

 reviewed paper

On the Path towards Smart Mobility: the Journey of three Forerunner Cities Eindhoven, Manchester and Stavanger

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1 ABSTRACT

Within the European Smart Cities and Communities Project - Triangulum (SCC1), focus areas have been selected for their transformation into living labs in the three cities, Eindhoven (NL), Manchester (UK) and Stavanger (NO). In Manchester it is a 2 km spine referred to as “The Corridor” that is home to two of the UK’s largest universities and one of the largest medical research campuses in Western Europe. In Eindhoven the former Philips industrial complex in the “Strijp-S” and the Eckart Vaartbroek neighbourhoods have been chosen for the implementation of the planned activities and in Stavanger the focus area is the Paradis/Hilleveg district. These areas will be transformed into sustainable living environments during the course of the project, which started in February 2015 and will reach completion in January 2020. The aim is for them to become well-connected low carbon areas, which shall be reached by implementing clean technologies as well as innovative and alternative mobility concepts.

Understanding the city context, their approach, as well as the challenges the cities have faced in the implementation, is the basis for initiating a replication process of similar projects not only in the Triangulum Follower Cities but in any other city willing to invest in the field of sustainable and future-oriented mobility. This paper describes the Triangulum Lighthouse Cities’ journeys to becoming a reference for smart mobility.

Keywords: Stavanger, Manchester, smart mobility, Lighthouse cities, Triangulum

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2 INTRODUCTION

2.1 The Triangulum Project

In Triangulum the aim of the Lighthouse Cities is to demonstrate that the integration of technologies from the energy, buildings, mobility and ICT sectors within a district can induce significant reductions in energy demand and local GHG emissions and at the same time enhance quality of life, and provide a basis for economic growth and development. The project consortium combines the interdisciplinary experience and expertise of 22 partners from industry, research and 6 municipalities, committed to develop and implement smart solutions which are planned to be further disseminated and replicated primarily, in the three Follower Cities: Leipzig (DE), Prague (CZ) and Sabadell (ES) but also beyond.

As an overarching objective, Triangulum seeks to develop a model for the replication of smart city solutions based on cost and benefit as well as maximize the dissemination and impact of the knowledge and innovation generated during the project. The replication approach has the following three stages as shown in the graphic below: demonstration, assessment and replication. In the demonstration phase projects such as E-bus lines in public transport are implemented to show how public and private actors can work together to jointly improve the quality of life in the cities. The assessment phase serves to generate robust evidence by describing and quantifying the impacts and the benefits. Later and based on the former, business models that enable replication in the Follower Cities and beyond are elaborated. To facilitate all this process “on-site assessments” took place in the lighthouse cities. The visits took place between late 2015 and early 2016 and were led by researchers from the Institute of Human Factors and Technology Management (IAT) at the University of Stuttgart, the Fraunhofer Institute for Industrial Engineering (IAO), the Fraunhofer Institute for Open Communication Systems (FOKUS) and TÜV Süd. Each of the assessments took place over a period of approximately two weeks, undertook 25-40 interviews (political, management and technical) and a creativity workshop. All of this activity was supported by the local Triangulum coordinators in the cities.

