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Market development strategies for Smart Cities: How can an open innovation policy make Berlin a testbed for automated, connected and electrified passenger transport?

Dr. Nico Grasselt, Martin Sölle[1]

[1] *Berlin Agency for Electromobility eMO, Berlin Partner for Business and Technology GmbH, Fasanenstrasse 85, D-10623 Berlin, Germany, nico.grasselt@emo-berlin.de, martin.soelle@emo-berlin.de*

Abstract Summary

The paper describes the strategy of the City of Berlin to promote the local development of electromobility both in terms of putting new mobility solutions into visible practice and strengthening its economy. The region combines all the key systems of electromobility – vehicles, transport and energy – into a single approach which is supported by one agency (Berlin Agency for Electromobility eMO). eMO agency follows a holistic approach to set up and support an agile Open Innovation ecosystem for intelligent mobility, where practical applications are tested and concurrently adapted for industrial-scale rollout. On the long run these ecosystem will support the bigger picture of the Smart City Berlin and enables Berlin to become a key provider for future mobility solution. This paper covers the main criteria which are needed to successfully fulfil this challenge.

1. Challenges for Smart Cities

The growth and compaction of cities are global trends that not only pose technological and economic challenges but are also associated with ecological and social issues. Progressive urbanization makes a significant contribution to increased traffic emissions and is driving climate change. The transport sector plays a key role in ensuring that life in expanding and changing cities remains tolerable. The pressure on existing public mobility services is increasing and traffic flows are changing.

New mobility technologies and concepts are swamping the market; private and public transport is converging. The future of mobility lies in the intelligent combination of different modes of transport and in the digitalization of transport. Information and communication technologies are creating smooth, user-oriented transitions between private and public transport.

Electric vehicles (EV) can be one key to facilitating this complex global process of change while at the same time helping to spark new developments. EV-solutions are already on the market for quite a while and in some countries and regions like Norway, The Netherlands or California market penetration and market share have already reached a significant impact. Just recently Great Britain, France and of course Norway defined exit strategies for using fossil fuels in vehicle engines. But still, affordable EV-solutions for the mass-market especially in public transport sector or city logistics are on an early stage. Although there are varieties between different countries and regions, in general one can say that electromobility faces not just technological or infrastructural but also major societal challenges.

For example the German Capital Region (Berlin-Brandenburg) has the highest number of EVs in metropolitan area in Germany (currently around 4.600 EV).[1] In relation to about 1.400.000 registered vehicles in Berlin that is obviously just a drop in the ocean.[2] But simply exchanging conventional cars by electrical ones does not solve any mobility related problem for cities.

Berlin of course has a well-developed public transport system and is already the German capital of sharing economy. The numbers of inhabitants in Berlin which are not owning a car is significantly higher that the number of car owners. Citizens in Berlin are used to use different modes of transport.

[1] The Governing Mayor of Berlin Senate Chancellery 2017
[2] Kraftfahrt-Bundesamt (KBA): Pressemitteilung Nr. 6/2017

But still, especially metropolitan areas like Berlin are on the one hand side in need for innovative mobility solutions in order to cope with major societal challenges and are on the other hand side influenced by general global mobility trends:

- Challenges like air pollution and health issues (e.g. noise, particulate matter and Nitrogen oxides)
- Climate-Change and Traffic-related CO2 emissions
- Growing Cities as well as city densification and its impact on urban traffic situations
- Global trend to more intermodality and the need to offer barrier-free systems
- Increasing individualism and higher traffic volumes, increasing commuter traffic
- The trend from vehicle ownership to need-based use of transportation system (mobility on demand) and Mobility as a Service (MaaS).

