on urban mobility has started to merge with the sustainability agenda, stemming from the climate change movements. Mobility management has broadened in scope, to include sustainability targets. Parking policies were renewed in the last decade (Mingardo et al. 2015). In parking policy 2.0 the focus is no longer on accommodating all cars, but on managing private car utilization using parking capacity. An influential report published in 2011 by the Institute for Transportation and Development Policy (ITDP), a New York based not-for-profit policy and program centre, presented an overview of parking practices in European cities, which were often designed to comply with air quality or greenhouse gas targets. Instrumental, but still contested, in this respect are also the Low Emission Zones – areas in cities where specific types of vehicles should be banned. The agenda has also broadened in a geographical sense: outside Europe an enthusiasm for elements from this agenda can be seen, at first in Canadian cities, in university towns in the U.S. and Oceania, and more recently also in the developing world.

3. INNOVATIONS IN INTELLIGENT SYSTEM MANAGEMENT, WITH A FOCUS ON BUS RAPID TRANSIT (BRT)

In Goldmann and Gorham (2012), the direction of Intelligent System Management is related to three innovations, namely, congestion charging, automated traffic enforcement and comprehensive bus system management. BRT systems also fall under this heading, and this chapter's content will concentrate on the BRT narrative. BRT systems can be considered real innovations in the environments where they were originally introduced, the big cities in the Global South. What the four innovations have in common is their systemic approach. Each acts

on the level of (a part) of the urban system, and tries to influence the working of (that part of) this system.

First a few remarks about automated traffic enforcement and congestion charging. Traditional traffic enforcement needs a large commitment from police and justice while the newer technologies of camera-based enforcement of speed limits, red lights, jointly with license plate recognition were created to reduce operational costs for these institutions. Congesting charging finds its basis in these techniques, but there is a mismatch between theory and practice. On the one hand there is a complete library of academic literature on congestion charging, but on the other hand, there are only a few functioning congestion charging schemes in practice. For two functioning systems, the London City scheme and the Stockholm scheme, the real innovation has been the introduction of an unpopular measure at such a great scale, in a time period where many efforts on congestion charging failed (e.g. the Netherlands, the city of Edinburgh).

Investments in public transport have been increasing in most cities over the last decade, indicating some shift away from the primary investment in road infrastructure systems, and leading to greater transit infrastructures (data in Newman and Kennworthy 2015, p. 36). Although public buses predate the automobile, one of the important newer public transport domains is bus public transport. Comprehensive bus management is a relatively new phenomenon; in many cities the bus system is now managed as a comprehensive integrated system, combining the different parts of the system; the stops, the information, time tabling, ticketing, bus infrastructure, and bus design in one philosophy.

The concept of Bus Rapid Transit (BRT) originated in Curitiba, a big Brazilian city, in 1974. BRT can be described as "a high–quality bus-based transit system that delivers fast, comfortable, and cost–effective urban mobility through the process of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service." (Hensher and Golob 2008, p.502). The key continent for BRT is Latin America. After Curitiba a BRT was created in Bogota, and this BRT–system, the *Transmillenio*, became a landmark. BRT can contain many passengers, for example, the main trunk corridor in Bogota has a peak maximum ridership of 35.000 trips per hour, one way, with a bus spacing of 3 minutes maximum at peak hours, average station dwell times of 25 seconds and articulated buses having a carrying capacity of 160 passengers and off-vehicle smart card payment (Hensher and Golob 2008, p. 502). BRT characteristics however vary depending on the conditions of the cities where the systems are implemented, but essential to BRT is the provision of segregated busways over de majority length of the systems' trunk. After Curitiba and Bogota,

dissemination went quickly in Latin America,.(Cervero 2013). In Latin America, a network of cities seems to have emerged that is willing to learn and exchange innovative BRT solutions. Of the 157 BRT systems that were in existence in **(year??),** 88 are in the Global South, other ones are in South East Asia, China and Africa.

