Smart Mobility and Sustainable Mobility: two separate worlds?

Jeroen Quee – Sweco – jeroen.quee@sweco.nl
Stijn Altena – Sweco – stijn.altena@sweco.nl

Bijdrage aan het Colloquium Vervoersplanologisch Speurwerk
22 en 23 november 2018, Amersfoort

Samenvatting

Duurzame mobiliteit en slimme mobiliteit zijn twee veelgebruikte termen in de hedendaagse onderzoekswereld en in de praktijk van mobiliteitsbeleid. Beide concepten kunnen op brede steun rekenen en worden dan ook veel genoemd in visies en beleidsdocumenten van overheden. De relatie tussen duurzame mobiliteit en slimme mobiliteit is echter een onderwerp dat nog te weinig onderzocht is en ook in de praktijk van mobiliteitsbeleid is nog te weinig aandacht voor de verhouding tussen de twee concepten. In dit paper komen ten eerste wetenschappelijke theorieën aan bod die de uiteenlopende relaties duiden en pogen te verklaren, aan de hand van een aantal perspectieven. Vervolgens wordt ingegaan op een uitgevoerde case study naar meerdere slimme mobiliteitsmaatregelen in Eindhoven en Utrecht. Gekeken wordt naar de visie die deze steden hebben op slimme mobiliteit en hoe dit terug komt in de maatregelen die worden uitgevoerd.

De paper sluit af met een evaluatie van de verschillende maatregelen: in hoeverre dragen het beleid en daartoe genomen maatregelen bij aan het verduurzamen van de mobiliteit? Ook belangrijk: wie initieert de projecten, welke rollen spelen de gemeenten en hoe zetten zij hun visie kracht bij? Omdat dit een verkennend onderzoek betreft, is geen poging gedaan om tot algemeen geldende uitspraken of generalisaties te komen. Er is bewust voor gekozen om meerdere projecten te analyseren om zo de verschillen te kunnen duiden en beleidsmakers te kunnen inspireren met voorbeelden van succesvolle en minder succesvolle slimme mobiliteitsmaatregelen en hun effect op de uitstoot van broeikasgassen en het energieverbruik door mobiliteit.

1. Introduction

1.1 The call for sustainable mobility

The mobility of people has major implications for energy use and emissions. Approximately 20% of all CO2-emissions in the European Union originates from the transport sector and the sector accounts for about 33% of all energy consumption (Berger et al., 2014). Therefore the European Commission calls for a significant reduction of greenhouse gas emissions (GHG) and energy use in their White Paper on Transport. With the underlying ambition to limit climate change below 2°C, "the EU needs to reduce emissions by 80-95% below 1990 levels by 2050" (EC, 2011, p. 3). The transport sector is required to reduce at least 60% of the emissions by 2050.

The subtitle of the White Paper, "Towards a competitive and resource efficient transport system", indicates that the ambition of the European Commission is twofold: urban transport should enable economic growth, but also diminish its energy use and emissions. The Commission mentions innovation and technology as important possibilities to reach these goals. Research and policy should support technological improvements, as these will contribute to a more efficient and sustainable transport system, is the belief (EC, 2011). In the broader field of research and practice of transport planning there has been an increasing consensus over the last decade that innovative technologies can have positive effects for urban mobility (Lyons, 2016). This belief resounds in the concept of 'smart mobility', or 'smart cities' more generally spoken.

1.2 Introducing the smart mobility discourse

The number of publications and programmes regarding smart cities has considerably increased since 2010, after the EU started embracing and supporting smart city projects (Ahvenniemi et al., 2017). What one understands exactly as smart cities differs. Several studies have been executed to compare, combine or criticise definitions and implementations of smart cities. The role of technology seems to be regarded as one of the key elements of the concept (Albino et al., 2015; Caragliu et al.,2011).

The most, so to say, basic notions of a smart city are thus 'technology-centric', but different approaches have evolved over time (Martin et al., 2018). As Lyons (2016, p. 2) mentions, the "interpretation now extends beyond being technology-centric to (also) recognising people and community needs". Martin et al. (2018) state that the concept has recently been connected to visions on sustainable cities. In line with this, smart city visions offer possibilities to achieve social equity and environmental protection "in parallel with digitally catalysed economic growth" (Martin et al., 2018, p. 2).

