



## *How can Eindhoven become a Smart City faster?*

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## Nederlandstalige Samenvatting

Smart City ontwikkelingen komen doorgaans als technologie-uitbreidingen tot stand. Dat varieert van het installeren van een infrastructuur (niveau 1), het slim maken van een bestaande infrastructuur (niveau 2), het integreren van parallel ontwikkelde slimme infrastructuren (niveau 3) en het daadwerkelijk realiseren van een sociale en duurzame slimme stad (niveau 4).

De onderzochte projecten in Eindhoven vertonen een goede spreiding: Strijp-S op niveau 2-3, Living Lab/Stratumseind 2.0 op niveau 3 en AiREAS op niveau 4.

In de overgang van niveau 2 naar niveau 3 ontstaat de noodzaak om d.m.v. software integratie te realiseren. Hiervoor lijken wereldwijd nog geen kant en klare oplossingen beschikbaar te zijn; niet als beschikbare software, niet als referentie architectuur (a.h.w. een ‘bouwplan’) en evenmin als City Platform (de concept-naam voor de oplossing).

Opties zijn:

- (a) inkopen van een werkende deel-oplossing (de daarop volgende afhankelijkheid van de leverancier is niet bijzonder welkom);
- (b) vanuit Europees verband wordt er geïnvesteerd in FIWARE (Future Internet Ware) - conceptueel een aantrekkelijke referentie-architectuur; in de praktijk weliswaar nog nauwelijks bewezen - en
- (c) ontwikkelen (dit moet geen enkele stad doen zonder partners en mede-financiers).

Voor Eindhoven is het interessant dat de volgende stap voor Strijp-S (TRIANGULUM), volgens de projectleider vanuit Fraunhofer, een dergelijke software oplossing (architectuur) zal opleveren.

Naast de gerealiseerde diversiteit van de projecten, kan Eindhoven een 2e portfolio-afweging maken. Bedrijfssucces hangt af van de mate waarin een onderneming erin slaagt ontwikkelde opties (in een incubatie-fase) via een transformatie-fase succesvol in haar produktie onder te brengen. AiREAS wordt nu als optie verkend. Zowel Strijp-S als Living Lab/Stratusmeind 2.0 zijn locaties voor transformatie. Smart Lighting/Smart Grid tender (deployment van de Urban Lighting Roadmap) kan wellicht beter worden benut als het niet rechtstreeks wordt ingezet om het licht-netwerk te vervangen. Wanneer de 7 te kiezen gebieden worden ingezet als aanvullende ‘Living Labs’, kan er optimaler experimenteel onderzocht worden wat het toekomstige Smart Grid (slimme, geïntegreerde, van software-oplossingen voorziene netwerk) moet kunnen. Kortom: zet het tender-project in de incubatie- en transformatiefases in.

Overweeg alle Smart City projecten tot één Smart City Eindhoven project te combineren. Betrek startups, ondernemers, bewoners evenals andere steden en gemeenten. Co-creëer een visie.

Overweeg parallel daaraan meer initiatieven te ontwikkelen die residenten (burgers en bedrijven) aanspreken op hun directe interesse. Denk aan slimme toepassingen voor vrije tijd (Smart Leisure), cultuur (Smart Culture), retail (Smart Retail) of ondernemen (Smart Business).

## Executive summary

### Smart City Efforts in Eindhoven

Research indicates there are 4 tiers to develop Smart Cities:

- Tier 1: The Basic Infrastructure (putting base-level infrastructures in place for utilities, mobility, etc. Examples: current mega city projects in China, Brazil, India)
- Tier 2: The Parallel Smarter Infrastructures (equipping parts of a city infrastructure with smart devices. Example: install sensors in garbage cans so that collection only takes place when full)
- Tier 3: The Integrated Smart City (combining various municipal silos and making the whole smarter. Example: use pollution measurements to guide parking)
- Tier 4: The Social and Sustainable Smart City (taking citizens and businesses as starting points and designing a smart city around their needs)

In most European cities tier 2 and tier 3 projects are underway, tier 4 being rare (and tier 1 projects lacking greenfields). Although none of these projects is easy, bigger challenges arise when the combination of sensors, data storage, data sharing and other ‘smart technologies’ allows for integrated perspectives. The ‘digital revolution’ then starts creating new connections that require substantial adaptations and technological innovations.

For this report 4 Smart City projects in Eindhoven were studied

1. **Living Lab/Stratumseind 2.0** is a tier 3 project, arising out of an effort to create an integrated solution for ‘Smart Crowd Management’ with the ambition to make a clubbing district more attractive and profitable (at tier 4) for businesses, citizens, law enforcement and other stakeholders.
2. **Strip-S** is a larger district with more residents, more businesses and a larger area. It also functions as a Living Lab, a.o. for energy, light, mobility (meaning: making parallel infrastructures smarter at tier 2). In its efforts to integrate the various improvements, it has found its size is insufficiently critical to determine what services should be next. Suppliers offering advice have too much self-interest at stake.
3. **SmartLighting/SmartGrid Tender**. Eindhoven is also taking the lead in Europe with a tender aimed at procuring a LED public lighting solution for the next decades. The Roadmap for Urban Lighting is the most advanced roadmap of Eindhoven, increasing the relevance of this Best Value Procurement process even further. New types of questions present themselves, like ‘What will we do with Smart Lighting?’, ‘What can we do more with a Smart Grid?’, ‘How should the municipal organization adapt to working with a Smart Grid, Smart Lighting system, other ‘smart technologies’ and a different type of partner?’.

Out of a tier 2 project, aimed at making street light smarter, questions associated with concerns at tier 3 pop up. Given the durability of the solution that will be selected, some questions at tier 4 arise: 'What are individual's rights when Smart Lamp Posts can read out IP addresses?', 'Who will own the data the Smart Streetlights collect?', 'What type of services will we want 10 to 15 years from now and how will we pay for them?'.

4. **AiREAS** is a tier 4 project, dedicated to improving the air quality in Eindhoven together with citizens. It is experimental in nature, organized by people with a great drive, set up by partners operating beyond a financial model (but one based on creating opportunities to learn, on sharing knowledge and insights). It is as much a project envisaging what 'smart technologies' can offer to make the world more sustainable, people more healthy as well as innovating in how cities can be organized through social involvement rather than solely through financial rewards.

## Conclusions

The Smart City projects in Eindhoven that we have reviewed seem largely driven by hardware innovations and considerations rather than software.

Each project is technologically optimized for its own efforts. Living lab/Stratumseind 2.0 for speedy experimentation. Strijp-S for putting sustainable smart improvements in place, AiREAS for exploring new ways to organize collaboration with citizens, businesses, knowledge institutes and make the world more sustainable by improving air quality. The Smart Lighting/Smart Grid tender is gearing up and has not yet arrived at technical decisions.

In this phase it is not advisable to standardize on a homogeneous technical architecture and reduce the optimizations of each project. Currently process is more important than control. The goal should be to strive for a heterogeneous reference architecture to enable business generating opportunities, to facilitate knowledge sharing, common standards, interfaces, components, and to allow the integrating external open and proprietary solutions (a City Platform).

It would seem that the TRIANGULUM project will enable Strijp-S to address some of those challenges. According to the project manager Fraunhofer, an architecture allowing the TRIANGULUM achievements to be implemented in other cities across Europe will be a key deliverable.

Eindhoven has the potential to combine at least the 4 researched projects into a bigger 'Smart City Innovation Drive'. Perhaps a combined effort could build on the progress realized so far and propel existing initiatives (e.g. create more exposure for Living Lab/Stratumseind 2.0 and generate more financial space) and could put Eindhoven at the heart of a technology-driven yet citizen-focused effort to ensure future Quality of Life.

Clear attempts are already being made to engage citizens and resident businesses. Yet there seem to be limited efforts at using ICT and/or other smart technologies to address the most likely

primary interests of these two groups, e.g. by focusing on Smart Leisure (think of a recommender for your spare time), Smart Culture (allowing you to share what an artwork means to you) or on Smart Business (which could e.g. have a portal directing you to today's events in Automotive, the presentations given at local universities, job offers in automotive vacancies, patents filed, etc.).