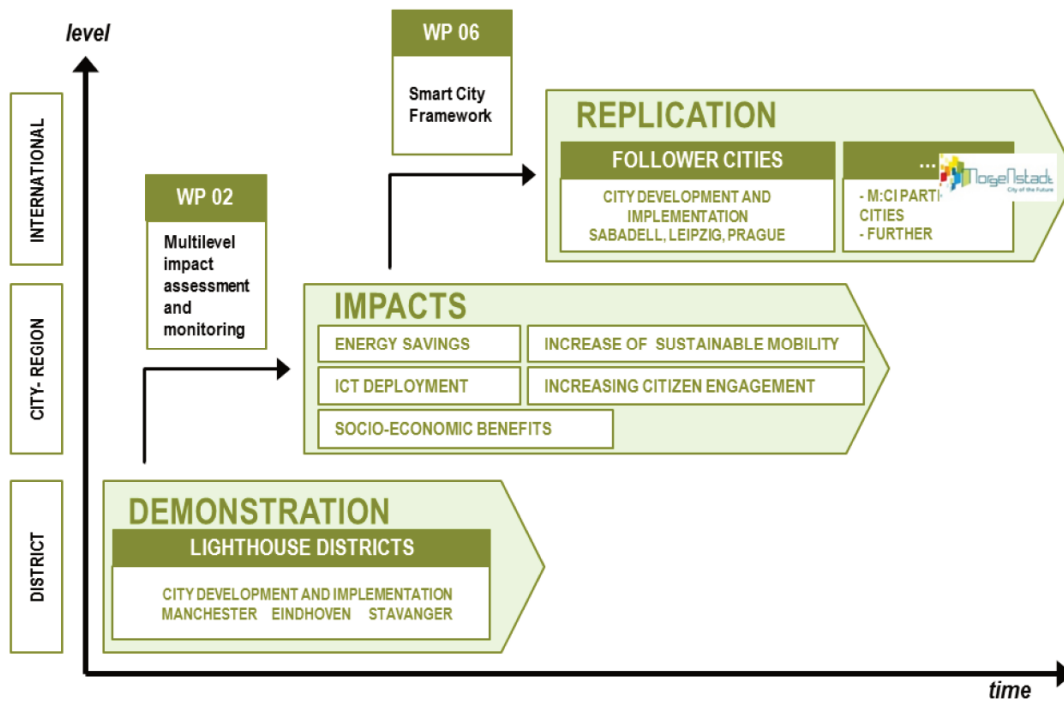


Figure 1: Triangulum Demonstration, Expected Impacts, Replication¹

3 BACKGROUND

3.1 The Journey - How did it all start?

Each of the lighthouse cities in Triangulum has a particular story of how they became a smart city and this is linked to their city context.

In Manchester the journey began in the 90’s with the development of the cities “information society”. This promoted the development of digital inclusion projects and supporting digital infrastructure. Later in the 2000s a local digital agenda was set, working towards the growth of the digital sector through projects focusing on e-Government and digital innovation. Ten years later, the smart cities era began to deliver cloud computing and the potential of the internet of things. The current city-wide approach includes private and public partnerships with the focus laying on smart energy and transport.²

Although the city made unsuccessful bids to host the Olympic Games, this was part of a process that helped to raise the international profile of the city. The Commonwealth games in 2002 were a successful story and built on the legacy of the earlier submissions. The games attracted huge investments in infrastructures and were the beginning of strong partnerships that last until today.

The focus area for the Triangulum project is the Corridor area. This was established in 2002. The formal partnership Corridor Manchester integrates two of the UK’s most important universities, the University of Manchester and the Manchester Metropolitan University, with the Central Manchester University Hospitals NHS Foundation Trust, Manchester City Council and Manchester Science Partnerships; MSP is a private company and the UK’s leading provider of specialist environments and growth support to science and technology companies. The Corridor is therefore a unique location, at the heart of Manchester’s knowledge economy. With a 60,000 strong workforce and around 70,000 students, it is recognized as an innovation district with leading higher education, health, cultural and important commercial assets.³

Regarding Eindhoven, one of the main drivers for urban development has been the long history of entrepreneurship driven by companies like Philips and DAF. By the time Philips was founded in 1891, Eindhoven was a rural farm. The gradual evolution of Philips into a multinational company turned this city into a major industrial centre triggering a rapid urban growth during the 20th century. Next to the creation of

¹ EU SCC1 Triangulum Project, “Triangulum Grant Agreement”, 230.

² Nixon, “The Strategy of the City of Manchester”

³ Corridor Manchester, “About Us.”

jobs, Philips played an active and important role in the city's urban development, e.g. by building neighbourhoods for workers, running schools, offering health care services, constructing a library, supporting the local football team and the Technical University Eindhoven TU/e.