1.3 The contested relation between smart and sustainable

There is thus more attention for the broader positive effects of smart cities in this sense. However, there are serious concerns regarding the component of sustainability within

current visions on smart cities. Lyons (2016, p. 2) states that "sustainability" is often but not always referred to in definitions of smart cities. Martin et al. (2018, p. 2) add, based on a literature review, that the smart city concept "as a whole does not emphasise concerns of sustainability". To illustrate their point, they mention five tensions between visions on smart and sustainable cities. One of the tensions is that the use of technologies to integrate and optimise infrastructure leads to majors gains in efficiency, but that the proclaimed environmental protection can be criticised as a form of 'greenwashing'. The focus on realising efficiency savings leads to a tendency that the reduction of environmental impacts is often neglected in smart city visions (Martin et al., 2018).

Moving back to the transport sector, it is thus questionable whether a focus on innovation and technology has a positive (read: diminishing) effect on the environmental impact of urban mobility. Lyons (2016) argues that the lens of transport planners may have become too much technology-centric and that sometimes technological opportunities may become "solutions looking for problems" (Lyons, 2016, p. 5). Some critiques are even more fierce, stating that smart mobility practices may lead to more energy use and emissions (Ringenson & Höjer, 2016). Their argument is that certain smart mobility initiatives will make urban transportation more efficient and comfortable, resulting in increasing travel demand and more car use.

Therefore, Papa & Lauwers (2015) argue that the concept of smart mobility should go beyond innovative technological solutions. Urban mobility systems that are truly smart take advantage of technology to improve quality of life and the process of decision-making. Going beyond technology and aiming for quality of life and sustainability ambitions is what Papa & Lauwers (2015, p. 543) call "smarter mobility". Put differently, they state that mobility innovations have to include sustainability and quality of life planning in its goals and planning practice. Inspired by Gehl's 'city as a place'-approach (Gehl, 2010), Papa & Lauwers plead for a "citizen-centric approach" to smart mobility. Policy measures should not solely be evaluated on their consequences for the mobility system, but on the consequences for the urban system and the lives of citizens in general. Following this approach, smart mobility can deliver more sustainable mobility and, in the end, a sustainable, prosperous and inclusive future for urban citizens.

1.4 Reading guide

This paper explores to what extent the above described vision on smart mobility is pervaded in local mobility policy making. The planning practice in the cities of Eindhoven and Utrecht are used for an explanatory case study. That is to say that no general assumptions or conclusions can be made based on the research, rather the paper aims to serve as a learning guide with best practices.

2. Theoretical framework: the discourses of smart and sustainable mobility

2.1 Sustainable mobility

Sustainable mobility may at first have been a popular buzzword, following from sustainability as a general concept, without any significant meaning. However, this concept has come into widespread attention and for a period of time was regarded as the most popular buzzword in urban mobility planning (Ahvenniemi et al., 2017; Lyons, 2016). The concern for sustainable mobility came forward from a broad-based concern of climate change. The awareness that mobility causes serious problems regarding air pollution, emissions and high amounts of energy use, gave rise to the call for sustainable mobility. Recently, the call for a more sustainable urban mobility has been revitalised and reinforced by United Nations' Paris climate agreement signed in 2015. A few years earlier, the European Union also decided that it had to curb its emissions (EC, 2011). There is extensive documentation available from all governments levels, pronouncing the ambitions to achieve more sustainable mobility.

Reducing CO2 emissions and energy use is often not the only objective concerning sustainability. A lot of definitions operationalise sustainability in a broader sense. Generally, it is described from an economic, social and environmental viewpoint (Banister, 2007). As Campbell in his famous paper – 'Green Cities, Growing Cities, Just Cities? Urban Planning and the Contradictions of Sustainable Development' (1996) – explains, sustainable development is always balancing on the interface between economic growth, environmental protection and social justice. More recently, sustainable urban development has been defined as "achieving a balance between the development of the urban areas and protection of the environment with an eye to equity in income, employment, shelter, basic services, social infrastructure and transportation in the urban areas" (Hiremath et al., 2013).