## Main recommendations

1. Set up an Eindhoven Smart City Architecture team. This team should review, approve and oversee all smart city projects from an architectural integrity and continuity perspective. Consider staffing that team with persons currently involved in Smart City projects, as they already have gained valuable field experience.
2. Appoint leaders from current efforts and welcome initiators of new proposal, from the Municipality of Eindhoven and others in and around the city of Eindhoven. Set up the leadership team to initiate, approve, foster and terminate Smart City projects. Explicit attention to governance will be required. Consider the approach taken by Birmingham to create a Smart Ecosystem (see page 38)
3. A substantial, creative, mobilizing effort is needed to drive the initiative and engage the citizens. Invest in that effort.
4. Engage with stakeholders from industry, academic/research and Eindhoven Municipality.
5. Co-create a vision with the leaders and keep on iteratively updating that vision collaboratively. Consider pursuing Government 3.0. Consider being the first city in the world pioneering Smart Business solutions. Evaluate applying the integrated strategy developed in Valencia (or the modified version created in this report to incorporate an innovation and startup business perspective, see page 32).
6. Set up an independent Security and Risk Assessment audit team for all operational smart city projects. Define guidelines to have security embedded into solutions from the beginning.
7. Base operational programs on common architectures and platforms. Consider the desired solution as a City Platform. Partner with others to co-create a better, interoperable, jointly tested City Platform faster and to ensure future support commercially. Evaluate these options:
  - FIWARE - Future Internet middleware for Smart Cities
  - Collated and integrated open sources components managed by a Public-Private consortium approved by the Steering Board
8. From the options available, select a vendor independent, non-proprietary reference architecture based on open standards and specifications to:

- Support a heterogeneous and evolving infrastructure, components and platform
  - Embed integrity, security and authentication in a uniform way
  - Extensible to incorporate and integrate vertical proprietary solutions
  - Flourish as a public-private ecosystem of suppliers, developers, citizens, businesses
  - Have an effective community supported with professional development kits, software tools, component libraries and infrastructure
  - Be supported by strong consortium that fosters open innovation
  - Deployed by multiple cities in Europe
  - Share Open Data - storage and access and ownership. Default is public ownership. Data format, ownership and access to be formulated and agreed upfront
  - Ensure that by default future Smart City projects be based on the selected reference architecture
9. Ensure people see and experience the (financial and non-financial) results as meaningful on the short, mid and long term to keep the strategic momentum going.
10. The way to increase the odds that Smart City efforts will create a city that is social and sustainable, is by ensuring that steps along the way contribute directly to realizing that objective. In establishing connections, people should be given space and energy to grow. In organizing, organic approaches should be preferred over classical hierarchical templates. In pursuing the realization of a vision, effective action is the best way to bring it closer.

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## About the authors

Venturespring B.V. is a networking organization that energizes ecosystems emerging out of new ICT applications. Ecosystems can be as small as a single festival. Think of STRP Festival that already showed in 2010 and 2011 how touch screens and apps can engage visitors, enabling them to capture and share their experience, in tweets, Facebook shares, pictures and even reviews. Venturespring created an impression of how the notion 'Clickable Festival' developed with STRP Festival could be translated to a '[Clickable City](#)', together with Park Strijpbeheer in 2012. In 2014 Venturespring consulted for VisitBrabant, the marketing organization for the leisure industry in Brabant, to scale up Smart Culture 'Clickable Festival' application to a Smart Leisure platform. That platform is now online at [www.visitbrabant.nl](http://www.visitbrabant.nl). Venturespring is currently developing a SmartLearning app in the context of EindhovenLeren2030. Together with Mark van der Net (OSCity), Venturespring is one of the founders of the Big Data Lab, a network seeking to find out how Eindhoven can use Big Data.

[CeesJan Mol](#) developed the Philips intranet in 1996. He created the first Internet of Things pilot at the annual Corporate Research Exhibition in 2006. As co-owner of U-Approach he was one of the forces behind the Smart Culture pilots at STRP Festival (2010 and 2011) and the Smart Leisure approach by VisitBrabant. His ambition is to introduce ICT innovations in business, in order to speed up innovation and create Smart Business as a new domain for Smart Cities.

[Osman Khan](#) was one of the original drivers of the internet in Philips. He linked Philips and Cisco when Cisco was still a 10 person startup in Silicon Valley. At that time Philips was the largest customer for Cisco in Europe. The realization of the Philips technological infrastructure was rapidly followed by others. At present Osman Khan is an independent consultant.

[Rob Aalders](#) was among the first to launch free open wifi in The Netherlands, has experience in developing fibre networks, urban media and services for local governments. More recently Rob has been involved in creating startup communities and helping corporate organizations and governments act to emulate startup behavior in order to speed up innovation.

[Nico Schouten](#) is a pioneer with a background in electronics, mechanics and software. Nico's work field varied from bicycle engineering to medical devices. Nico moderated Europe's biggest forum for innovative startups founded by the Dutch Ministry of Economic Affairs. Is being consulted by tech start ups for his strategic insights. Is associated with StudentsInc, the incubator founded by University of Utrecht and Hogeschool Utrecht.

## Introduction

# *Cities are real-time systems, but rarely run as such<sup>1</sup>.*

There is no lack of information on smart cities<sup>2</sup> today. A great number of projects are being conducted and new ones announced daily. Resources deployed differ in kind and scale, in areas where they are deployed and cities have different scales on which their projects are run. It also seems that the cities maximize the label 'Smart City' to make their city look even smarter, more attractive to settle in or even more innovative than the neighbouring cities. This makes it a challenge to bring beautifully articulated ambitions to normal proportions, do deflate wishful thinking and to relate the available information to actual innovative practices.

For this report desk research has been conducted. We have looked at publications from other cities and experiences shared online, we have mined our own experiences and networks and have listened to others. We have tried to find a way to sketch a path for smart city development. This has made the first conclusion inevitable: there is no single clear strategy available to be inspired by. There are however quite a few resemblances in vision and strategy that we have attempted to combine to create a development process for Eindhoven to become a Smart City faster.

The first building block in our development process consists of a framework for determining the right ambition level. There are many ways of thinking about the scope of a Smart City: it can be defined at the level of an infrastructure (utilities, roads, the 'mobility challenge' as a complex whole) or even at the level of participation (increasing the quality of life in co-creation with citizens). We propose to distinguish between four tiers in order to determine what Eindhoven aims to achieve with its efforts to being a Smart City. These four tiers will be clarified in paragraph 1.5.

These are the 4 Smart City projects in Eindhoven we explored:

1. the **Living Lab/Stratumseind 2.0**
2. the area previously known as the forbidden city **Strijp-S**
3. the **SmartGrid tender** (at the moment of writing still open) and
4. **AiREAS**, the community-based effort to make the environment in Eindhoven a more healthy one.

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<sup>1</sup> Arup (2010); Smart Cities; Transforming the 21st century city via the creative use of technology. Retrieved from: [http://publications.arup.com/~/media/Publications/Files/Publications/S/Arup\\_SmartCities\\_June2011.ashx](http://publications.arup.com/~/media/Publications/Files/Publications/S/Arup_SmartCities_June2011.ashx)

<sup>2</sup> When we mention 'city' in this report we mean the ecosystem of local government together with all related stakeholders. The term 'local government' is used to restrictively refer to city officials and civil servants. For this purpose also the synonym 'municipality' is occasionally used.

Three projects appear to share an interest in ‘Smart Lighting’. Living Lab/Stratumseind 2.0 functions as a lean setup for rapid experimentations with lighting, but also video analysis, sound detection and other technologies aiming to create what could be called an integrated Smart Crowd Management. Strijp-S currently has LED streetlights that are unique in the world, when it comes to their potential to create different colors as well as their ability to be individually controlled through internet. The Smart Lighting/Smart Grid tender is an innovative way to arrive at a blueprint for a LED Lighting solution by co-creating one with a market consortium. Regarding Smart Lighting as the innovative force strategically connecting these 3 projects, would give Eindhoven one strategic Smart City innovation drive<sup>3</sup>.

The remaining project of AiREAS is positioned slightly further removed from municipal influence, as it is a more community-driven project. What could be learned however from aligning the three Lighting related projects might serve to create a similar ‘innovation pathway’ for the focus of AiREAS, which is not lighting but ‘healthy environment’. In our view, it is the most ambitious Smart City project aiming to combine social objectives with sustainability goals. AiREAS in co-creation with citizens, companies and knowledge institutions deployed a sensor network measuring air quality with data sharing abilities, advanced analysis tools and an informational app and is pioneering how such a Social and Sustainable Smart City project could be set up and run.

From the interviews with the 4 Smart City projects in Eindhoven and through evaluating them based on our experience, we conclude that a common architecture should not be a leading direction for improvement at this moment. Maintaining the current diversity or even increasing it would seem to offer more opportunities for becoming a Smart City faster. Purpose and flow are guiding the projects and seem to be doing quite well, based on the fact that the challenges we would expect Eindhoven to be facing in its development process towards a Smart City are the actual ones the projects are addressing. The process is therefore more important than control at this moment. However, it is advisable to propose a common reference architecture and for future Smart City projects to be compliant with it to facilitate later harmonization, integration and reuse. This integrated architecture will be vital within 2-3 years.