A holistic approach is necessary in order to promote the local development of electromobility and to help to face those challenges. Electromobility alone cannot help to solve major challenges and support global mobility trends. Agile players (particularly start-ups) are entering the stage and adding innovative new stimuli to the field. For metropolitan regions with a lack of economic power like Berlin especially in traditional industries and strong ICT and Service Sectors, this dynamic development offers the chance to generate more added values and create more jobs. New global trends like automated and connected driving and digitization in general are supporting the Berlin specific location factors.[3] In combination with these general trends electromobility is changing existing value-adding structures in the transportation and energy markets and opens room for new technology and business cases.

"Smart City" is the integrated approach to all the future topics with which Berlin – like many other cities in Europe and worldwide – will be dealing with in the decades to come. In 2015, the Berlin Senate decided on the Smart City Berlin Strategy, where electromobility plays a crucial role to link energy, transport and traffic system in order to make urban areas smart and creating a pilot market for innovative applications.[4] Additionally the City of Berlin has set up an Energy turnaround law. The goal is to become climate neutral until 2050 (minus 85% in reference to 1990).

[3] McKinsey Berlin 2016

[4] Senatsverwaltung für Stadtentwicklung und Umwelt 2015: Smart City Strategie Berlin

The traffic sector is an important aspect to achieve this target.[5] In 2017 the Senate of Berlin in addition decided to push for example bicycle traffic and in addition support intelligent mobility more strongly which includes collective electromobility and innovation activities on automated driving. In this bigger picture the smart and climate neutral City of Berlin opens space for new business solutions meeting citizens future mobility needs.

The questions of this paper are – within this given framework and political goals – how can Berlin become a hotspot for new mobility solutions in terms of new ITS-Technology and Mobility Services and how should an Open Innovation approach look like to help accelerate those efforts? In order to answer the questions this paper will describe the specific Berlin approach in part 2 which leads to the Smart eMobility concept the eMO agency is implementing (part 3). In addition the article defines some criteria to create an active Open Innovation Ecosystem system for intelligent mobility (part 4).

2. The Berlin approach

Suffering from deindustrialization since the early 1990s Berlin has been in strong need to focus on new innovative businesses to create jobs and economic growth. To support this purpose the joint innovation strategy of the two German Federal States Berlin and Brandenburg (innoBB) was established.6 The capital region, with its excellent research and technology expertise, already has a leading position in the German and international innovation landscape. Joint efforts are the appropriate way to implement the requisite measures in targeted and effective ways. This policy includes electromobility as key future technology in order to cope with challenges of future mobility.

Therefore the Berlin Agency for Electromobility (eMO), founded in 2010, is supporting as a one-stop agency the market development by providing promotional services and joint projects funding advisory as well as consultancy and supervision. Ultimately an environment conducive to innovative companies and research institutes needs to be created that will encourage businesses to move to the area, expand or start up.7

The strategy of eMO follows a holistic approach to bundle local value added services and create a strong network for collaborations between the private sector and science to create innovative applications. In 2012, Berlin-Brandenburg has been chosen by the federal

[5] Abgeordnetenhaus Berlin 2017: Gesetz zur Änderung des Berliner Energiewendegesetzes (EWG Bln)
[6] Wirtschaftsförderung Land Brandenburg 2017: Joint innovation strategy of the States Berlin and Brandenburg (innoBB)
[7] eMO 2014: Action Plan for Electromobility

Government of Germany to become one of four regions to take part in the Electromobility Showcase initiative. The objective of these large-scale regional demonstration and pilot projects (volume of € 80 million per region) is to test and promote electromobility at the interface of vehicles, energy systems and traffic systems (as indicated below).