Two elements should be noted here. The first are the differences between the BRT systems. There are *full* BRT systems, with metro-quality services, integrated networks, very frequent service, and there are BRT *light* systems, having some free busways, but not a complete comprehensive system. The capacity shows a great difference. As Pojani and Stead (2015) mention, full BRT systems can take up to 45,000 passengers per hour in one direction, while light BRT systems serve up to around 13,000 passengers. The second element is about the role BRT systems play. In most cities in the developing countries the starting situation on public transport was as follows. Public transport was mostly primarily paratransit: small buses and minivans operated by many local entrepreneurs, without time tables and route scheduling, plus (sometimes) some metro lines. Here the creation of a BRT system was the paradigmatic change. BRT systems did become the backbone of public transport services in around 100 major cities. We will concentrate on these BRT systems, as the major innovation on mobility in many cities of the Global South. Who were the initiators? And what has been the development on BRT systems in the last decades? What were important conditions for innovation?

Whereas in most cities in the Global South BRT is the central system, often originating from situations where informal paratransit was the norm for public transport, in many cities in OECD countries BRTs are adjacent to already existing urban rail systems and metro systems, and play a smaller role. BRT systems can be seen as an innovation in public transport originating from the Global South. A few reasons for this start in cities in the Global South should be noted. Essential to BRT is that these systems can be created in only a few years. Not much new infrastructure is needed; most of the roads exist and usually only the stations have to be built. Charismatic and visionary leadership is needed, often in the form of directly chosen mayors (see Davila 2009, for India, see Ponnaluri 2011). Leaders have been successful in promoting and completing first phases of BRT projects within their terms in office (Hidalgo and Gutiérrez 2013). When such a first phase is a success, the reputation of the systems leads to following phases, often also on the ticket of the same mayors. And the successes of the early initiators – Curitiba, Bogota, Mexico City, Ahmedabad, Guangzhou - helped decision makers in other

developing countries to present BRT concepts. Essential also is the lower cost of BRT systems. BRTs represent a far cheaper option than light rail or metro systems (Cervero 2013, p. 25).

Political dynamics work towards BRT systems in the developing world; many roads were built in the 1960s and 1970s, particularly in Latin America, and in many Asian countries, but the number of households with cars was, then, still rather low. Mayors were directly chosen by the electorate, that mostly did not own cars. Bringing the use of the roads back to the majority of the households, by offering superior public transport, was then an accepted and even welcomed message.

BRT systems need to be embedded in day to day working structures, particularly that only BRT-buses be allowed to use the infrastructure as necessary. In countries where reinforcing the road usage laws is lacking, BRT systems can fail, as Sengers (2016) shows in his thesis on Transport in Thailand. The Bangkok BRT failed because the segregated busways were used, from day one, by all paratransit modes and most of the motorcycles.

More important even is the structure of governance of BRT systems. This structure is probably the greatest innovation stemming from BRT. In most cities of the developing world many informal smaller bus and paratransit operators exist. A main concern for the creators of BRT systems has often been to accommodate these operators. A basic goal was to try to turn informal operators to professional bus companies. Two roles can be distinguished in the set-up of this systemic change. The first is the planning, designing and controlling the system, and the user information. This role is in most BRT systems in the hands of a public authority. The second is operating the system. For this role governments have often created a public agency to bid out contracts to operate the service and the fare collection technology. In Bogota 13 concessions were made, and won, initially by five investor groups, with the goal to integrate and change the informal bus operators to professional bus service providers partly succeeding.

Paget-Seekins (2015) tried to put this governance model for BRT into perspective in BRT as a neoliberal contradiction. On the one hand the governance acts like neoliberal, with contracting a public service to private companies. On the other hand, the bidding process does not take place in a free market, as first and foremost existing operators can present bids. In many cities the BRT systems work with this division in authority between planning and controlling on the one hand, and operating day-to-day services on the other. However; there is some variation. For example, in India there are many publicly owned bus companies, whereas in Johannesburg the BRT operators were selected from the informal public transport sector, initially working with minibuses. Taking into account this variation, on a generic level the innovation, as formulated by Hidalgo and Gutiérrez (2013, p. 12) stands: '*BRT implementation*