During the recession in the 1980s, Philips moved its manufacturing processes to cheaper production sites, which included the giving up of around 14000 local employees until 1993. Additionally, the collapse of DAF cut 2.500 jobs.⁴

The Regional Authority for Greater Eindhoven was set up in the 1980s as a governmental initiative to improve the economic situation through cooperation on the regional scale. Later on, with the aim of mobilizing European funds, the economic development office (NV REDE) was founded in the 1990s and kicked-off the strong collaboration between the local stakeholders, e.g. the Chamber of commerce, TU/e and municipalities. This resulted in the foundation of the Commission for Regional Opportunities which eventually led to the foundation of the public-private partnership Brainport Development, which acts at regional level and has actively been shaped for becoming an innovation centre.⁵

Stavanger has been the centre of the Norwegian oil industry since 1969 when oil was discovered in the Norwegian waters. Nevertheless, with the decrease of the oil price in recent years new business areas have been promoted in the context of a smart city: e.g. solutions which address the high energy consumption, smart home care services that help the increased elderly population, technologies that replace the expensive labour force and smart mobility solutions that help reducing the traffic of the large number of commuters.⁶

In 2008 Stavanger joined the governmental project Cities of the Future which involved "Norway's 13 biggest cities in an urban development project to reduce greenhouse gas emissions and make the cities nicer to live in".⁷ In 2009 the city signed the Covenant of Mayors agreement – to go further than the European ambitions on 20/20/20 by 2020. These were two important steps for becoming a smart city.

Moreover, Stavanger possesses excellent technological and infrastructural advances. The city has the highest density of EVs in Europe and a dense network of charging stations. There is a high concentration of fibre-optic cable which ensures a coverage of 86% of the population with 1GB internet since approximately 2005. This infrastructure was the basis for installing smart meters in homes and public buildings, which is endorsed by a law in Norway and special dedicated R&D programs by the Research Council of Norway (RCN).⁸

3.2 Smart city drivers & strategic approach

As every city is different from each other, very specific drivers can be identified for each of them. However there are certain conditions that have been present in all of them and that have promoted their development towards becoming a smart city;

- Political will and the expressed commitment to the sustainable development of the city have been keys for success. This is reflected in the number of strategies that have been elaborated and in the number of sustainable/smart city projects that these cities are involved in, Triangulum being one of them;
- Strategy development: the existence of a clear strategy and the definition of a common vision, has allowed for the alignment of sectorial plans and joined efforts towards the achievement of a common goal e.g. Greater Manchester Transport Strategy, Low carbon Strategy, Stavanger Roadmap for the smart city, Stavanger Common Strategic Business Plan 2013-2015;^{9 10}
- Innovation environment: the promotion of innovation being through a systematic model as in the Philips approach in Eindhoven, Lyse in Stavanger or through a founded institution as the Corridor in Manchester, has been a great push in the cities towards smart technologies in the transport sector.

⁴ Winden et al., *Urban Innovation System*, 58.

⁵ *Ibid.*, 55.

⁶ Schmidt et al., "Stavanger Onsite Visit Report- EU SCC1 Triangulum Project Smart City Replication Framework," 5ff.

⁷ Nordregio, "Cities of the Future, Norway,"

⁸ Schmidt et al. "Stavanger On-site Visit Report- EU SCC1 Triangulum Project Smart City Replication Framework," 10.

⁹ Stavanger Kommune, "Roadmap for the Smart City Stavanger,"

¹⁰ Greater Stavanger, "Strategic Business Plan 2013-2025,"

With specific reference to Manchester, the city has developed a vision and aims to be in the top flight of world class cities by 2025. A smart city program is underway led by a small team responsible for drawing funding from a range of sources including the UK Government and the EU Commission. The smart city program is looking at new ways to make the city more efficient using technology. The program is based on the work the city is already doing around transport, health, environment and energy efficiency and encourages further investments by supporting pilot demonstration projects and working with partners in the universities, business and the public sectors. Furthermore, political stability in the leadership has allowed for long term planning and has promoted economic growth. E.g. the City Council Leader in Manchester has been in the leadership since 1996.¹¹

The most important drivers for the smart city of Eindhoven are the strong research and development environment, start-up-incubators, co-working facilities, living laboratories and the entrepreneurial mentality of the inhabitants, all being components of the innovation system of the City of Eindhoven.