This paper focusses, while not undervaluing the importance of economic growth and social justice, on the environmental aspects of sustainability. This means that energy use and GHG-emissions are the main indicators that operationalise 'sustainability'.

2.2 Smart mobility

Smart mobility is part of the smart city discourse. This latter concept has evolved rapidly over the last decades into a key pillar or strategy in many policies. However, the rise in popularity of the concept has been accompanied by an increase of discussion and debate about it. Both academics and planners indicate smart cities, just like sustainability, as a buzzword. Haarstad (2017) calls these kinds of concepts 'empty signifiers'. Such concepts leave room for different interpretations, hence there are many of them. This section will shortly provide an overview of the different definitions of smart cities.

Albino et al. (2015) describe the emergence of the smart city concept, that was first used in the 1990s. They explain that the focus in the first years was on the importance of new ICT for modern infrastructures in cities. As explained in the introduction chapter, this strong orientation towards technology was the most common approach these days. The belief in smart cities was (and in many cases still is) based on the persuasion that diffusion of ICT throughout cities can stimulate economic growth, by increasing efficiency and thereby competitiveness of urban systems (Caragliu et al., 2011).

Hollands (2008) also emphasises that ICT plays a key role in smart cities, but points out that there are many different meanings related to the smart city concept. One meaning could be, for example, "the application of a wide range of electronic and digital applications to communities and cities". Another meaning could regard smart cities "as spatial territories that bring ICTs and people together to enhance innovation, learning, knowledge and problem solving" (Hollands, 2008, p. 305). The many different definitions that are present, can be explained by the presence of multiple approaches towards smart cities. Section 2.3 will elaborate on these different approaches.

2.3 Different perspectives on smart mobility

When comparing the two definitions of a smart city given by Hollands (see 2.2), one could draw up different visions about what people actually see as a smart city. The latter definition, "spatial territories that bring ICTs and people together to enhance innovation, learning, knowledge and problem solving", fits better in the notion of critics who thought that the concept of smart cities was too much technology-oriented. Such critics, for example Albino et al. (2015), state that the component of 'people' and/or 'community' is often missing. However, "these are the protagonists of a smart city, who shape it through continuous interactions" (p. 9). In their opinion, a city that focusses on technological improvements only is not a smart city. Therefore, many researchers pleaded for a broader understanding of the smart city concept.

Technological dimension vs. human dimension

According to Caragliu et al. (2011) the role of human capital and education should be stressed in urban development. Nam & Pardo (2011) distinguish, apart from the technology dimension, also a human dimension and an institution dimension. In other words, an approach emerged that, more than technology, highlights the social structures in cities.

The human dimension, as explained by Nam & Pardo (2011), is about smart people. People who "generate and benefit from social capital" (p. 285). For these kind of smart cities (Nam & Pardo indicate the existence of strongly related definitions of creative,

humane, learning and knowledge cities) the human infrastructures are of crucial importance for city development, for example the presence of knowledge networks, creative occupations and a diverse mix of enterprises. In essence, this dimension regards a smart city as a city that fully exploits its human potential. The institutional dimension is about smart communities "in which government, business, and residents understand the potential of information technology, and make a conscious decision to use that technology to transform life and work in their region in significant and positive ways" (California Institute for Smart Communities, as quoted in Nam & Pardo, 2011, p. 286). This definition shows that a smart city can also be operationalised as a city that is governed in a 'smart' way, with new governance relations, decision-making, participation and collaboration. The institutional dimension stresses this aspect.

One of the conclusions that Albino et al. (2015) draw from their study is that the confusion about the smart city concept is explicable by the emergence of these different dimensions of smart cities. As they state, the concept has been used to describe developments in two different kinds of domains. The first is that of hard domains, consisting among others on buildings, energy grids, mobility and logistics. The second is that of soft domains, about education, culture, policy innovation and governance. The role and application of ICT in each of these domains is different. In the first types of domains ICT can play a decisive role, while in the latter ones it mostly plays a supportive role rather than being decisive (Albino et al., 2015).