has facilitated the evolution of several developing cities from unregulated private operations to more organized forms of public transport provision with well-defined contracts, with adequate assignments of responsibilities, revenues and risks'. More politically in a way, BRT can be seen as 'a technology transfer between countries in the Global South' (Paget-Seekins 2015, p. 119). BRT means priority for the bus over the private automobile, which can be seen as a more democratic allocation of public space, especially when the routes for BRT are taken from the roads for car traffic. However, there are some negative points to be mentioned: several BRT systems suffer from problems, inherent to their design (Hidalgo and Gutiérrez 2013) including rushed implementation, very high occupancy rates, early deterioration of infrastructures, delayed implementation of the collection systems and too tight financial planning.

Also, it can be argued that BRT systems have mostly not been very successful in helping cities as a whole to become more sustainable. As the sustainability of the BRT- systems *sensu stricto* is mostly acknowledged, the situation that BRT – systems are being designed primarily by the singular objective of enhancing mobility, made them fail to be fully helpful in promoting more sustainable patterns of urban growth. More thought needs to be given to locating the stations, taken into account perspectives of value capturing and densification. As Cervero (2013, p. 30-31) writes, empirical evidence on BRT's shaping spatial and investments impacts is limited, and non–conclusive. There is even some doubt on whether BRT can promote transit-oriented development, meaning compact, mixed-use, pedestrian-friendly development organised around a transit station at a significant scale, as there are so many stations.

It will be interesting to see what will happen with the full BRT systems in the cities of the Global South when a majority of households in these cities gets access to a private car. Are the BRT- systems so successful that they will remain and develop even further, or will we see the same diminishing of public transport as could be noticed in many cities in the developed world, where the liveability movements had to fight back routes to car dominance.

From Latin America another innovation should be noted: the cable-car as a form of regular public transport, especially useful in mountainous cities. Medellin in Colombia implemented in 2004 the world's first modern urban aerial cable-car public transport system. Cable-car systems are rather cheap and easy to construct, as they require little land acquisition. Cable car systems have now been built in cities as Caracas, Bandung, and Rio de Janeiro. One of the reasons for building is related to social integration. The city of Medellin, formerly known for its drugs-related criminality, had many un-connected barrios, not integrated in the urban fabric, and seedbeds for criminal activities. Again, a charismatic mayor took the lead in the cable-car

project, connecting the poorer households.. The system is a success, however, probably more from a point of view of marketing, symbolism and creating feelings of proudness among citizens than for its mobility results, as cable-cars are used for only 10 per cent of all trips in the connected barrios (Brand and Davila 2011).

All in all, innovations in Intelligent System Management have mostly come from public leaders (BRT systems, but also the cable-car, and the congestion charging schemes) and from the use of clever governance models, defining different roles, like initiator, planner and operator. Broadly speaking, the public sphere has been in the lead while private enterprise has showed no great innovation capacities here. Helpful conditions were the density of the cities, creating markets for very frequent public transport, and feelings of crisis in the delivery of mobility without the new innovations, whether the case was London, Stockholm, Bogota or Medellin. The innovations presented were helpful in creating better situations on mobility, but did, at least in the case of BRT, not lead to great investments in the broader sustainability of the cities where the innovations were introduced.

4. INNOVATIONS IN NEW MOBILITY

Most of the actual mobility innovations are to be found under the heading of the third direction. These innovations focus on new and more efficient ways of moving through and interacting with the city infrastructures by providing customers with more flexible, more convenient, and better integrated travel options. Many of these options are based on information technology (IT). Many of them also relate to the sharing economy. Four categories will be introduced: travel information, fare integration, car and bike sharing and new mobility services.