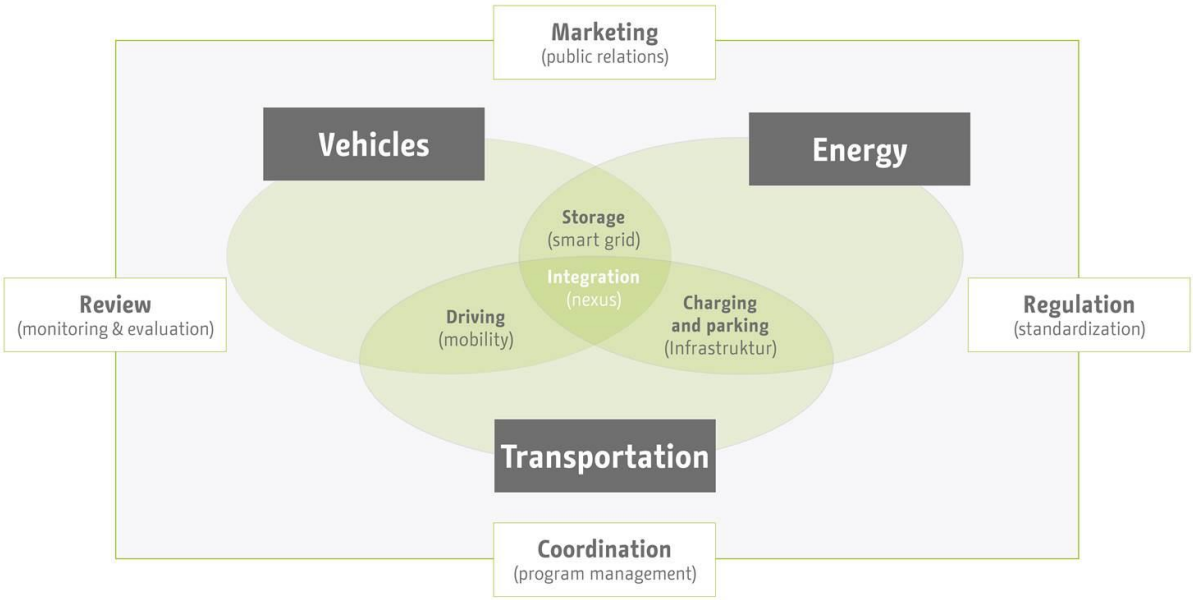

Figure1: EMO Agency´s fields of action

In order to steer new mobility technologies, products and services to market maturity, eMO combines the region's strengths. Berlin is a hotspot of mobility transformation and the location has crucial benefits for the implementation of "smart electromobility"8:

- an excellent public transport network and low car ownership,
- an affinity for new mobility concepts and multi-modality, along with a pronounced sharing culture,
- a dynamic landscape of young, creative start-ups and a dynamic ecosystem of innovation acceleration,
- a high proportion of scientific institutions and research-oriented engineering service providers,
- "global players" in the city and a distinct SME environment in the technology sectors: ICT, automotive, rail technology, aerospace, electric and automation technology, as well as sensor technology,

[8] eMO 2017: Strategy

- established cross-sector and international collaboration among stakeholders in the Transport, Mobility and Logistics Cluster to enable "cross-innovation",
- strategic collaboration with the State of Brandenburg, in the field of regenerative energies (Berlin as an energy drain), for example.
- In Berlin-Brandenburg more than 100 project partners drawn from the worlds of politics, business, and science, including global automobile brands, take part in Showcase projects.

After the Electromobility Showcase initiative has been completed in 2016, eMO is funded by the Senate of berlin and private partners to continue its activities to developing this approach forward from demonstration and pilot projects towards the creation of sustainable business cases to make the City of Berlin a testbed for automated, connected and electrified passenger transport.

3. Smart eMobility and best practices solutions

Many projects, firms and research facilities in the capital region are already identifying current trends in mobility transformation. New technologies and the sustainable use of natural resources when transporting people and goods play an important part in reducing health risks due to traffic-related pollution and noise. eMO identifies current trends in mobility transformation in order to bundle and accelerate the skills and activities of stakeholders in the capital region. In order to promote the topic of smart mobility in the capital region, eMO performs the following tasks:

- initiates pilot projects at a regional, national and international level,
- positions the region as a leading market and leading provider of intelligent mobility solutions,
- bundles and structures the issues,
- networks between existing and new stakeholders,
- increases the visibility of projects, products and firms,
- promotes and integrates a vigorous start-up culture,
- provides information about market trends and developments,
- increases the transparency of activities in the region.