Technology-centric vs. citizen-centric

Another way in which the smart city concept can be regarded differently is explained by Papa & Lauwers (2015). Focussing on urban mobility, they distinguish a technology-centric approach, a consumer-centric approach and a citizen-centric approach. In the broader field of smart cities, especially the differences between the technology- and citizen-centric approach are relevant to review here. The technology-centric approach, "provides a vision of smart mobility as capable of maximizing its efficiency thanks to a large and widespread use of ICT. Such a vision, which has been largely sustained by multinational companies, leaders in the sector of ICT manufacturing, focuses on infrastructural innovation" (p. 545). Two important remarks can be made about this approach. First, it puts ICT central and sees it as independently operating systems offering solutions for (efficiency) problems in urban systems. This matches the explanation of Albino et al. (2015) about hard domains. Second, it pays attention to the governance aspect, stating that in this approach innovation and improvements are provided by multinational companies, which implies that community needs are not per se taken into consideration.

The citizen-centric approach, on the other hand, views technology as only one aspect of a more complex system. It views smart cities as "a system capable of using ICT in an extensive and intelligent way, in order to improve the overall urban performances and, above all, the quality of life of citizens" (2015). For this approach, community needs and citizens' active role in the transition are key elements of smart cities. Hereby it also pays attention to governance, stating that the integration between technological and social innovation should be ensured, by involving communities and creating conditions for learning and innovation. Also, the approach pleads for a focus on the local context.

Technology-centric	Consumer-centric	Citizen-centric
ICT is regarded as the keystone for smart mobility. Infrastructural innovation with help of ICT enables cities to optimise their efficiency. The focus is thus on the supply side. This vision is largely sustained by multinational companies in ICT sector.	*Technologies are enabling tools, but insufficient to make "smart" an urban context. The human component is crucial. Foremost aimed at optimising consumer's mobility behaviour through ICT, without considering other more comprehensive goals. Transport users are seen more as consumers of a service (demand side) than as citizens.*	*Stresses the importance of human capital. Favours "citizen" over "consumers". Smart mobility requires an integrated and collaborative approach. Smart mobility is capable of using ICT in an extensive and intelligent way, aiming for improved quality of life and sustainable urban mobility.*

Table 1: summary of different approaches towards smart mobility as described by Papa & Lauwers (2015)

The distinctions that Papa & Lauwers and Albino et al. describe thus show major similarities. In summary, both distinguish a technology-based approach and a citizen- or community-based approach. Moreover, both distinguish a more corporate, business-driven transition towards smart cities striving for innovation and efficiency and, on the other hand, a governance of smart cities that emphasises bottom-up initiatives and a more collaborative process towards smart cities. It can be concluded that nowadays there is a broad understanding of smart cities and what issues are related to them.

2.4 Relationships between smart and sustainable mobility

Lyons (2016) presents a very interesting schematic presentation of the possible relations between the concepts smart and sustainable mobility (figure X). These schematic relations offer possibilities to compare the visions that different cities have regarding smart and sustainable mobility. Also, it can help to assess to what extent certain projects have sustainability as ambition in the end. The meaning of the different diagrams is explained shortly below.

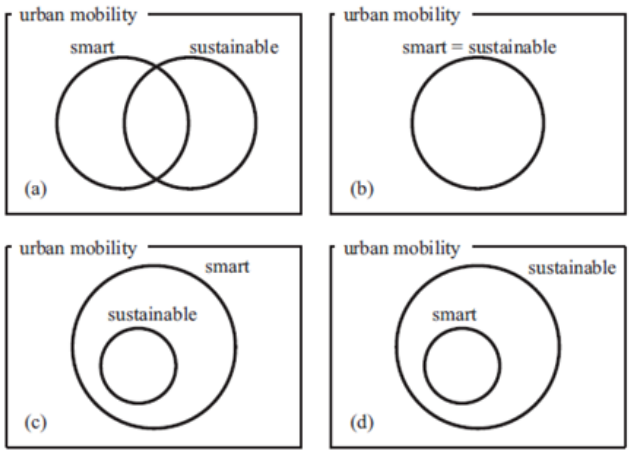

Figure 1: Venn diagrams representing the different possible relationships between the smart and sustainable mobility components (Lyons, 2016)

Diagram A depicts a situation in which a good coordination between smart and sustainability is lacking. Governments may develop policies that promote sustainability on the one hand, and on the other hand policies that are in favour of technological development without regarding sustainability issues at all. In some cases, it is possible that there is (accidently) a slight overlap between those policies.