Travel information is already with us for a long time, but only in recent years it did grow from uni-modal to multimodal, and, even more important, it started to be personalized. Now passengers can see, wanting to make a trip, what are the best options for organising a trip using intelligent apps showing this information. Innovative agencies and companies are starting to repack existing data, publish these over the internet, so that they can be accessed from mobile devices anywhere. Next is fare integration. Fare payment technologies needed to be modernised and simplified. Ambitious fare integration strategies can now be seen in all parts of the world. This development is certainly broader than the scale of cities. Fare integration, for example, in the form of one smartcard or paying by smartphone, removes barriers between the different transport modes and between the different transport agencies, that, until recently, still employed

forms of single mode-thinking in their pricing strategies. Here, mostly the initiatives are with public transport organisations, often supported for IT and marketing by market partners.

The world of sharing is a third category of innovation (see Deloitte 2015), with car sharing and bike sharing as the most important elements. The first reference to car sharing in print identifies the *Selbstfahrergenossenschaft* car share program in a housing cooperative that got underway in Zurich in 1948, but there was no known formal development of the concept in the decades that followed. The early 1970s saw the first whole-system car share projects, in France and in Amsterdam. In 1977, the first official British experiment in car sharing started in Suffolk. An office in Ipswich provided a *Share-a-Car* service for 'putting motorists who are interested in sharing car journeys in touch with each other'. The 1980s and first half of the 1990s was a 'coming of age' period for car sharing, with continued slow growth, mainly of smaller non-profit systems, many in Switzerland and Germany, but also on a smaller scale in Sweden, the Netherlands, Canada and the United States.

Car sharing is now growing in importance in cities in the developed world, as younger households consider this an alternative to owning, or leasing, a private vehicle, an expensive, depreciating asset, at least for a part of their life. Car sharing has different forms, with two basic different options, renting or buying. Rent-a-car has existed for a long time (since 1918!). Adjacent to this well-known business, car clubs have started to become more popular[1]. Innovations in this field are numerous, and mostly spring from citizens initiatives, or from small, niche-oriented, companies. Many of these initiatives are inspired by sustainability objectives, with a focus on more sustainable living.

Bike sharing has been mostly set up by governments or by public transport organisations (Shaheen et al. 2010). There was an early form of bike sharing in Amsterdam, but often the start is thought to be in Rennes, France, in 1998 with the "Velo a la Carte"- system. Most common is a system using self-locking bicycles that are distributed throughout the city, which can be unlocked by calling a phone number, entering a code and providing credit card information. Customers can use their smartphones to locate the nearest bicycles. Bike sharing has been researched rather extensively; bike sharing can be seen a niche market.

Finally, in recent years, there is the development of new mobility service paradigms. Here at least two developments can be noted, divided between type of provider, public transport or owners of cars. In this context, providers of public transport are reframing their business,

[1] In a car club, the individual becomes a member, pays a subscription, and can hire a car from the pool maintained with the club's money. In a purchase club, the car is owned by a number of households, and gives the member shared ownership.

understanding that their customers want to make a trip, and want to make their trip as seamless as possible. Optimising only their part in the trip chain is less useful than trying to organise for their customers the complete trip.

The concept of "mobility" is beginning to get traction and this asks for integrated concepts, and for integrated trip chain management. We will look at two recent examples, in Chinese cities and in Helsinki in Finland. In some Chinese cities, customized bus service has been introduced as a new concept of demand-responsive transit that provides user-oriented services to especially commuters, by aggregating their similar travel demand patterns, using online information platforms, such as Internet, telephones and smartphones (Liu and Ceder 2015). The service was first implemented in Qingdao in August 2013, and operates now in 22 Chinese cities. Essential in this service is the focus on the user demands. Demands that have similar origin areas, similar destination areas, similar departure times and similar arrival times are aggregated and a specific route is designed. Between origin and destination areas there usually are no stops, no interchanges and no transfers. The national government of China gives support to this commuter oriented form of public transport, but individual cities make the investments. While optimal use is made of IT, one element is failing: most routes of these customized bus services are not well connected with other modes of transportation systems (Liu and Ceder 2015).