Among all Smart City projects currently conducted in The Netherlands, including those in Eindhoven, very few appear to be paying serious attention to safety and security risks. To ensure citizens do not withdraw support of such efforts in the future, it is essential to evaluate the current exposure to such risks and take steps to reduce them significantly. This is likely to become a more urgent matter quite soon. Architectures need currently not be standardized on, yet they should also not be neglected. Important notions are the necessity to become and remain vendor-independent, to re-use elements and components (meaning: technologically compliant with standards, market-supported and backed up by a flourishing community). Guidelines for

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<sup>3</sup> We also believe this resonates with the history of Eindhoven, its founding multinational having emerged from Lighting technology. It also fits with its profile, as GLOW Eindhoven is one of the Netherlands most visited light art festivals. It also reflects the current leading role Eindhoven is playing in LUCI, the international network of cities on urban lighting, by providing its vice-chairwoman.

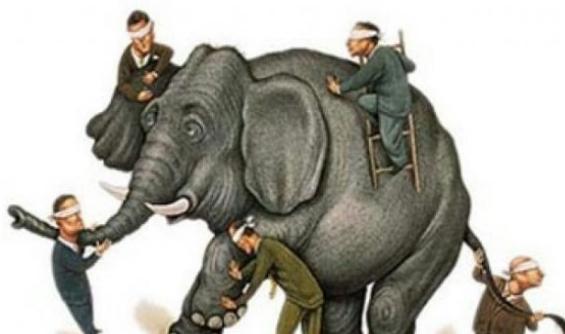
ultimately arriving at a heterogeneous architecture are expanded upon in chapter 2 (also see the recommendations).

Eindhoven is more than a city of Light. It is also home to high-tech. Multinational Philips developed from a Lighting company to the creator of the Compact Disc and is one of the world's leading players in solutions for Health and Wellbeing. ASML quite literally lies at the heart of the digital revolution, as its lithography machines are the devices used to create 80% of all chips in the world market. It is possible to see the current development of Smart Cities as the continued technology trend of 'digitization'. First communications infrastructure was created to connect computers across the world. Then chips became digital; rather than being stand-alone components they became 'integrated circuits' (ICs). Then electronic systems became smart: consumer devices now standard in people's homes (PCs, notebooks, tablets). We now have SmartPhones, SmartWatches and even homes are becoming Smart. The further digitization progresses, the smarter public space can become.

This is a huge opportunity for a city like Eindhoven. Partnering with other cities and attracting entrepreneurs offers new ways to increase the momentum for Smart City Eindhoven, attract new business initiatives and position itself in the front-end of a new phase of digitization. Several options will be clarified under Step 3 in chapter 2. Making it possible to get startups and other innovative entrepreneurs involved in Smart City efforts could increase Eindhoven's critical mass and speed up the process.

The remarks on architecture, on using Smart City efforts to stimulate new business development are complemented by comparisons with cities elsewhere: how do they work together, mobilize their citizens, keep the communication going? We propose 7 steps to combine efforts, increase the pace and speed up progress. In Chapter 2 we will address them, including the need to be aware of the difficulty for organizations to change. Yet truly becoming a Smart City will require cities to adopt a different 'operating model' and act accordingly.

One burning question remains: What is a smart city? What form does it take? What are cities across the world doing to make their city 'smart'? In Chapter 1 we will highlight some examples and introduce a structured way to think about Smart City efforts.



*It was six men of the urban world  
To learning much inclined,  
Who went to see the Smart City Elephant  
(Though all of them were blind),  
That each by observation  
Might satisfy his mind.*

Adapted from John Godfrey Saxe  
[Smart City - Blind Men](#)

## Chapter 1. What is a Smart City?

'Smart City' appears to be the latest concept when it comes to building the cities of the future. Smart cities are expected to be the key to combining a sustainable future with economic growth and job creation. Many definitions articulate these expectations differently. As consultants from Osborne Clark state: 'Ask a hundred government officials, senior corporate executives or investors what a smart city is and you will probably get a different answer each time. We believe each city should define its own smart city.'<sup>4</sup>

Quite a few definitions use terms like 'sustainable', 'climate', 'mobility', 'ICT' and 'sensors'. Common denominators however seem to be 'access to (open) data', 'intelligent tools to share knowledge and connect people' and some need to 'drive change'. Quite useful is the 'Smart Cities Readiness Guide' that clearly distinguishes traditional from smart cities (see table).

**AT A GLANCE: TRADITIONAL CITIES VS SMART CITIES**

	The Problem	The Smart City Solution
<b>Planning</b>	<ul style="list-style-type: none"> <li>Ad hoc and decentralized</li> <li>Cost savings aren't realized</li> <li>Limited potential for scalability of investment</li> </ul>	<ul style="list-style-type: none"> <li>Coordinated and holistic</li> <li>Resources are shared</li> <li>Cost savings are fully realized</li> <li>Investments are scalable</li> <li>Improved city planning and forecasting</li> </ul>
<b>Infrastructure</b>	<ul style="list-style-type: none"> <li>Runs inefficiently</li> <li>Costs more money and resources to run</li> </ul>	<ul style="list-style-type: none"> <li>Optimized with cutting-edge technology</li> <li>Saves money and resources</li> <li>Improved service-level agreements</li> </ul>
<b>System operators</b>	<ul style="list-style-type: none"> <li>Guess at infrastructure conditions</li> <li>React to problems</li> <li>Can't deploy resources efficiently to address problems</li> </ul>	<ul style="list-style-type: none"> <li>Enjoy real-time reporting on infrastructure conditions</li> <li>Predict and prevent problems</li> <li>Deploy resources more efficiently</li> <li>Automate maintenance</li> <li>Save money</li> </ul>
<b>ICT investments</b>	<ul style="list-style-type: none"> <li>Piecemeal and siloed</li> <li>Deliver suboptimal benefit</li> <li>Don't realize economies of scale</li> </ul>	<ul style="list-style-type: none"> <li>Centrally planned</li> <li>Deployed across city departments and projects</li> <li>Deliver optimal benefit</li> <li>Provide maximum value and savings</li> </ul>
<b>Citizen engagement</b>	<ul style="list-style-type: none"> <li>Limited, scattered online connection to citizens</li> <li>Citizens can't make optimal use of city services (or easily find them)</li> </ul>	<ul style="list-style-type: none"> <li>Complete and singular online presence</li> <li>Citizens can easily find and use services</li> <li>Citizens can participate in smart city initiatives</li> <li>Two-way communications between government and people</li> <li>Specialized services focused on the individual citizen</li> <li>Citizens can both contribute to and access real-time intelligent city data</li> </ul>
<b>Sharing data</b>	<ul style="list-style-type: none"> <li>Departments and functions are siloed</li> <li>Departments rarely share data and collaborate on initiatives</li> </ul>	<ul style="list-style-type: none"> <li>Departments and functions are integrated and/or shared</li> <li>Data is shared between departments and better correlated with other data services</li> <li>Results are improved</li> <li>Costs are cut</li> </ul>

Figure 1.14

### SMART CITIES READINESS GUIDE

<sup>4</sup> Osborne Clarke (2015). *Smart Cities in Europe, Enabling Innovation*. Retrieved from: <http://www.smartcities.osborneclarke.com/general/publication/smart-cities-europe/>

What is clear from the Readiness Guide is that more parameters than ICT are important: infrastructure, using the data by sharing them, engaging citizens, planning for smart city development at an appropriate level. By exploring concrete efforts in more detail, the clarity missing from any single definition can be further increased. Santander for example is one of the cities in Europe where the European FIWARE programme has originated; it has played a significant role. Vienna, Copenhagen and Delft also have valuable insights to share. For each of these cities we briefly address their vision, their roadmap and their architecture. The exemplified cities were chosen not for their spectacular project, but because of their contribution to a clear way of working and/or architecture plus the quality of the material they share for others to re-use<sup>5</sup>.

## 1.1 SANTANDER

Santander is a medium-sized city on the northern coast of Spain. The city is well-known for its Internet of Things projects and is frequently referred to as a leading example. The goal of its smart city program is to promote the economic growth, social development and new business models within the cities through innovation. Its objectives: sharing experiences, strengthening mutual cooperation, identifying synergies and developing new smart innovation strategies.