eMO therefore supports the development and testing of efficient, low-emission and resource-saving mobility and transport solutions, which combine new concepts and alternative drive forms, while optimally complementing existing services. It drives the topic of smart mobility,

together with the Transport, Mobility and Logistics Cluster (TML)[9] and the Transport, Mobility and Logistics Sector of Berlin Partner für Wirtschaft und Technologie GmbH.[10] Its activities follow the so-called CASES approach: connected, automated, shared, electrified and sustainable mobility.[11] This approach comprises the three pillars of sustainability: environmental, economic and social sustainability.[12] It therefore exploits the opportunities of technological, social and ecological innovation by doing more than simply electrifying vehicle powertrains, thereby making mobility safer, cleaner and more sustainable and helping improve people's quality of life. With that guidelines eMO makes a significant contribution to Berlin's Smart City Strategy.

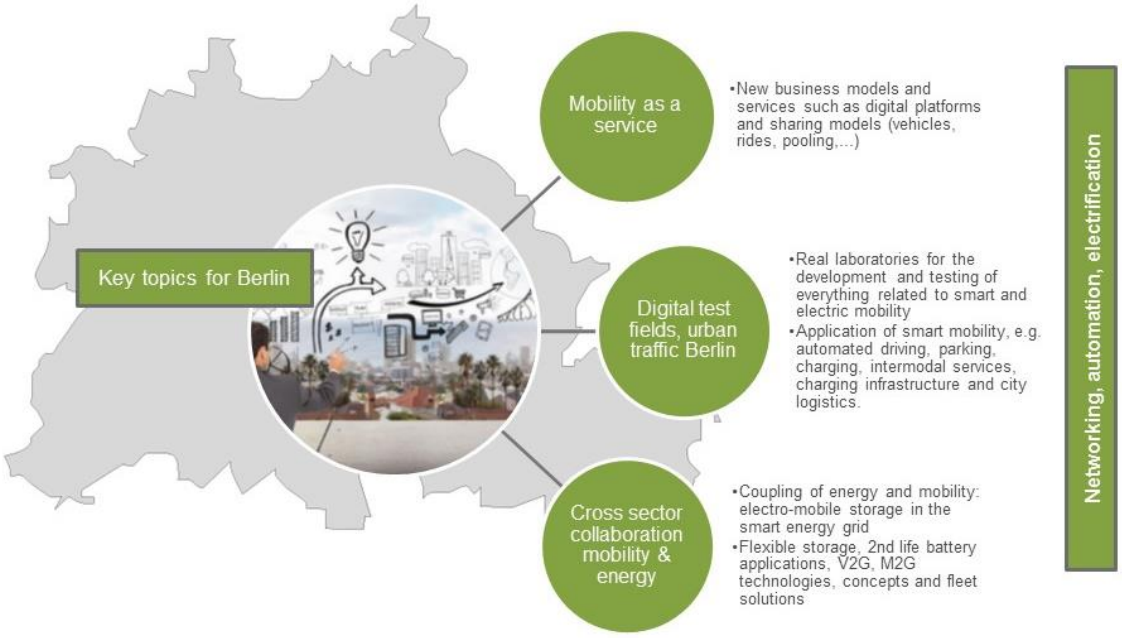

Figure 2: Intelligent Mobility key topics for the City of Berlin

Three key topics for the City of Berlin including best practices examples help emphasizing the Berlin innovation approach with demand and technology oriented EV solutions (Figure 2). The following is a brief explanation about the three key topics with some best practice examples.