Another example, was Kutsuplus, a demand-responsive service in Helsinki. It worked as follows: the route of the Kutsuplus-bus was determined by the customers and the service was booked online or via smartphone. It was possible to decide whether you want to use the service in 5, 10, up to 45 minutes. Kutsuplus operated with mini-buses and did not follow regular routes, and was notably cheaper than taxi services. The service was popular for going to the city centre, and was on these connections an alternative for car traffic. Kutsuplus started in 2013 as a technological spin-off from a research project at the Department of Computer Sciences of the Aalto University. Although the system was rather popular, the service could only have been profitable if it had been scaled up. This problem has been often observed in initiatives in "new mobility" (car sharing, bike sharing, real- time travel information). The initial success of such a niche needs upscaling to become part of the over-all transportation regime (or even disruptive to the regime), but a well-defined business case for upscaling seems difficult. For Kutsuplus this caused a stop in the service for 2016 (Kutsuplus 2015).

The second type of provider, *owners of cars* started to see perspectives for new mobility services by using drive-sharing, or electronic hitch-hiking. The innovation here is that the empty seats in a car can be brought to the market by a car owner. The car owner can ask money for

the joint trip, or does it for free (the 'hitch-hiking' element). When some revenues are asked, this drive-sharing comes near to taxi services. However, the real innovation (and the difference) is in the origin: the car owner already needs to make the trip himself or herself, and some passengers can join. Basically, this is not just a situation where a car owner waits with his or her car for passengers and then starts to make the trip which these passengers wish. In this last situation, the car owner – not wanting to make a trip himself or herself - is just a competitor for regular taxi services, however, without the necessary education and juridical arrangements. Uber has been exploiting this niche, but incorporates a far more flexible hailing, billing, and indeed costing regime than most conventional taxi services: it is not surprising that this specific form of mobility service has been banned by most governments. This model of new mobility is still in development, and it is likely information technology will get a firm grip on the ways mobility can be organised. Disruptive elements will come up (Van de Weijer 2015), and in this direction, essentially for the first time, companies will also be active as innovators.

There is a lot of publicity about automated driving in cities. Automated driving will not be an option in cities for the next decades, at least not in a non-controlled way, as all experts consider city traffic the most difficult to programme (Jeekel and van de Weijer 2015). People movers, as active in Rotterdam (from Capelse Brug to Rivium, since 2005), will grow in importance but still need their own defined and designed infrastructures.

A perspective that could be appropriate in mobility services in cities in the somewhat longer run has been presented in Jeekel and Van de Weijer (2015). In cities and urban areas space is scarce, and driving space and parking space are in competition with leisure space, working space and historic spaces that need protection. However, the demand for mobility in these urban areas remains, and conventional public transport can only be made flexible enough to meet this demand with difficulty. While bicycles will grow in importance in urban mobility, the greatest game-changer could be another use of private cars. With apps in smartphones matching demand for mobility and supply of mobility, cars could deliver mobility services (Van de Weijer 2015). Most cars have very low occupation rates. This could change, when cars will be used to pick up customers with travel wishes made in arrangement with the driver. A study of ITF (International Transport Forum 2015) presented interesting results: nearly the same urban mobility could, in a situation of demand–supply optimisation, be delivered with 10 per cent of the cars. In this context, it is likely that private cars will only be allowed to access cities when transporting more people than just the driver. The move to a sharing economy could in built-up areas lead to shared mobility which could also be done by conventional cars. Such an urban mobility car service system could be ready and working a few decades before the introduction

of fully automated city driving. Whether a move towards automation in driving in cities would then be wanted, after at least two decades of experience with shared car service mobility, is an open question.

5. BROADENING THE ISSUE

After the discussion of the spectrum of 16 innovations in mobility in cities the perspective should be broadened, simply just because of the necessity to search for conditions under which cities can create successful mobility innovations. Three themes will be presented here, the concept of path dependency, the Smart City movement, and cities as 'incubation environments'.