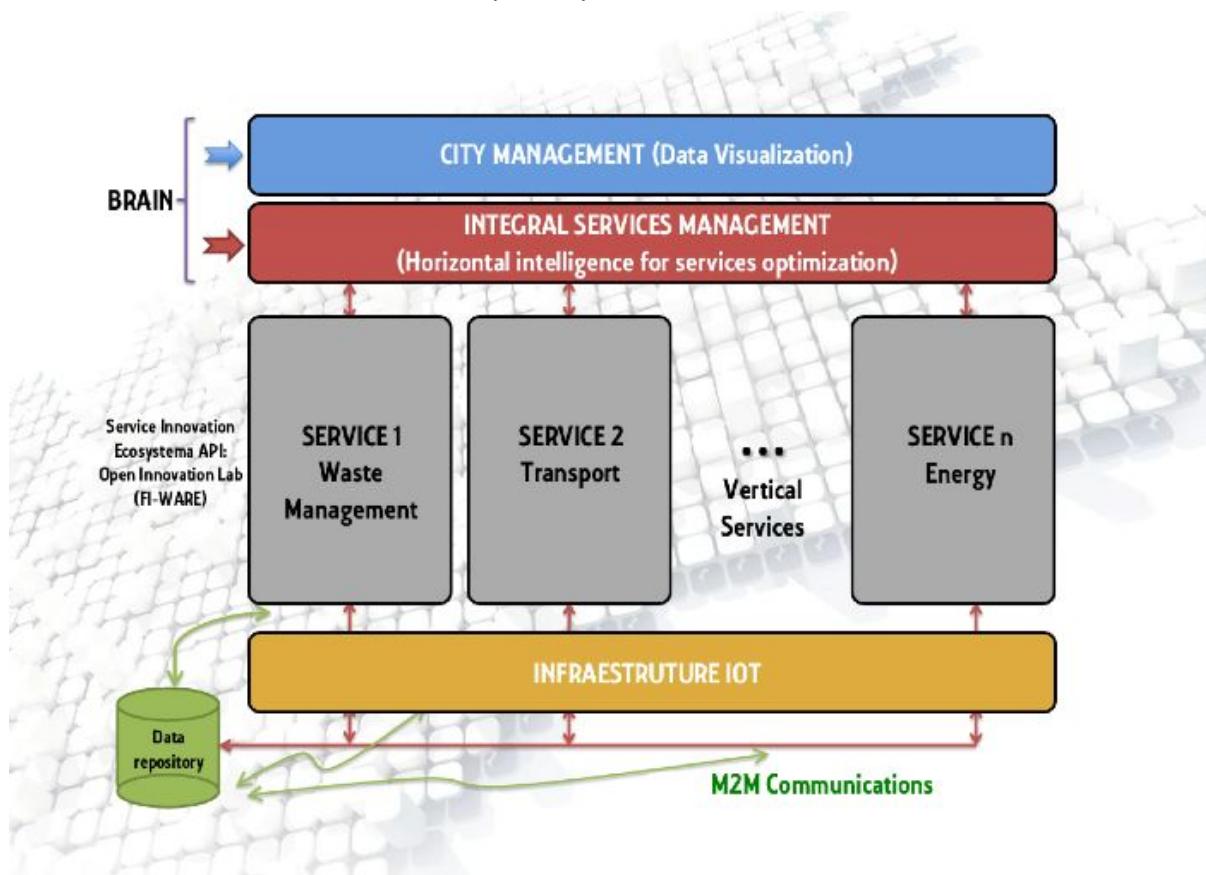
Santander has three main directions for its smart city program 2010-2020:

1. Santander Smart City Platform
  - a. The city-wide Internet of Things Living Lab. The city has over 12.000 sensors deployed in the city to improve services like public transport.
2. Santander Open Innovation with focus on energy & environment, security & e-health, smart mobility and city economy
  - a. citizens engagement by Santander brain, an open platform for ideas and idea voting
  - b. living labs
  - c. demo center and entrepreneurship
  - d. partnerships
3. Public Administration modernization (City Management)

<sup>5</sup> In this document we will also refer to other Smart Cities, notably to Valencia, Aarhus and Birmingham as three of the most interesting cities when it comes to providing particular tools that seem quite helpful. Please note that we have had only desktop research to build on for those cities, as well as for the ones described above as the initial steps to be more acquainted with Smart Cities. It has been difficult to assess to what degree texts reflect reality.

### a. cooperation with network of cities

Santander's architectural approach is quite high level (i.e. abstract). It makes an implicit distinction between underlying functionality and the 'brain', which consists of a ***services management function*** (of integral services) and a ***city management function*** (through data visualization). Services themselves are conceived of as 'vertical functions' (as opposed to the horizontal management functions). The actual infrastructure consists of an Internet of Things with data being fed into and downloaded from a data repository.



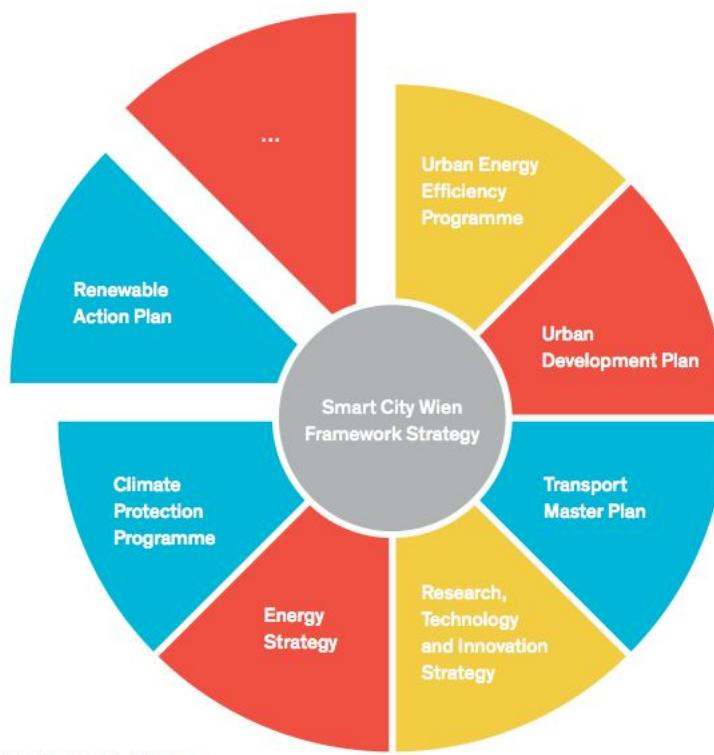
## 1.2 VIENNA<sup>6</sup>

The capital of Austria has held high positions in Smart City Rankings for the past few years. Vienna seems to steadily move forwards by realizing three plans across three different time horizons:

- 'Smart Energy Vision 2050' (long-term)
- 'Roadmap 2020 and beyond' (medium-term)
- 'Action Plan for 2012-2015' (short-term)

Vienna's Smart City Framework Strategy shows how the Smart City Framework works with new and existing strategies in different domains.

<sup>6</sup> [https://SmartCity.wien.gv.at/site/files/2014/10/140924\\_KF\\_SCW\\_gesamt\\_ENG.pdf](https://SmartCity.wien.gv.at/site/files/2014/10/140924_KF_SCW_gesamt_ENG.pdf)



**Fig. 3** Interaction of Smart City Wien framework strategy with existing and future strategies

Another key take-away from Vienna is the clear objectives the city has set for itself.

#### **Overview of Selected Objectives:**

Reduction of CO2 emissions from currently 3.1 tonnes per capita to 1 tonne per capita. (- 80% CO2 from 1990 to 2050).

#### **Energy**

By 2050: 50% of Vienna's gross energy consumption will originate from renewable sources. Primary energy input should drop from 3,000 to 2,000 watt per capita.

#### **Mobility**

Decrease of motorized individual traffic (MIT) from currently 28% to 15% by 2030. By 2050 all vehicles within the municipal boundaries run without conventional propulsion technologies.

#### **Buildings**

Reduction of energy consumption of existing buildings for space heating/cooling/water heating by 1% per capita and year.

#### **Innovation**

By 2030 the Innovation triangle Vienna–Brno–Bratislava is one of the most future-oriented cross-border innovation Regions in Europe.

The share of technology-intensive products in the export volume will have increased from currently 60% to 80% by 2050.

In 2050, Vienna is one of the five biggest European research and innovation hubs.

#### **Social Affairs / Health-Care**

All people in Vienna should enjoy good neighbourly and safe life conditions irrespective of their background, physical and psychological condition, sexual orientation and gender identity.

Safeguarding of medical care at the highest level.

#### Environment

The share of green spaces will remain at over 50%.

Source: Smart City Wien, Smart City Framework Strategy, 2014

Noteworthy also is Vienna's planners incorporating stakeholder consultation processes into building and executing carbon reduction, transportation and land-use planning changes. The key project in Vienna is Aspern, a new housing area on a former airfield. Examining Aspern in more detail, a direction/approach can be determined. Several more or less independently operating projects are connected to a common 'city data-center', which a central point where all real-time data flow together. These data are translated into valuable services and products for the citizen<sup>7</sup>.



### 1.3 COPENHAGEN

The capital of Denmark is another city that tops the lists of Smart Cities in the world. The Danish capital is now quite famous for how urban design transformed the city into a more livable

<sup>7</sup> Images retrieved from:

<http://www.wienernetze.at/eportal/ep/contentView.do/pageTypeId/40374/programId/65183/contentTypeId/1001/channelId/-45606/contentId/64013>

urbanization, with many people commuting on bikes, indicating an overarching focus on increasing the quality of life for its citizens.

The smart city development is driven by the municipality, Copcap (an organization for economic development) and the Cleantech Cluster. Interesting about the approach in Copenhagen is that local government controls the infrastructure (in Santander e.g. a large part of the infrastructure is in the hands of the university). This level of control by the city enables the public authorities to maintain the openness of the system and to control the integration of new requirements. Its ownership avoids the situation in which a private company could exploit the financial potential of the infrastructure for itself alone.