[9] Cluster Verkehr Mobilität und Logistik 2017
[10] Berlin Partner 2017
[11] Daimler 2016: CASE - Neue strategische Schwerpunktsetzung in der Mercedes-Benz Cars Strategie
[12] General Assembly of the United Nations 2011

3.1 Mobility as a Service

Need-based technical transport solutions and mobility concepts must be researched, developed and tested for the growing metropolis of Berlin. The effective interplay of the various means of transport is just as important for a smart city as efficient and sustainable supply and disposal mechanisms. The challenge lies in the efficient interlinking of collective and individual mobility. New concepts and business models help reduce traffic congestion and optimize routes in the smart city of Berlin. App-based mobility services combine the strengths of different modes of transport. Smart mobility offers are being tested in digital test fields for city traffic and integrated in future transport concepts. Since sharing services with electric cars are mainly operated by subsidiaries of big OEMs (e.g. DriveNow, Car2Go, Multicity) and new players with on demand and door to door services (e.g. Clever Shuttle with services in seven German Cities and the Door2Door GmbH just lunched its service). There is in addition a market gap for scooter sharing. In 2015 the Berlin start-up emmy launched their local service with only 150 electric scooters as a free-floating system, fully accessible by mobile applications. In 2016 the Bosch daughter COUP added another 200 scooters within their own App-Service. In 2017 the two companies already have almost 2000 electric scooters at place in Berlin. Emmy just recently expanded to Hamburg, Stuttgart and other German Cities, COUP just expanded to Paris. In addition eMO supports several MaaS projects.

For example New Mobility Berlin (NMB) analyzes and supports the introduction of e-mobility solutions in Berlin's city districts in combination with new land use concepts and mobility services. The project examines the possibilities and limitations of local mobility. The aim of the project is to inspire the local players, upgrade certain neighborhoods through innovative mobility concepts and thus increase the quality of life in urban areas. NMB intends to involve all relevant local stakeholders and promote the development of a sustainable mobility concept. This includes using public road space more flexibly, testing and experiencing innovative technologies in a user-oriented way in a real laboratory as well as using "freed-up parking space" to increase residential quality in the neighborhoods and for other purposes. Once successful, the initiators want to include, in agreement with the Berlin Senate, more districts and neighborhoods in their plans. The approach supports Berlin's energy and climate goals as well as its Smart City strategy.[13] While NMB aims for improvements for passenger transport other activities deal with City-Logistics.[14]

[13] eMO 2017: New Mobility Berlin (NMB)

[14] For example “Distribut(e)”, eMO 2017: Distribut(e): Grüne Kiez-Lieferketten für die Stadt von morgen

3.2 Cross Sector Collaboration

Another very important topic for Berlin is the collaboration between mobility and energy sector. Electric vehicle traction batteries – whether cars, trucks or buses – can make a significant contribution to the implementation of the energy transition. Using them to temporarily store electricity from renewable energy sources has tremendous potential: during the charging or service time, the electricity from solar or wind power plants can be cached and fed back into the electricity grid when it is needed. Intelligently controlling the charging process in the vehicle can also prevent so-called load peaks and valleys that can reduce the costs related to the build-up and extension of the electricity grid. These positive effects of electromobility are tested in a variety of projects in order to drive the success of the energy transition. It is necessary to research the technical interplay of the various components, such as photovoltaic systems, vehicle batteries and the charging infrastructure. Economic aspects must also be considered and business models developed, which will benefit the owners of electric vehicles as well as the operators of electricity grids and renewable electricity power plants. In order to advance Cross Sector collaboration eMO is supporting several research and implementation activities in the region such as:

- "Mobility2Grid" is a Research Campus funded by the "Federal Ministry of Education and Research" (BMBF) and conducting research in the field of "Vehicle to Grid" (V2G) solutions, micro smart grid management and bidirectional charging technologies and use cases.[15]
- "Windnode" a project supported by the Federal Ministry for Economic Affairs and Energy (BMWI) and a national showcase for intelligent energy solutions in Northeastern Germany. The goal is for example combining transport and energy systems to integrate traction batteries (mobile & stationary) in view of the dynamic growth of volatile, renewable energies.[16]
- "Sleep & Charge" is support by the City of Berlin and aims to expand Berlin's charging infrastructure in proximity to hotels, thus making tourism in the capital city more sustainable. In addition, the number of charging points for electric vehicles in the urban area will be increased.[17]