The system has been developed based on the fundamental idea of open innovation, the quadruple helix model, which together enable the process. The function for Eindhoven's innovation system, developed by the city's marketing organization Eindhoven 365, consists of three components: $E = U \times C$, where E= Energy, U= Unconventional and C= Collaboration. This function characterizes the Eindhoven model and underlines the relevance of the collaboration between different actors, forming the basis of the economic structure of the Brainport Eindhoven Region.¹²

The city of Stavanger has had a regional office in Brussels for 25 years, which initiates international projects. In 2013 one of them introduced the city to the SCC1 program. This was the beginning of the cooperation with Eindhoven and Manchester and led to the design of the joint proposal of Triangulum in 2014. This led to the interest of joining forces with Eindhoven and Manchester to the birth of the idea of designing the integrated project Triangulum in 2014. Since the beginning of Triangulum in 2015, the Nordic Edge Expo takes place every year and constitutes one of the "most important smart city arenas in the Nordic Countries".¹³ Stavanger is like Eindhoven also known for the quadruple helix concept (defined by the city as an extended version of the triple helix the strong involvement of the citizens), consisting of the city itself, research institutions (e.g. University of Stavanger), industry representatives (e.g. Lyse) and the citizens. This constellation allows face-to-face cooperation and co-development due to flat hierarchies and low bureaucracy. Stavanger's citizens participate more and more actively in urban development processes and have a high willingness to pay for new technologies, which has pushed forward innovation projects such as smart home applications and e-mobility.¹⁴

4 SMART MOBILITY PROJECTS IN THE LIGHTHOUSE CITIES OF TRIANGULUM

4.1 Manchester

The Triangulum mobility project in Manchester is focused on the modal shift towards more sustainable options. In the initial phase an investigation of the current state of mobility looking at movement of goods and services was carried out to capture key data and identify opportunities for implementation. Using interviews current initiatives and new opportunities were identified. The procurement and implementation of cargo bikes and electric vehicles (EV) followed this.

4.1.1 Cargo bikes

The procurement of a managed service to provide cargo "pedelecs", also known as e-bikes or power-assisted cycles, fitted with a battery powering a motor, which will assist the riders own pedalling efforts up to 15.5mph was undertaken by MMC to identify a provider. The Cycle Waggle is providing a managed service for 4 cargo bikes fitted with GPS tracking along with access to other bicycles in their fleet. Partners have full access to them including training, fleet management and maintenance. Currently the bikes are being used for

¹¹ Nixon, "The Strategy of the City of Manchester."

¹² Schmidt et al., "Stavanger On-site Visit Report- EU SCC1 Triangulum Project Smart City Replication Framework," 6.

¹³ AS, "Join the Expo | Nordic Edge Expo 2016,"

¹⁴ Schmidt et al., "Stavanger On-site Visit Report- EU SCC1 Triangulum Project Smart City Replication Framework," 7,8,9.

post services and food delivery. The company is able to use their experience and knowledge to support the users and to identify new opportunities.¹⁵ An additional stimulus has been the closure of the Oxford Rd in summer 2017. The road is closed between between 6 a.m. and 9 p.m. to all traffic other than buses, emergency and taxi vehicles plus “white listed vehicles” i.e. those on a centrally held list. The data from these assets is being collected and monitored, in order to inform future mobility choices.