Quite remarkable is the explicit aim of the Copenhagen municipality to collaborate with the private sector, as can be seen from the 8th bullet on the slide below. Due to the fast pace of changes, the slow nature of government, not having a sufficiently talented workforce and a lagging development of its technological capability, local government has repositioned itself. The ownership of the underlying infrastructure complements the will to collaborate nicely.

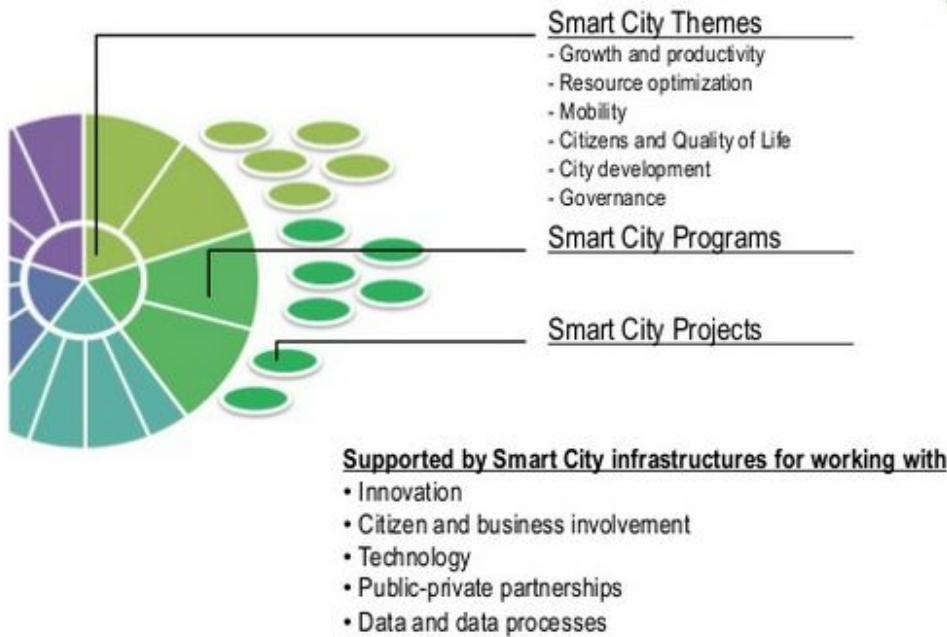
## CPH definition of a SMART CITY



- A city that thinks about how it works:
- A city that is adapting to current and future challenges and demands
- A city that learns to handle for changing demographics
- A city that creates an attractive place to live and work
- A city that makes intelligent, efficient and sustainable use of natural resources
- A city that decides on and controls the necessary public infrastructure
- A city that can work with private expertise and excellence in efficient sustainable service provision
- A city that can make use of private companies to implement innovative solutions for the challenges ahead
- A city that is able to deliver in a low carbon economy

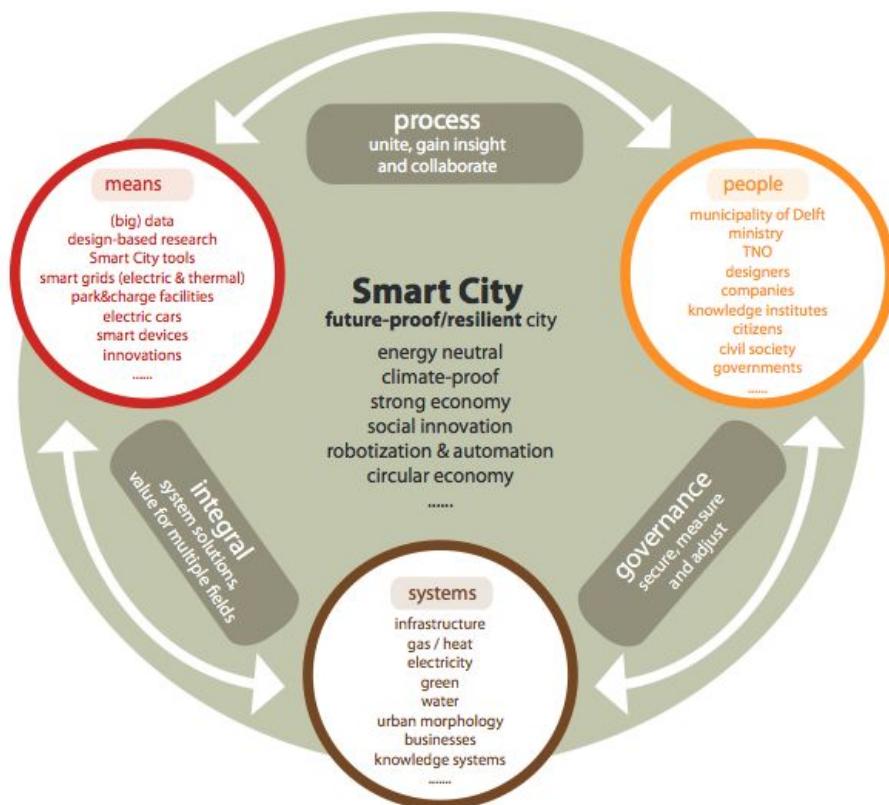
As in Vienna, Copenhagen also works simultaneously in three time horizons. For the longer term, 'themes' are used like 'mobility', 'growth and productivity', 'citizens and quality of life'. These become operational through 'programs' which consist of 'projects' (see visual below).

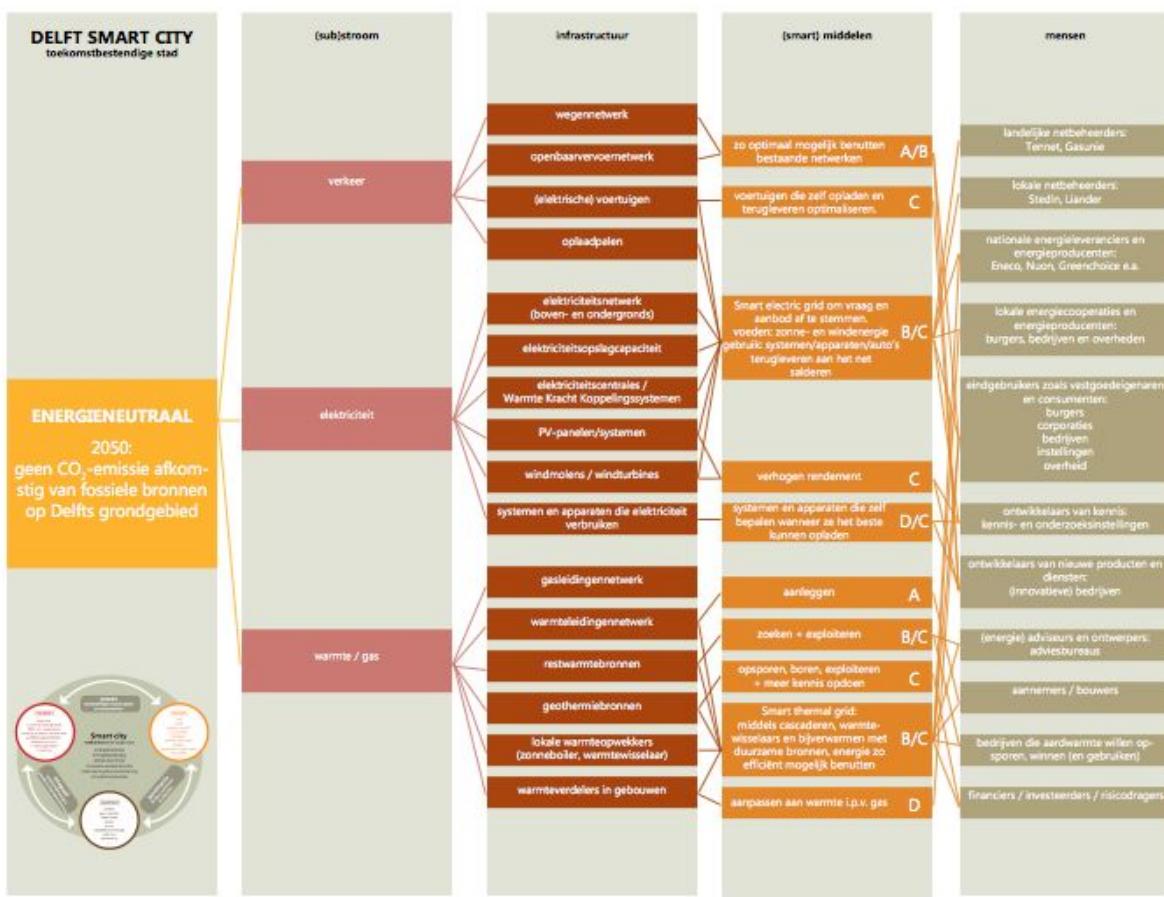
## Copenhagen Smart City



### 1.4 DELFT

The models Delft uses for their Smart City projects make their efforts interesting. The model distinguishes between means, systems and people around a number of themes. This distinction makes it easy to make the vision operational across ambitions, infrastructure, means and people.