[15] Mobility2grid 2017
[16] WindNODE 2017
[17] The Senate Department for Economics, Technology and Research is supporting the project with funds from the Berlin City Tax: eMO 2017: Sleep & Charge

3.3 Digital Test Fields for Urban Traffic

A very dynamic Topic for Research and Development are currently activities to develop Demonstrators and test fields for intelligent mobility to connect digitalization, automation and electrification of urban transport services. In connection with smart infrastructure it plays a major role for future urban traffic and public transport. To complement the existing public transport system in the Berlin region there is for example a demand for smaller and more flexible minibuses for peripheral areas.

To create a future proof system the Berlin based company Local Motors (coming from US) has developed a purpose-design Mini-Bus-Shuttle which has high level connectivity and autonomous driving capabilities. Between 2016 and 2017 this autonomous Shuttle System (Called "Olli") was tested under real time condition in Berlin on the EUREF campus. For Local Motors Berlin GmbH, the focus was on whether a driverless "people mover" can make a contribution to the public transport network, closing gaps and significantly increasing accessibility and comfort for the users. The concrete objective is to test the "Olli" prototypes from Local Motors in a real urban environment. Local Motors was using the first test field for (highly) automated and connected public transport in Berlin to collect experiences under real but nevertheless protected conditions (no public roads) that can feed directly into the parallel batch production in Berlin. It was the first project implemented in Germany and is supported by the Senate of Berlin and Deutsche Bahn.[18]

Overview 1: "Olli" Picture source Deutsche Bahn and Map Pilot Route source InnoZ (It shows the route at EUREF Campus Berlin)

[18] eMO 2017: First Mover

Other pioneer project followed in 2017. For example DIGINET-PS: The digitally connected 'protocol route' – an urban test field for automated and networked driving in Berlin. The DIGINET-PS research project involves the development and implementation of a networked urban infrastructure test field along a stretch of "Straße des 17. Juni" between Ernst-Reuter Platz and the Brandenburg Gate.

The project is designed to advance and validate automated and autonomous driving and its broad range of individual areas under real-life traffic circumstances. The test infrastructure is intended to provide central, regional and supra-regional companies and R&D institutes with the opportunity to field test automated driving within an authentic urban setting. This will establish Germany's first pilot project to build a digital test field for automated driving in highly complex traffic situations. DIGINET-PS will contribute to implementing Berlin's smart city strategy in the area of mobility and will also support the state's Digital Agenda. The project follows three major objectives:

- Development of a real digital infrastructure and a virtual test and validation environment for automated vehicles
- Establishment of an open and scalable platform for testing automated and networked driving
- Establishment of an ecosystem of key players who are working on the future of automated mobility and the collaborative development of new applications

The Diginet-PS test field is supported by the Federal Ministry of Transport and Digital Infrastructure (BMVI) within the framework of its funding guideline "Automated and Networked Driving at Digital Test Fields in Germany".[19] DIGINET-PS will contribute to implementing Berlin's smart city strategy in the area of mobility and will also support the state's Digital Agenda.

The City of Berlin, the Berlin Transport authority (BVG) and the University Hospital Charité just recently (3rd of August 2017) announced a testing project for four automated electric shuttle under real time conditions at two campus areas in Berlin Mitte beginning in 2018. The testing will include three lines to transport visitors, patients and employees under real-time conditions on non-public roads.[20] Soon there will be a second BMVI test field established in

[19] eMO 2017: DIGINET-PS and DIGINET-PS 2017
[20] Charité 2017: Gemeinsame Pressemitteilung von BVG, Charité und Land Berlin

Berlin conducting R&D of updating high resolution maps for autonomous driving and the necessary ICT Infrastructure for automated and connected driving.