The coordination between the components that is lacking in diagram A, is found in diagram B. Lyons (2016, p. 5) advocates that this situation "may, for some, depict an optimal reality in that all that is smart is sustainable and vice-versa". In this scenario, the terminology and the meaning of both concepts have converged.

The relation between the components get a more hierarchical character in diagram C and D. Diagram C represents a situation where the smart component prevails over sustainable, which means in practice that developments may become too technology-centric. As Lyons (2016) also states, this can be regarded as a 'dystopian' situation.

Diagram D, finally, illustrates the situation in which the sustainable component dominates the smart component. Or in other words, smart is seen as part of sustainable. Technology can then be seen as a means with sustainability as the end. Lyons (2016, p. 5) describes this very stylish as "a stronger level of stewardship over urban futures". Policy makers should be aware of the influence they can have on how this relationship is evolving. In the next chapter of this paper, different projects will be assessed about the relationship between smart and sustainable.

3. Case study of Eindhoven and Utrecht

This case study is executed as part of a master's thesis in the programme Spatial Planning: Urban and Regional Mobility at Radboud University. The projects are only very briefly described here.

3.1 Smart mobility in Eindhoven

The analysis of smart mobility initiatives in Eindhoven focussed on two programmes: 'Mobility-S' in the district of Strijp-S and the for 2019 planned MaaS-pilot, which is going to be part of the national programme on MaaS.

Strijp-S

At Strijp-S, a special public-private partnership (PPP) is established between the municipality and VolkerWessels. Part of this PPP is the organisation Mobility-S, which is responsible for the mobility and accessibility of the area. This organisation takes care of the public parking facilities for cars and bikes and invests in the development and innovation of the mobility system on Strijp-S. Mobility-S has a high amount of autonomy to manage mobility in the area, for example they manage public parking on the street, conventionally a municipality's task.

The ambition of Mobility-S is to reduce car use as much as possible in the area. They critically analysed the existing parking capacity of the area and in case of new developments, they only build the amount of parking places that is really needed. In some cases it is possible to use available rest-capacity from already existing parking places. Mobility-S also uses new technologies to organise parking more efficient. With an overarching system (called Parkrest) they make it easy to park in garages of different operators, while the system also manages reservations and payments. The plan is to use this system as well in the case of large events. In this way, Mobility-S reduces the need for and prevents new large parking places as much as possible.

Besides, they offer a range of alternative mobility services for people that live or work in or visit the district. Shared mobility services such as Amber (electric cars) and Hopperpoint make it easy for people to get to and from Strijp-S without their own car or bicycle. This may contribute to a reduction of cars in the area, since inhabitants have less necessity to own a car and employees that work in the area can choose to use their bike or public transport to get to work, while their business trips can be made with shared mobility services. Mobility-S spreads this vision and therefore the area also attracts businesses that are willing to cooperate with such systems. On the other hand, businesses that were situated in the area for a longer time already can be convinced with the experiences of Mobility-S.

MaaS-pilot

In 2019, the national programme with seven Maas-pilots will start and the municipality of Eindhoven is going to host one of them. This pilot focusses on 'sustainability' and, more specifically, within the own organisation. This focus is motivated by the fact that the municipality has the ambition to be an emission-free and 100% sustainable organisation by 2025.

The main objective of the pilot is thus to provide sustainable alternatives for business trips of the municipality (which comprises 1,5 million kilometres per year). There will be one MaaS-platform that offers several travel options, including for example Hopperpoint. Employees can use the platform to plan, book and pay their business trip. The pilot will start with a small group of employees, to be able to quickly optimise and avoid risks as capacity shortage. But eventually it will become more widely available, also for other large companies and citizens that are interested.