Figure 2 E-cargo bike on loan to MMU post team¹⁶

Electric vehicles procurement and implementation

The MMU has procured two Nissan Leaf vehicles to be used as staff pool cars, while UNIMAN are leasing seven Nissan vans, replacing their diesel vehicles fleet. Additional charge points have been installed in each of the universities. Triangulum has therefore enhanced the business case for EVs and therefore reduced the number of diesel vehicles operated within the Corridor. Due to the success of the EVs at the MMU, they have acquired an additional vehicle at their own costs.¹⁷

4.2 Eindhoven

In Eindhoven, the mobility tasks involve on the one hand, the purchase of intelligent chargers and the development of effective means of communication, and on the other hand the implementation of innovative ICT solutions for better managing the parking facilities.

4.2.1 Smart charging of electric vehicles and mobility management

In Strijp-S, the existing electric vehicle charging infrastructure has been connected to the ICT backbone to allow for data transfer. The new charging poles include various functions for the clients such as making a reservation for a charging pool, receiving a message for the car when the car is fully charged, emission of a unique bill for parking and charging, among others. A real time parking guide system, able to be integrated in a navigation system will be developed. For this purpose, the existing ICT networks managing current parking spaces have been connected to the ICT backbone, and a management service has been developed and is currently available for usage.

4.2.2 Tender to stimulate the development of innovative smart city services

Furthermore, with the purpose of engaging the citizens and making good use of the new generation of the data through the newly installed sensor system in the public space, the city has designed and launched the iCity tender open to public applications, challenging SMEs, entrepreneurs and start-ups to present their ideas

¹⁵ Triangulum Project, “Part B: Technical Periodic Reporting Version 2.0,” 61.

¹⁶ WP3 Triangulum Project, “D3.3 2nd Technical Implementation Report Manchester,” January 2017, 25.

¹⁷ Triangulum Project, “Part B: Technical Periodic Reporting Version 2.0,” 62.

for the development of innovative products and services.¹⁸ Here, one of the selected projects for the further development of its business case is an electric bike sharing system for the city.

5 STAVANGER

The mobility modules in Stavanger aim on the one hand, to “combine advanced ICT solutions and load management in the electricity grid in such a way that future demands are met in areas such as supercharging and traffic surveillance”¹⁹ and on the other hand, to help achieving a reduction of emissions from traffic, by switching to electric mobility.²⁰

5.1.1 Electric battery bus demonstration

The project, implemented by the Rogland County Council, includes investment of three 12 meter long electric buses through public tendering, ensuring their operation and maintenance, setting up charging infrastructure installations and the training of personnel. The buses’ performance is analysed via an online monitoring system.²¹ At the moment the busses are driving in regular city routes and data is being send to the University of Stavanger for research purposes. The design for the three busses was finalized through an open design competition in cooperation with the street art festival NuArt where students from three local high schools submitted their ideas. 25000 citizen voted online and chose their favorite design among 7 finalists. This process was done in cooperation with the local newspaper.²²



Figure 3 Winning design ‘Mother earth’ by Morten Hansen Amdal²³

5.1.2 Electric vehicle charging infrastructure

This module is being implemented by the company Lyse and includes the installation of ICT-based charging solutions for EV mobility in private homes (10 homes with 7-11kW AC chargers), as well as in apartment buildings (cable infrastructure in parking space with individual meters and 7-11kW AC chargers).²⁴ This project not only allows Lyse to gain data about energy consumption patterns and their effect on the grid but also gives customers the opportunity to avoid peak hours for charging their vehicles and gives them more flexibility.²⁵

¹⁸ Ibid., 85–87.

¹⁹ EU SCC1 Triangulum Project, “Grant Agreement-ANNEX 1 (Part A) Innovation Action, Number 646578,” 53.

²⁰ EU SCC1 Triangulum Project, “Part B: Technical Periodic Reporting Version 2.0,” 114.

²¹ Shetty, Schmidt, and Stöffler, “Module Description Electric Battery Bus Demonstrator,”

²² EU SCC1 Triangulum Project, “Part B: Technical Periodic Reporting Version 2.0,” 115.