Just to give a brief overview about the numbers, at the end of 2016 there was only one R&D Project known in Berlin which was addressing automated and connected transport issues (Volume around 400.000 Euro). By the end of 2017 eight major R&D activities (Projects or studies) are launched and funded by national and regional funds. These projects are involving several stakeholders from research institutions, science, industry and from public administrations (Volume more than 12.000.000 Euro only by public funding).

All those activities addressing different R&D areas and fields of interest: technological, environmental, social challenges, regulatory issues, security questions, promising use cases and business models in order to identify the best automated and connected transport solutions. This holistic approach strengthens Berlin as an excellent location for conducting research and business development. In addition new public transport systems help to improve the quality of public transport for example in terms of efficiency in low demand time. This gives public transport operators like Berlin transport authority (BVG) or also Deutsche Bahn opportunities to connect new housing areas in the fast growing Smart City Berlin with new on demand services.

The next section will discuss specific criteria to establish an agile network of stakeholder which does help to stabilize this positive development and creating an Open Innovation ecosystem for intelligent mobility.

4. An Open Innovation Ecosystem for Intelligent Mobility

In chapter three we described a lot of different innovation activity. Here we try to summarize the different characteristics identify some criteria or some condition which help to establish an Open Innovation ecosystem for intelligent mobility at least in Berlin or similar metropolitan cities. Open Innovation simply means to open an innovation process within an organization for the outside world to accelerate the internal innovation process and vice versa.[21] It can be described as an "(..) innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model".[22] But what does that mean for Smart Cities in order to

[21] It is all about the management of knowledge and the knowledge flow as an "Outside-In- Process" an "Inside-Out-Process" and a "Coupled-Process". BGW 2017

[22] Chesbrough/Bogers 2014

optimize their transport and mobility system towards the CASES approach as we described it above?

Most of the CASES themes come along with disruptive technologies or at least open the door for disruptive business cases. Disruptive technologies significantly alter the way that businesses operate: "A disruptive technology may force companies to alter the way that they approach their business, risk losing market share or risk becoming irrelevant."[23] Organizations very often can only support incremental innovations to improve efficiency because of internal or external barriers (cultural, financial, regulatory and organizational). Although incremental innovations have of course advantages.[24] The ability only to focus on incremental innovation reduces the chances to develop new products or a new service portfolio. In general "Open innovation can be understood as the antithesis of the traditional vertical integration approach where internal R&D activities lead to internally developed products that are then distributed by the firm."[25] For Cities incremental innovation – or with other words the traditional vertical integration approach – might help preserve and develop existing systems but it makes it more difficult to adjust public services and systems (for example the transport system) to new (disruptive) technologies. This makes it difficult to integrate and test business cases which come along with those technologies. The following criteria are recommended to support an agile Open innovation process to support intelligent mobility solutions in Smart Cities, where practical applications can be tested and in the long run help to adapt industrial-scale rollout:

- Open Innovation needs of course to be **science based**. Technological innovation comes mostly from R&D. But it is a long way to bridging the gap between academe and business. Berlin has of course an excellent science and research community. This community needs to be linked to the economic structure. It is diverse and is shaped by industrial firms with long traditions. Berlin has strong SMEs and a dynamic service sector, as well as innovative high-tech businesses. Innovation intermediaries can help bringing together research and SME-industry.
- Intelligent mobility solutions in Smart Cities need to be **demand-driven** and contribute to the solving of local transport problems. Berlin has twelve boroughs or districts. Each district has its own local government and its own requirements for efficient mobility to solve although the all belong to the City of Berlin. But in addition you will find a highly efficient public transport system. It is important to bring new mobility solution to those

[23] INVESTOPEDIA 2017: Disruptive Technology
[24] Globerman/Lybecke 2014 and Grasselt 2016 Grasselt, Nico 2016: 43-54.
[25] Chesbrough 2011

districts or regional locations where are transportation problems. New ideas and companies always want to be present in the center of the city but this might not be the place where the demand is high.