With the execution of this pilot, the municipality of Eindhoven profiles herself as launching customer. They are going to be one of the first organisations using such a platform that enables, and simultaneously restricts, her employees to use emission-free mobility services.

3.2 Smart mobility in Utrecht

The analysis of smart mobility initiatives in Utrecht focussed on two programmes: 'Multimodal Accessibility for Utrecht Science Park' and 'Smart Solar Charging'.

Multimodal Accessibility for Utrecht Science Park

Utrecht Science Park (USP) accommodates numerous large knowledge-based and health-related institutions and is therefore one of the 'hotspots' of the municipality for economic development. The area attracts more and more students, companies and, with that, employees. As a consequence, the area faces major accessibility issues. In the foundation called 'Stichting USP', different large institutions (Utrecht University, University of Applied Science Utrecht, University Medical Center Utrecht) and the municipality and province of Utrecht work together on these issues. Smart mobility projects are expected to help guaranteeing the accessibility of area.

One of those projects is Campus Bike, a bike sharing system. It has multiple docking stations, located spread over the USP terrain, at the Park & Ride, at the train stations of Bunnik, Lunetten and Bilthoven, and at multiple companies in the direct surroundings. People can access the bikes with a mobile application, that also manages their payments. Campus Bike is an attractive last-mile solution. It improves the connection to the nearest

train stations, serving as an alternative for Utrecht Central Station and crowded buses. Besides, some destinations at USP are located further away from a bus stop, so the bike may help here as well. Campus Bike also helps to keep cars out of the central roads in the area, since the bikes are available at the Park & Ride as well. This makes it more attractive for people to park their car in the Park & Ride and then take a bike. In the end, the Campus Bike is a healthy and affordable alternative for short distances.

The Park & Ride itself is not smart, but combined with other actions it does fit within the 'smart' framework: the Campus Bikes for example, but also an integrated ticketing system. Since the Park & Ride is located at the edge of USP, people still have to cover some distance when parking their car here. An integrated parking ticket is available for them that also offers access to the buses and trams at USP at a low price. These can be booked and paid online and in advance.

Smart Solar Charging

With the 'We Drive Solar'-project, inhabitants of the neighbourhood Lombok could use shared electric vehicles, charged with local generated solar energy. This idea (originally from local internet company LomboxNet) has been scaled up, with help of the Utrecht Sustainability Institute (USI) and national and European funding, to the programme called Smart Solar Charging.

They developed a system that enables car batteries to be charged and discharged. The generated solar energy can therefore not only be used to charge electric vehicles, but also the car battery can function as storage for solar energy. On moments without sunshine, tis energy can be used to supply houses or offices. The party that generates the energy also has the possibility to sell their energy to energy companies. The programme's primary ambition is to create more value out of solar energy, and the link with mobility is proving itself as an attractive way to do so.

The project is extended to four other locations in and around Utrecht now: Houten (with a project developer and the municipality), Zeist (with Triodos Bank), Jaarbeurs and USP. The aim was to cover (as much as possible) different 'types' of users and organisations that cooperate. In this way, USI hopes to learn what demands and preferences different stakeholders and systems have.

Noteworthy about this project is that is has been initiated completely bottom-up. The role of the different governmental bodies involved should not be undermined, however. Especially the municipality of Utrecht is praised by the actors involved with Smart Solar Charging, because of their facilitating and supportive role in the implementation of the project.

4. Conclusion

4.1 Eindhoven

On Strijp-S in Eindhoven, Mobility-S wants to reduce the number of parking places and thereby the number of cars in the area, to create a more liveable city district. They hope to achieve this by reducing the existing stock of parking places and by only developing an amount of new parking places that is really necessary, regarding new developments. Mobility-S tries to reduce the demand for parking places by improving high-quality public transport and by offering shared mobility options. Also, their Smartparking system aims to better integrate the different parking systems that are used in the area, to make it easier to use the available parking places more flexible (in case of an event for example). But on the other hand, this Smartparking system makes it easier to park and thus to come to the area by car. So then, what is the problem they want to solve with this solution? Is it the fact that people cannot easily find a parking spot at the moment, or that there are too many cars in the area? The solutions that are provided now are directed at two different, slightly contradictory, ambitions. Reflecting on the diagrams presented by Lyons, this situations fits best in diagram A.