## 1.5 What Smart Cities pursue: framework for focus

On the one hand Smart Cities are ‘hot’. That makes it quite difficult to determine what is really happening from the stories created by such efforts. We can nevertheless conclude from the examples above (and from further case studies in addendum 1), that Smart Cities aim to make the cities a better place to live. Although at quite different scales.

In Santander efforts focus on energy and environment, security and e-health, smart mobility and city economy. It also wants to modernize the quality of city administration. In Vienna efforts are driven by a long term vision on smart energy. In Copenhagen the Clean Tech cluster is one of the 3 main partners. The themes explored are ‘mobility’, ‘growth and productivity’, ‘citizens and quality of life’, ‘resource optimization’, ‘city development’ and ‘governance’. Efforts in Delft focus on becoming energy neutral, climate proof, on creating a strong economy, realizing social innovation, robotization and automation and working towards a circular economy. In the Danish Smart Aarhus initiative groups are working on ‘smart supply’, ‘open data’, ‘digital entrepreneurship’, ‘sustainable development’, and ‘public-private partnerships’. The Swedish city of Malmö has stated that it wants to become carbon neutral by 2020 and run on entirely renewable energy by 2030. In Germany efforts are ongoing in Hamburg to address ‘greater mobility’, ‘safety’ and ‘sustainability’ through Smart City initiatives. In the Ruhrgebiet there is a model city in which industry and

scientists are working on developing a sustainable city. In India a single projects aims to realize a 4,500-acre Smart City on a new suburb of Delhi as part of the recreation of an entire industrial corridor....

There are also different types of Smart City developments. In China, as in India, a number of 'megacities' is being erected from a 'greenfield' starting point (meaning: from a situation where there is nothing to start with, where all options are open from the beginning). A big advantage for greenfield efforts is the lack of restrictions (usually in combination with tax advantages). In Europe it is rare to find space for such an initiative. The greenfield advantage to industry is huge: they can immediately go for a novel approach and have the chance to not only create new products but also to test them. Failure may not be very helpful for the new citizens but from a product development viewpoint having such massive opportunities for testing and market exploration is an enormous benefit.

How can we compare the various efforts? Do the different focuses complement each other and can they be distinguished from one another? We suggest they do. Looking at the different deployments in Europe, India and elsewhere, one distinguishing parameter is the available infrastructure. Another is the level of ambition, the level of effort to making people's lives better. Taking these two parameters into account, we propose four tiers of Smart City efforts (see table).

<b>Focus</b>	<b>Name</b>	<b>Description</b>
Tier 1	The Basic Infrastructure	In a greenfield approach there is no infrastructure available, Efforts focus on putting those in place.
Tier 2	The Parallel Smarter Infrastructures	Lighting, mobility etc. etc. benefit as efforts focus on optimizing a stand-alone infrastructures.
Tier 3	The Integrated Smart City	The focus of efforts is on bringing improvements of infrastructures together, no longer as isolated silos.
Tier 4	The Social and Sustainable Smart City	Focus is on creating involvement of stakeholders, a.o. citizens, industry, scientists and business in realizing long term smart solutions.

When no infrastructure exists yet, logically focus is first on putting that in place. In a number of primarily Asian cities this is the case and smart solutions are being created and tested. When infrastructure does exist, as is the case in most European cities, the focus falls on making infrastructure smarter. Normally such efforts are restricted by existing organizational boundaries, leading to parallel efforts within stand-alone parts city infrastructures. At this level (tier 3), it is clear that integration is required to make new solutions possible. CO2 emissions can be reduced when people commute less by car. In addition, promoting cycling makes people more active and improves their health. Such an effort that can be seen in Copenhagen is quite a different approach for 'mobility' than optimizing traffic flows in the city.

Efforts at the next layer (tier 4) focus on realizing long term sustainable solutions with all stakeholders in a city especially citizens. The focus of Aarhus (Denmark, see addendum 1) is a good example of such a focus: starting from the point of view that the cities (not the municipalities) problems should be addressed and consequently creating workgroups with all stakeholders.

## 1.6 Which challenges do Smart Cities need to address?

Cities face into challenges when they start working on becoming more smart. We have summarized them in the table below.

Challenge #1 (at tier 1): digital competencies. The first challenge is related to competencies. If the digital wave is new to a city, who knows how to deal with it? When it is indeed new, there will not be many people with experience. And without knowing what ‘going digital’ means, how can informed decisions be made<sup>8</sup>?

Challenge #2 (at tier 1): integrity and security. As soon as systems are put in place, technical challenges of ‘integrity’ and ‘security’ are relevant. Integrity in a technical sense refers to the requirement that the system has to be able to trust that the user working with the system is that specific user with those specific rights to operate the system. If the system cannot be sure of that, its operations will not be reliable. Security relates to the system being difficult to break into, difficult to hack.

Challenge #3 (at tier 1): data access and ownership. A working system will start to collect data. Who has access to that data? To do what with? Who owns that data? The last question is becoming much more important. The internet began with everyone having his or her own website. Nowadays quite a few people are constantly updating Mr. Zuckerberg’s website (Facebook). Google not only uses your search queries, it keeps track of your location, reads your email, owns the files in Google Drive.

People are increasingly aware that a ‘free’ service means their eyeballs are being sold to advertisers, as was the case with classical broadcast (radio, TV, movies). But what happens when Google also knows if I am home or not, as it shortly can through Nest, its SmartMeter. What if it knows that I get excited about something, as it will be able to determine when I start carrying a SmartWatch.

On a city level similar questions are important. If we want people to know where there are parking spots available, but we have to buy back the data from the parking garages, public money is being

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<sup>8</sup> Whereas this is a struggle, the reality is the same as in any company going through a cultural change. The definition of a cultural change is that an organization lacks the required traits, competencies, characteristics or habits to accommodate a newly emerged situation. Like Philips Electronics during the early nineties, as it realized its customer awareness was insufficient. Like any attempt at cultural change, there is only one recipe: do! Simply attempt to make that change happen. Realizing that the organization lacks the required trait, it will probably initially implement solutions that are wrong. Philips organized 3 Customer Days: satellite broadcasted customer awareness programmes with 160.000 employees. All 3 mostly with Philips employees talking to each other; only the last Customer Day was actually attended by customers.

spent on data being generated by the public itself for a facility built on ground sold by the municipality to begin with.

Challenge #4 (at tier 2): outdated infrastructures. When efforts are being put in place to make parking facilities or other infrastructures smart, those efforts will be limited to what the existing infrastructures can accommodate. How up to date are they? Can they be adapted for the required upgrades?

Challenge #5 (at tier 2): evaluating Return On Investment. If the existing utilities and infrastructures cannot be upgraded, how much will it cost to put an alternative in place? Can it be guaranteed that those alternatives will not be outdated soon? What are the returns on the required investments? How do you calculate them? Over what period? Against current benchmarks and evaluation criteria? Or in relation to the emerging smart city contours?

Challenge #6 (at tier 3): overcoming silos. Before chips became digital, it was important to know where to locate which functions of a chip where on the lay out in order to prevent interference. Companies had experts who knew exactly which function should go where. Digital solutions evolve less around avoiding interference. Their point is to speed up the connection. The analogy is that municipal services have developed largely in functional isolation from each other, each optimized for their own purposes. In efforts to become a Smart City, those silos need to be connected. This raises new challenges: which interests should prevail over others? What speed is appropriate? Can other important parts of the organization deal with that speed?

Challenge #7 (at tier 3): sourcing and funding innovations. Constituting a world that is no longer defined by physical separations, the merging digital infrastructure needs to be able to connect to new ideas. Conceptually, technically and financially. What do people want in a Smart City? Which services would they like? What digital equipment do they have, on themselves, in their cars, in their homes? Is it information they would like to receive on those devices? What information? Do new technologies provide new possibilities? Are new startups seeing the opportunities those possibilities may provide? As a Smart City starts to emerge, one erecting itself on an integrated 'layer', the sourcing, connecting and funding of new ideas offers itself as a new challenge.

Challenge #8 (at tier 4): commitment and participation. When the city is already involved, either by citizens asking questions, companies providing new solutions or innovations or by people questioning what those innovations are used for, the effort does not have to start from scratch. Yet arriving at a level where commitment is felt and participation guaranteed is another challenge. Some suggest that leadership may be vital. Others may recommend co-creation. Either way, from changing into a city perceive as not-yet-smart to a Smart City requires quite a significant number of changes on a structural and cultural front. Such efforts never come easy.