- On the other hand one will find different quarters within these districts which have its own mobility problems and mobility demands. It is important to include citizens which are willing to change mobility behavior. This **participatory approach** to innovation helps to develop intelligent mobility more distributed and more decentralized. It is very important to bring this demands together with new mobility solutions in order to find a fertile soil to bring new mobility solutions to demand and finally to market.
- Cities strategy often lacks a **start-up mentality**. Berlin is the start-up capital of Europe because of its comparatively low cost of living, lively local life and international environment. These are some of the reasons for young entrepreneurs to realize their business ideas in this location. As a result, the city has developed into a start-up hub with the highest levels of growth in Germany in recent years. But because of internal restrictions public bodies are often not able to take risks, to test disruptive mobility solutions and adapt quickly to a changing mobility world. For cities it is not easy to change policy radically therefore there should be an opportunity to test new solutions in "pilot project" or "learning projects" and in addition the accept failure of a pilot project.
- Classical R&D Projects normally answering a certain research question and are not to looking beyond that subject. A **platform approach** might help to add the right projects at the right time to a research network. Therefor it is essential to set-up projects which allow adjusting research activities to a dynamic environment, to look after new research questions and also collaborate with new partner. It requires to think more in R&D networks than in closed R&D projects.
- In addition testing laboratories and **test fields** in public space are necessary in order to test solutions under real time conditions. To create one test field for different ideas makes it easier to bring together recourses from industry, science and public administration. It might be easier to give exemption clause in an area where already a lot of R&D activities are conducted than to define for each idea an own testing space. In addition it makes it easier to promote the location to the outside world. Transport and mobility solution in general need a public space to be tested.

Of course there are certain instruments like public funded technology programs, enabling producer-user relationships and spending for R&D that support innovation processes.[26] Most important is an ecosystem of different stakeholder groups which support innovation activities. To moderate those stakeholders is often a challenging task and a neutral entity is needed. eMO takes over this role in Berlin in order to create an efficient output from the complex ecosystem of stakeholders.

5. Summary: An Open Innovation Approach to cope with future challenges

This paper has developed a framework and strategic recommendations on how Berlin can become a hotspot for new mobility solutions in terms of innovative ITS-Technology and Mobility Services and furthermore has discussed the meaning of how Open Innovation approaches should look like to help accelerate those efforts. In order to cope with current challenges of a growing metropolitan area Berlin is strongly focusing on non-traditional (with other words future) technologies. Regional strategies have been set up to provide efficient infrastructure, informational networking and creativity ultimately combining high productivity with high quality of life.[27] An important part of the Berlin innovation policy is the creation of test fields for automated, connected and electrified passenger transport. Within these (open) laboratories pilot projects are set up to showcase new technologies with the clear goal to create new market-oriented products and services. Under real-time conditions and focusing also on questions like communication technologies or user acceptance, the new digital test fields for city traffic will be focusing on two main purposes: developing mobility solution for the smart cities of tomorrow and helping local companies to grow along an ever-changing value-added chain to be ready for future markets.

[26] Innovation Future 2017: Demand and Supply-Driven Innovation Policy
[27] eMO 2017: Smart Mobility

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Authors

Dr. phil Nico Grasselt is Innovation Manager at Berlin Agency for Electromobility eMO a branch of Berlin Partner for Business and Technology GmbH, a public private partnership to support companies, investors and scientific institutions in Berlin. Nico Grasselt used to work as managing Director for the NRW School of Governance. From 2010 until April 2015 Nico Grasselt used the work as Manager at the Potsdam Institute for Climate Impact Research (PIK) and the EU Initiative EIT Climate-KIC.

Martin Sölle (MBA&E) has worked for the Berlin Agency for Electromobility eMO since 2011 as Project Manager for Vehicles System and ICT. He was previously working for Volkswagen and holds a master´s degree in Business Administration and Engineering.