First, we look at the relation of innovative initiatives with the common practices in mobility. The seedbeds for innovations in mobility are not always existing; after an encouraging start period many innovations fail to reach take-off, and remain marginal. Upscaling is difficult in these situations, as in early car sharing and bike sharing initiatives and the Kutsuplus initiative. Difficulty in upscaling is also explained in the book, "*How does Urban Public Transport Change Cities*?" by Pflieger et al. (2009) in which theories of path dependency and inertia are discussed. Many cities have strong historical (and sound arrangements, at least in their individual business plans) in providing mobility options. New options that do not fit the paths of these arrangements can cause difficulties in upscaling. But these path dependencies can be overcome through the construction of coalitions of active stakeholders, the creation of new institutions and the rebuilding of certain urban artefacts.

This happened in the liveability movement of the 1970s. At that time the new practice of car mobility domination was challenged from different sides – traffic safety, interests of pedestrians, the environment - and although starting points differed, coalitions were formed, new institutions were built and urban artefacts, such as freeways through the city centres, were rebuilt, in more citizen-friendly designs. This happened also with the BRT projects in the cities of the Global South. However, this coalition and institution building has failed thus far in the area of the New Mobility (Holmberg et al. 2016). One reason which could be the main driver of this direction, is disruption related to IT, and not creation of alternative institutions that challenge the existing ones. This leads to the situation that real time travel information, car sharing, bike sharing, user-oriented public transport and drive sharing are still – often for many years or even decades - the 'shape of things to come', instead of existing systemic elements.

The second concept to discuss is the Smart City movement and its relation to mobility. The adjective 'smart' is often used in debates about the future of cities and mostly implies that cities need improved use of IT and need the capacity to bring IT-based solutions and approaches into city governance. Hambleton (2015) suggests in his paper 'From smart cities to wise cities' a somewhat broader use of the adjective 'smart' and sees three city perspectives for 'smartness', namely, digital cities, green cities and learning cities. The 16 mobility innovations in the current chapter can be framed using the three perspectives.

Learning cities are important in implementing the innovations of the initiator cities. A number of the innovations in mobility mentioned here fit into the perspective of the digital city: real-time travel information, automated traffic enforcement, fares integration, car sharing and user-oriented public transport innovations. Further, a number of mobility innovations seem to fit into the green cities perspective, pedestrianization, traffic calming, low emission zones, cycling, parking 2.0, bike sharing. Some innovations seem more neutral towards this trend of green cities or digital cities, but could probably be helpful for reaching greater sustainability, namely, congestion charging and BRT systems. From the previous analysis stems the idea that not all mobility innovations will fit into the Smart City concept defined rather strictly, as IT based cities.

How do the 16 mobility innovations relate to the broader debate on cities and innovation? There is a wealth of literature on this debate, and the overall impression is, as stated by Sheamur (2012, p. 501) 'one of confusion'. On the one hand, it can be concluded that "whatever the ways in which firms draw upon their outside environment to innovate, this environment is richer, more knowledge intensive, diverse and specialised in urban areas than in non- urban areas" (Sheamur 2012, p. 513). But on the other hand, how important is this generic conclusion really, as cities are not isolated entities but parts of wider systems of interdependent and functionally differentiated entities? Overall, it appears that cities can excel in more radical innovations, but the reasons are as yet unclear; is it because the density and frequency of contacts, or more because cities provide the specialized workforce, the infrastructure and the market access for these radical innovations? Or is it because crises in the delivery of transport have the strongest media impacts in cities?

It also looks that cities are incubation environments for passenger mobility innovations, with most innovations originating from citizens and leaders, often relating and reacting to crisis situations in cities. We already noticed the relatively weak position of small firms and large companies in organising mobility innovations, but we consider it worthwhile to put forward the benefit of a dense population for innovations in mobility. The density of population can be

called an asset in a model for urban innovation, as presented in Athey et al. (2008). Urban innovation in their model can be seen as a mixture of five components: firms, markets, assets, institutions and networks. Firms do not play a very important role in passenger mobility innovations. Markets do, and cities offer access to large markets. Assets such infrastructure and dense populations available are important. Institutions have played a major role, through the influence of public authorities, public transport organisations and elected officials like mayors. Networks are important in two ways. The first is exemplified by the liveability innovations in which networks of like-minded citizens were the agents of change, and secondly, networks have been very helpful in introducing innovations such as BRT-systems from one city to many other cities.