²³ “Design Competition for Buses in Triangulum’s Lighthouse City Stavanger Receives Attention – Triangulum,”

²⁴ Shetty, Schmidt, and Stöffler, “Module Description Electric Vehicle Charging Infrastructure,”

²⁵ EU SCC1 Triangulum Project, “Part B: Technical Periodic Reporting Version 2.0,” 125,126.

6 CHALLENGES AND LESSONS LEARNT

Important lessons emerge from the implementation in the lighthouse cities. They are principally about behavioural change. For example the promotion of the use of cargo bikes by non-cyclist require training and awareness raising as well as the willingness to try something new. Equally important is to consider all health and safety requirements before the implementation. People are for usually very hesitant to switch to bikes, when they feel unsafe or are unsecure. Risk assessments and training could help to mitigate the problem. Likewise it is important to think about training the staff for the use of an EV at an early stage. For instance the implementation of the electric bus in Stavanger has shown that the citizens not only choose the transport mode because of the clean technology (e.g. EV), but rather because of the services, benefits and confort (e.g. punctuality) that come with them.

Another challenge is the access to live data and the availability of interfaces to access the data i.e. APIs. In Manchester a new system had to be deployed to track the bikes and the API has been developed specifically. The EVs have relied on Nissan's own system, CarWings. However, this does not have the capacity to access remotely and accessing the data is via manual download. Nissan has no plans to introduce remote access and the only solution is to investigate a commercial service specifically for fleet management. Futhermore, the existing infrastructure also plays an important role. For instance when installing charging stations in private homes or apartment buildings, one has to check the ownership structure first. Private parking spots are the most suitable as an installation of a dedicated electric circle for the charging stations is necessary. Also, the existing capacity of the home electric circuit and the electric grid must be high enough to take the additional load. It is important to know that people like to charge their car right after coming home from work in the afternoon, so some measures have to be taken in order to shave peak loads. Here an effect based tariff could avoid expensive peak loads.

Legal policies are without doubt very important supporting factors. Particularly in the case of Stavanger they have been one of the significant drivers for EV. The privileges for EVs (tax benefits and priority road ways) as well as the National Transportation Plan, have helped to push this technology ahead,. Additional factors such as the cheap renewable energy and the technology oriented citizens further contributed to this development.

Finally, the involvement of the citizens from early stages and throughout the process has proven to be crucial for successful implementation in each of the cities. Taking into account the citizens preferences and requirements for designing the project, increases the probability for its acceptance afterwards. For example the payment method for a private home charging station can seriously affect the financing scheme, depending if the users prefer to pay a one-time installation or a monthly fee. Important is to remark that citizens need access to information and it has to be communicated in a way that it is easy to understand. The more the people are able to visualize and comprehend a specific solution or application, the easier they can contribute and give feedback.

7 CONCLUSION

Mobility can unquestionably be regarded independently from other sectors as energy and ICT. The evolution towards sustainable transport is a process - political, strategical and technical - which the cities in Triangulum have gone through for several decades.

This project has proved that strong established partnerships are the key for better networking and have enabled fast and joint innovation in all of the lighthouse cities. Smart mobility is on the one hand driven by a strong political will and on the other hand by the will of the citizens. Thus active citizen engagement and the use of new forms of communication are crucial for the realization and implementation of these kind of projects.

Finally, governace approaches as the quadruple helix model based on university-industry-government-collaboration and strong citizen involvement, have proven to be successful in its goal to meet local as well as regional challenges of urbanization, industrialization and economic down. Here strategic partnerships have not only been the key for better networking but have also formed the basis for the innovation landscape and constitute one of the main drivers for economic success on all levels.

The involvement and commitment to ambitious projects such as Triangulum, is something that evolves over time until building an international profile and reputation. Even if there is no instant or "one-fit-all solution"

for becoming one of the leading cities in terms of mobility, strong partnerships, active citizen involvement in the city planning, and an innovation environment can be considered -based on the Triangulum experience- important pre-conditions for starting a successful journey towards smart mobility.

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