If in this case the approach would be even more from a citizen's perspective, the attention should be shifted completely to how the area can be optimally accessible without further improvements that make travelling to the area by car more attractive. This is a rather extremist point of view and it is understandable that decision makers do not want to totally discourage car use at this moment. The ambition to reduce the number of cars in the area and to reduce the amount of parking places is already a good step in the direction of a better liveable city district. But, when one keeps the objective in mind to reduce CO2-emissions with 95% in 2050, one could advocate for a policy wherein sustainability is even more at the centre of attention. Such policies would be represented by Lyons in diagram B.

The MaaS-pilot in Eindhoven is an example of a programme that fully strives for an optimal use of new technologies to contribute to sustainability goals. Here applies the same as what is described just before, that such a programme is represented in Lyons' diagrams as diagram B, or even as diagram D. Obliging their employees to do their business trips in a way that is zero-emitting, by offering multiple providers of shared mobility services, is a perfect example of an optimal use of technology as instrument with sustainability as the ends. The providers that are likely to offer their services to the municipality include Hopperpoint, the shared bike system, and Amber, with their electric shared cars. With this idea, the municipality wants to be a good example of how a

government not only can promote sustainable mobility, but also actively work on making her own mobility sustainable.

4.2 Utrecht

The programme on multimodal accessibility of USP is in essence not about smart mobility, but about maintaining and improving the accessibility of USP in all possible ways. Smart mobility is one of the solutions that can contribute to this. But how does the smart mobility policy relate to the sustainability ambitions? Let's start with the Campus Bike project. This shared bike system has elaborately been described in chapter 4. The Campus Bike is a measure that primarily aims for enlarging the attractiveness of public transport. Because it improves the last-mile accessibility, the belief is that people are encouraged to make use of public transport more often. Therefore, this measure can be regarded as directed at sustainability by making use of technological possibilities. Lyons would argue that such a measures perfectly fits in diagram B or D. Although no direct information could be found that validates this statement, the extensive analysis and first-hand experience as user by the researcher serve as a sufficient support for this thesis.

Another measure at USP that has been described is the Park & Ride with integrated public transport tickets. The same contradiction strikes up here as with the Smartparking project in Eindhoven. On the one hand, the different actors at USP want their area to be a liveable, attractive location, according to the principles of Healthy Urban Living. Therefore, the Park & Ride is located at the edge of the area, keeping cars out of the centre of the area. To support this, enormous investments are made to improve the accessibility of USP by public transport. But on the other hand, the construction of an exorbitant large parking garage can be seen as an invite to car owners to travel to the area by car. Offering them discount on public transport services within the area is, moreover, a present or even a reward, for those people travelling by car. In the end this may even have a worsening effect on the accessibility of USP, since the already highly congested highways and other access roads around USP will get even busier. The proof therefore is already available: the discussion about enlarging the highways around USP has started. The relation between sustainable measures and smart measures on USP could thus currently be illustrated by Lyons' diagram A. Better integrating between the different measures is desirable, seen from a citizen-centric perspective.

One project that already works on this integration is Smart Solar Charging. LomboxNet and USI, the initiator and developer of the project, recognise the value that can be generated by solar energy. It is not only well suited for providing sustainable energy to houses, but can also be linked with electric cars on the street. In so doing, value is created in two ways. More important however, in the light of sustainability, is the fact

that it facilitates electric cars and provides them with local generated sustainable energy, derived from the sun. This project exceeds the domain of sustainable mobility, because it contains much more than only mobility. In the end, however, the strong link that is created between solar energy, charging and discharging and emission-free mobility makes it a very interesting project when analysing the sustainability ambitions within the smart mobility playfield. If a light is thrown upon the Venn diagrams of Lyons, this project would definitely be placed in diagram D, because it is very clear that sustainability is the main aspect and smart is only a, though very important, means to achieve it.