6. NETWORKS FOR INNOVATIONS IN MOBILITY

In the previous sections, we looked at cities that initiated innovations. Most cities, however, do not initiate innovations by themselves, but adopt and modify innovations that have started elsewhere. These cities learned about innovations created in other cities, and these learning processes have been useful for the dissemination and development of innovations. But how do innovations and innovative policies move over space and time?

Marsden et al. (2011) published an inventory on this theme in their paper "How do cities approach policy innovation and policy learning?" They demonstrated an active culture of innovation and policy transfer on mobility, especially in the Nordic countries, the UK, France and North America. The EU has been helpful in setting up dissemination programmes and programmes like CIVITAS; scanning tours of North American officials going abroad fulfil more or less the same function. Furthermore, cities themselves have created the Polis networking system, and transfer and knowledge exchange is also one of the goals of EPOMM, the European Platform for Mobility Management. Transfer of innovations is more actively approached by cities when there is a strategic need (call it a crisis), when very visible mobility projects collapse, and when extra support is needed for already existing ideas. Transfer also springs from curiosity, legitimization needs, or political interventions (Marsden et al. 2011). Elected officials are often active in the initial phases of the transfer but they are usually less involved in the entire process, which is often dominated by local professionals. Transfer is more complex when cities are not able to finance the majority of the innovation themselves, but need support from regional or national levels. In this case early adoption of innovation can then

become more difficult. It is interesting is to note that private suppliers and consultant firms often lag behind in being active on innovation transfers for mobility. Transfer is most often about exchanging insights and ideas in a more indirect sense, but Marsden et al. (2011, p. 508) identified three innovations that were introduced in other cities as an immediate result of transfers, namely, bike sharing, the Dutch *woonerven*- approach and the congestion charging schemes from London and Stockholm.

However, not all cities are active in transfer and exchange on innovations in mobility. Cities need to have an open and outward looking attitude – and time to spend on transfer- with their local officials. An organisational learning culture and the willingness to evaluate past approaches within city governments and public transport authorities are helpful. Basically, transfer functions and can lead to early adoption and further development of innovations, when social processes in urban governments are built around curiosity, exchange and trust (Marsden et al. 2011, p. 511).

BRT systems are a case in point. According to Van der Eerden (2013) BRT systems have, after the *Transmillenio* success of Bogota, gone around the world, as is witnessed by the establishment of 157 BRT systems in 15 years. In this context, 37 delegations from different countries visited Bogota in the four years after the introduction of *Transmillenio*. In an attempt to clarify the processes of transfer in space and time, Van der Eerden introduces seven types of actors. To start, the "champions", city leaders like the mayors of Curitiba and Bogota, had the power of vision and the wisdom and originality to restructure debates on mobility issues. Equally important are the international non-state and non-governmental organisations, like EMBARQ (part of the World Resources Institute Ross Center for Sustainable Cities) and ITDP. These organisations can be seen as counterparts of organisations like the already mentioned Polis and EPOMM, for mobility innovations in the developing world. Other actors include specific worldwide city networks, being able to organise innovation transfers, and technically-oriented associations, exemplified by bus benchmark groups that exist around the world which organise sessions on BRT-challenges. Another set of actors are knowledge sharing institutions, exemplified by the organisation SIBRT (Latin American Association of Integrated Systems and BRT) which, by bringing together the BRT expertise of 19 Latin American cities, have acted as promotors, in cooperation with VREF (the Volvo Research and Educational Foundation). These last two types of actors operate more often in the world of business, through international consultancies and funders of large projects, such as the World Bank, the Asian Development Bank, and the Inter-American Development Bank. Furthermore, Van der Eerden (2013) concluded that these many actors were mostly in alignment, thus creating a specific "transfer

environment" for BRT innovations. But even with such an environment it took some years before BRT spread to Asia. Here Matsumoto (2007) offers an explanation: he concluded (as cited by Marsden et al. 2011, p. 502) that BRT success in a broader range of institutional settings was dependent on the generation of trust in Asia on the potential transferability of the system.