Challenge #9 (at tier 4): governance. A small city does not have significant leverage compared to bigger cities like e.g. Birmingham (with over 1.000.000 inhabitants England's largest city outside of London) or Cisco, a multinational with over 70.000 employees and a revenue in 2014 of nearly US\$

50 billion. Even if a smart, small city does not cooperate with other cities, working with people across the city exploring what a Smart City could mean, such a networking effort is unlikely to be an everyday job. If somehow the various efforts are brought together, do solutions exist enabling them to jointly govern their efforts? Or do new solutions have to be tried and tested?

Challenge #10 (at tier 4): flourishing ecosystem. Crucial to grasping the essence of the Digital Era is the acknowledgement that **the dynamic of the networked connections** is the essential ‘unit’ of society (not a geographical entity or other physical structure)<sup>9</sup>. Something has to make sense to people; meaning is not a given. People therefore have to experience purpose, they have to see the benefits of the changes they are helping bring about. Companies have to be acknowledged and rewarded for their efforts. Communities have to share the good things that are happening. If the effort is to continue, these connections have to be maintained, nurtured and cultivated so that the ecosystem may flourish. Ecosystems that work well are more successful and bring more economic growth.

Challenge # 11 (at tier 4): continuous improvement. Working on Smart City developments requires different ways of working. Observing technical standards and making sure they are met should not be a process of endless creativity, quite the contrary. Yet ensuring people get energy from their contributions should be a process of strict observation of the rules; people need to feel celebrated, their work needs to be valued and shared. Working with companies that are providing new solutions, some perhaps even straight from the laboratory (or some actually still in the laboratory, requires a delicate insight into the particular mix of pride, exposure and hope startups feel. On the other hand, whereas these new dynamics need to find their way, an ongoing attempts to improve and to keep on improving continuously should be in place. The effort should be open to take on broad insights and successful experiments from elsewhere.

See the table below for an overview.

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<sup>9</sup> Castells, Manuel (2009, 2nd edition). *The Rise of the Networked Society: The Information Age: Economy, Society and Culture*. Singapore: SPi Publisher Services Ltd.

Challenges	Related to	Smart City tier
<ol style="list-style-type: none"> <li>1. Digital competence: given digitization is new to the people working on infrastructures, how can the competence to be able to deal with digitization be guaranteed?</li> <li>2. Integrity and security: it is important that a data request can be guaranteed to originate from the indicated party - how can the new system be sure? And how can the data be maintained, stored and transferred safely?</li> <li>3. Data access and ownership: who has the right to use the data? How can that be determined and policed? Furthermore, who owns the data? How can that be legally ensured?</li> </ol>	The Basic Infrastructure	Tier 1
<ol style="list-style-type: none"> <li>4. Outdated infrastructures may hamper developments. How can their current and future adequacy be determined?</li> <li>5. Return on investment (ROI) is a main driver for any investment, yet for something as new as digitization, how can ROI be determined and correctly evaluated?</li> </ol>	The Parallel Smarter Infrastructures	Tier 2
<ol style="list-style-type: none"> <li>6. Overcoming siloed thinking is required when existing silos need to be replaced by integrated solutions; how will leadership emerge without continuing to serve established interests?</li> <li>7. Sourcing and funding innovations is a challenge, because new ideas are not easily found as integration of existing silos creates a world previously unknown. Beyond finding new ideas and connecting with them, financing the required efforts to develop them is also not necessarily easy.</li> </ol>	The Integrated Smart City	Tier 3
<ol style="list-style-type: none"> <li>8. Commitment and participation: how can citizens, business and other stakeholders become actively participate in the development?</li> <li>9. Working on new types of solutions at ecosystem level with multiple stakeholders requires some type of governance. Which?</li> <li>10. Flourishing ecosystem: how do people experience the benefits from the smart city developments? Can they give feedback? What works to ensure collaboration continues to evolve for the greater benefit of more?</li> <li>11. How to ensure the improvement remains continuous?</li> </ol>	The Social and Sustainable Smart City	Tier 4

## Chapter 2. How are Smart Cities developing?

There does not appear to be a clear and widely shared recipe for becoming a Smart City. That is actually not surprising considering that each city is unique, has its own history, its own peculiarities and its own political context.

The worldwide development of cities becoming smart is not the first time that digitization takes place. What we nowadays call the ‘Internet of Things’ first came about by connecting infrastructure, connecting workstations and PCs across sites of multinationals<sup>10</sup> from the mid 80s onwards. Then the entire ICT industry went digital, influencing everything they were integrated in: PCs, MP3 players, notebooks, tablets, SmartPhones, SmartHomes, SmartWatches and since recently Smart Cities. What is significant now is that digitization is touching people’s lives in public spaces; digital technology is truly becoming ubiquitous.

From previous digital revolutions as well as lessons that have been shared, knowing which challenges a smart city needs to address, we propose the following pragmatic 7-step programme for Eindhoven to become smart (or for any party that wants to take the lead in such an effort):

1. Ensure that competent staff orchestrate and build the system
2. Build on technical standards that are open, clear and stable
3. Organize for leadership to emerge and allow for clear informed decisions
4. Realize a co-created vision and keep on iteratively updating that vision collaboratively
5. Work with competent partners and suppliers on vendor-independent solutions and ensure the ability and competence to evaluate their work
6. Ensure the applications have (financial and non-financial) meaningful results on the short, mid and long-term
7. Set up an evidence and metrics-based continuous improvement process

In the following sections we will explain the subsequent steps in more detail (referring to the challenges previously described). In the recommendations these steps will be made concrete for Eindhoven.

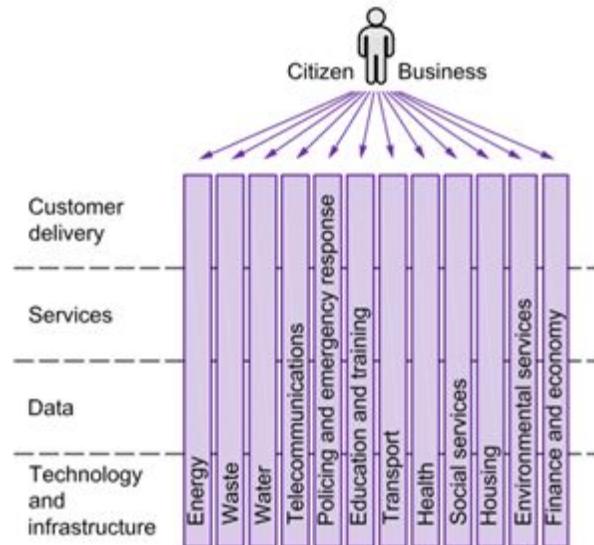
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<sup>10</sup> In Eindhoven the question was: how can we transfer a design for a chip made in the NatLab to the mask center in Hamburg? And then to the factory in Taiwan? Osman Khan was responsible for setting up a team to solve this urgent problem. This led to the Semiconductors division of Philips working with Cisco to create one of Europe’s first corporate intranet infrastructures. At that time Cisco was still a startup of around 10 people. Philips helped Cisco make its product compliant with EU regulations and the contacts of the Philips team with Matsushita Electronics Company (MEC) also helped Cisco expand in Japan.

## Step 1. Employ competent staff

Without the right people, it will be hard to achieve anything. Given that 'going digital' is new to municipalities, this may not be an easy step to take. This is complicated furthermore as municipal services and the related infrastructures are normally run in parallel.

According to BSI, the British Standards Institution, what they call the traditional 'operating model' for a city 'has been based around functionally-oriented service providers that operate as unconnected vertical silos' (see picture from [PAS 181 Smart city framework Guide to establishing strategies for smart cities and communities](#) by BSI ). Given these vertical silos, it is quite unlikely that 'digital competence' will be abundantly found in a municipal organization.



Hopefully in a situation like that, based on the expectation that there will always be competent people exploring new options, there will be certain people experimenting in pilots. In all likelihood those pilots will be conducted on the outskirts of the organization, in the periphery where such efforts remain unnoticed. Such efforts should be fostered and the knowledge gained in such pilots should be shared.

Another option is to tap into regional competencies and to try to find people with (multinational) experience. Working in a public organization, where a 'citizen' is not the same as a consumer and where the organization does not work for a customer may require some adjustments from them, but knowing how digitization works across large scale implementations will be a big asset.

Employing consultants is also an option. Their expertise will come at a cost and it may be that the solution they recommend is driven by their company's interests.

Working with other cities going through the same process is a good alternative. That will add weight in the selection process of solutions or suppliers.

All of these options are possible solutions for dealing with the challenge 'finding competent staff', challenge #1 of a tier 1 project, aiming to make a city's basic infrastructure more smart.

## Step 2. Build on technical standards

The main challenge in going digital is answering the question: how to connect? This means on the one hand determining what needs to be connected and for which intent and purpose. On the other hand it means that whatever is created as a means to connect should be implemented across the board. Digitization can only succeed if standardization takes place!