4.3 Smart sustainable mobility policies

All above described projects are examples of mobility policies that address the smart component, the sustainability component, or both. The relationship that evolves between these two different components can differ, as is explained with help of the Venn diagrams presented by Lyons. This paper advocates for a strong orientation towards sustainability, towards the reduction of CO2-emissions and energy use by mobility. Therefore, it is required that policy makers adopt a vision that fits within diagram B, where smart and sustainable are two interdependent components, or even more ideally within diagram D, where sustainable is the major component and smart the minor one, the means to the end.

This vision then should lead to projects and programmes that are primarily aimed at sustainability. The case study has illustrated that such projects can be governed in different ways. The initiator of a project can for example be a local entrepreneur, such as with LomboxNet. But it can also be a larger company, a municipality herself (whether or not commissioned or supported by higher governmental levels), or a combination of those parties. The latter is the case with for example Strijp-S, where the municipality cooperates with a bunch of companies and institutions in the area to govern the mobility projects.

It should be said that there is not one single proper way of policy-implementation and project design. What works in one district of a city might not work in another one, but may work in a comparable district of another city. Therefore it helps to experiment, to try new technologies in different ways, to share experiences and knowledge and to cooperate. Projects such as Smart Solar Charging and the national MaaS-pilot, that is among others executed in Eindhoven, are a big step in the good direction. What is really crucial in establishing more smart sustainable policies is a local government that has a strong vision on new mobility possibilities. A vision that states that sustainable mobility is

an absolute must, that new developments always should contribute to a more sustainable and more liveable city and that technology plays not a leading but a serving role in this.

References

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I. & Airaksinen, M. (2017). What are the differences between sustainable and smart cities? *Cities, 60*, 234-245.

Albino, V.B. (2015). Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *Journal of Urban Technology, 22*(1), 3-21.

Banister, D. (2007). Sustainable transport: challenges and opportunities. *Transportmetrica, 3*(2), 91-106.

Berger, G., Feindt, P.H., Holden, E. & Rubik, F. (2014). Sustainable Mobility - Challenges for a Complex Transition. *Journal of Environmental Policy & Planning, 16*(3), 303-320.

Campbell, S. (1996). Green Cities, Growing Cities, Just Cities? Urban Planning and the Contradictions of Sustainable Development. *Journal of the American Planning, 62*(3), 296-312.

Caragliu, A., Bo, C. de & Nijkamp, P. (2011). Smart Cities in Europe. *Journal of Urban Technology, 18*(2), 65-82.

European Commission. (2011). *White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system.*

Gehl, J. (2010). *Cities for People.* Washington: Island Press.

Haarstad, H. (2017). Constructing the sustainable city: examining the role of sustainability in the 'smart city' discourse. *Journal of Environmental Policy & Planning, 19*(4), 423-437.

Hiremath, R.B., Balachandra, P., Kumar, B., Bansode, S. & Murali, J. (2013). Indicator-based urban sustainability - A review. *Energy for Sustainable Development, 17*, 555-563.

Hollands, R.G. (2008). Will the real smart city please stand up? *City, 12*(3), 303-320.

Lyons, G. (2016). Getting smart about urban mobility – Aligning the paradigms of smart and sustainable. *Transportation Research Part A*. doi:http://dx.doi.org/10.1016/j.tra.2016.12.001

Martin, C.J., Evans, J. & Karvonen, A. (2018). Smart and sustainable? Five tensions in the visions and practices of the smart-sustainable city in Europe and North America. *Technological Forecasting & Social Change*. doi:https://doi.org/10.1016/j.techfore.2018.01.005

Nam, T. & Pardo, T.A. (2011). Conceptualizing Smart City with Dimensions of Technology, People and Institutions. *The Proceedings of the 12th Annual International Conference on Digital Government Research*, (pp. 282-291).

Papa, E. & Lauwers, D. (2015). Smart Mobility: Opportunity or Threat to Innovative Places and Cities? *20th International Conference on Urban Planning and regional Development in the Information Society* (pp. 543-550). Ghent: CORP – Competence Center of Urban and Regional Planning.

Ringenson, T. & Höjer, M. (2016). Smart City Planning and Environmental Aspects? *4th International Conference on ICT for Sustainability* (pp. 159-166). Atlantis Press.