7. CONCLUSION

The central theme of this book is the role of cities in transitions of systems towards higher levels of sustainability. In this chapter, the focus was on urban mobility, on passenger mobility, and hence on urban mobility innovations. Accordingly, 16 innovations in mobility have been identified, coming from three directions. For each of the innovations the focus was on the initiative, but which factors in cities – physical, social and institutional – could be considered as crucial for the innovation? The focus was on the diffusion, or transfer of innovations, as most innovations in mobility need to be transferred from the originating city to other cities, to create a force for innovation. What are the conditions under which cities can create mobility innovations and what are the most important initiators among the stakeholders?

Starting with the initiators: from the analysis of the 16 innovations (Table 7.1) the most important stakeholders for urban non-freight mobility innovations are city governments, citizen groups, public transport authorities and universities. Local political leaders play major roles in bigger innovations while the world of enterprise lags behind in innovations in passenger mobility, with minor roles for established firms active in parking management, public transport operators and consultants in fare integration, and with new small niche companies and consultants working on apps, sharing mobility, and travel information.

Table Stakeholders and 16 innovations in passenger mobility

Innovation in urban mobility/ stakeholders	C	U	P	G	T	R	EC	NF
Liveablity and urban mobility								
1. Pedestrianization	x	x		(x)				
2. 'Woonerven'	x	x		(x)				
3. Shared Space	x	x		(x)				
4. Parking 2.0				x		x	(x)	
5. Cycling	x			(x)				
6. Low Emission Zoning	x	x		x		(x)		
Intelligent systems management								

7. Automatic enforcement				x		x	(x)	
8. Congestion charging		x	x	x		(x)		
9. Bus Rapid Transit			x		x	(x)	(x)	
10. Cable Cars			x	x	x			
New mobility								
11. Travel information		x						x
12. Fare integration				x	x		X	
13. Bike Sharing				x	(x)			(x)
14. Car Sharing				x			(x)	x
15. Drive sharing	(x)							x
16. User-centred public transport		x		x	x			

Notes:
X = initiative; (x) = follower in the innovation process
C: Citizen groups; U: Universities; P: Local political leaders; G: City government; T: Public transport authorities; R: Reinforcement agencies; EC: Established companies; NF: Niche firms.

In terms of cities, the following conditions seem to be the most important in creating innovations on mobility. On the physical side, scale is important. Bigger cities seem to create more innovations in mobility. But density is also important, as high densities create the possibility to present fruitful public transport alternatives to car dominance. And the presence of one or more universities is helpful in generating innovations, as is the existence of a historic city centre, that needs to be preserved against car dominance. On the social side, in OECD countries, a population that is young and well-educated, wishing to remain living in the city, creates a positive force for innovations in mobility, especially for innovations related to smart cities and sharing mobility. In the Global South the importance of an electorate, where the majority does not own cars, cannot be overlooked for innovations in public transport. The role of an active citizenry with influence at the political side in leading circles is helpful, as a counterforce to car dominance. On the institutional side, the political leaders, with visions on mobility and liveability can make a difference. Active city governments, that can act and invest without control and compromise with regional and national levels, can create more innovations.

With regard to early adoption of innovations, early adopting cities have often seen a crisis on mobility (London, Stockholm, related to congestion charging, Curitiba on BRT, Medellin, Chinese cities related to Customized Bus) or failing projects in general, have had an open and outward looking attitude – and time to spend on transfer of knowledge, experience and insights - with their local officials. Early adoption and further steps in development of innovations can be observed when social processes in urban governments are built around curiosity, exchange and trust. In addition, most of the 16 innovations presented could be considered to be more sustainable than the private car dominance, that is still the regime in many cities. Many innovations fit in the green city domain. But serious doubts on sustainability objectives could

exist with regard to the innovations on real time travel information, Shared Space, and - but only when seen as a competition for conventional taxi services - drive sharing.

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