Some basic requirements need to be met before intent and purpose for connecting are resolved. Integrity, authentication and security need to be guaranteed<sup>11</sup>. A standard solution to safeguard that the system can know that the person using it is indeed the person authorized to use it has to be standardized and shared. Furthermore the system needs to be safe, people should know their data is not easily accessible.

Why is this relevant? HP conducted a study<sup>12</sup> of 10 types of connected devices. It found that 70% of the devices did not encrypt communication. 60% did not use encryption for software updates (making the devices vulnerable). Half of the devices raised security issues in the User Interface. Another alarming fact is that there are currently 2,5 million SmartMeters installed in homes across the Netherlands, none of which are adequately protected<sup>13</sup>. Furthermore, a study<sup>14</sup> by the Dutch Consumentenbond on web stores found the 60% had issues and 30% serious security risks.

Data access and ownership is strategic and important to be standardized on<sup>15</sup>. Who has the right to access what data? These aspects need to be resolved uniformly. To what degree should that data be openly available?

Following the rise of 'open source' software programmes supported by communities, the ideology of 'open data' is increasing in popularity. Making data available for citizens and companies to use, seems like a good idea. In practice, as became apparent on the '[Beyond Data Event](#)' (16th April 2015, Eindhoven, The Netherlands), having data available is no guarantee that the data will be used. Practice in Rotterdam was rather disappointing, whereas Helsinki was more positive in their conviction making their data available would stimulate the emergence of startups.

However, not all data should be open - in fact some data is proprietary and access could lead to serious disruptions of essential services<sup>16</sup>.

Existing infrastructures hamper the development and adoption of new ones<sup>17</sup>. What is the state of the existing infrastructures? How future-proof are they? What is happening elsewhere with similar infrastructures? What decisions are other people taking? How will they evaluate new investments that are being considered? Are they applying evaluation criteria that belong to the

<sup>11</sup> This is the 2nd challenge in working on a project aimed at making the city's basic infrastructure more smart.

<sup>12</sup> Hewlett-Packard (2014). Security of IoT Devices. Retrieved from:

<http://www8.hp.com/h20195/V2/GetPDF.aspx/4AA5-4759ENW.pdf>

<sup>13</sup> Green Hills Software, Chris Chubb, Internet of Things Event Eindhoven 2nd June 2015, [NRC, 30 jan 2015, 'De slimme energiemeter was toch niet zo veilig'](#), [Stentor, 29 jan 2015, 'Identiteitsfraude schaadt slimmer meter'](#), ['7 serious smart meter security threats'](#)

<sup>14</sup> Consumentenbond (2015). Digitale Gids

<sup>15</sup> Challenge #3: related to the question of data access and ownership..

<sup>16</sup> On the Internet, data of the internal routing of routers needs to be private and protected. On the other hand, information for managing the infrastructure through the SNMP protocols is open and made accessible on a 'need to know' basis.

<sup>17</sup> This relates to challenge #4, how to deal with outdated infrastructures?

not-yet-smart-cities reality? Have they already determined what Smart City evaluation criteria<sup>18</sup> are? Clearly it makes sense to expand beyond classical municipal boundaries and to aim to learn as much as possible from others!

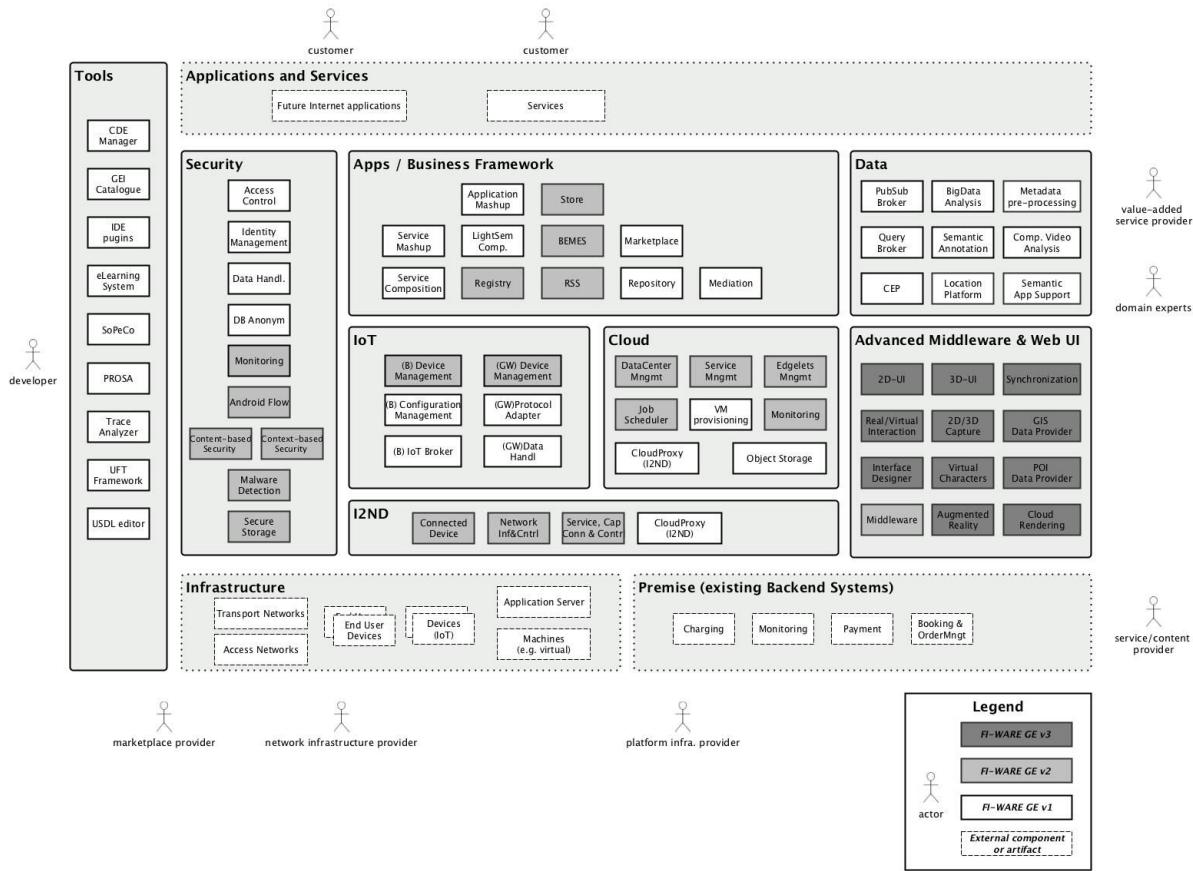
An important question for any party involved in developing cities into becoming smart, is: how can we, as a separate entity, contribute to standardization? Companies, mostly from the US, have commercial products readily available. Open source has software solutions. Any decision will strengthen the market opportunities for one solution and impact those of another.

At the same time, the European Union has invested millions of Euros into developing FIWARE (a contraction of Future Internet Ware) Internet of Things (IoT) middleware for Smart Cities. On paper FIWARE has a compelling set of specifications. Notably the reference architecture, the conceptual solution it is aiming to realize is elaborate and well thought through (see image).

Working with FIWARE requires working from the same specification, using the same solutions developed for implementation, using the same infrastructure and relying on the FIWARE organization. As far as we have been able to determine, by consulting people working with FIWARE, it seems that both the specification and the implementation are good, worth reusing and building on for standardization purposes. The third and fourth appear to be less well developed. This means that relying on FIWARE is not a foolproof solution nor is it without risks. On the other hand, the risks and costs of developing a new solution from scratch are huge. It would be better to evaluate FIWARE and then enhance and repair the shortcomings.

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<sup>18</sup> Dealing with limitations of the existing infrastructures and determining new and appropriate criteria for evaluating Returns on Investment (challenge #5) are the typical challenges of a tier 2 project aiming to make existing infrastructures smarter.



Alternatively, there is the option to implement a mixed approach, combining FIWARE solutions with proprietary ones. Valencia seems to be doing that, as visualized by their approach (see picture below). They use solutions emerging from FI-LAB (FIWARE components, etc.) in a way that is complementary to what they themselves develop.



Standardization cannot be done on your own. Smart Cities will have to ask themselves how to make the most of their investments: choosing for a fully proprietary commercially available solution, re-using elements from the available FIWARE solutions or to fully develop their own.

### Step 3. Organize for leadership to emerge

From previous successful digital revolutions of the past, a few iconic stories seem to lose very little of their appeal. The Linux operation system is said to have started to develop, when Linus Torvalds posted on a forum 'I am doing a free operating system (...) and I'd like to know what features most people would want. Any suggestions are welcome, but I won't promise I'll implement them'<sup>19</sup>.

Steve Jobs is said to have worked in a similar way, although he relied on a handful of specific people helping him evaluate pros and cons of new ideas<sup>20</sup>. It is easy to make decisions when you are in charge. But even in more complex situations, decisions need to be taken in order for innovations to have a chance. Not in the least because existing interests may not be susceptible to change.

Continuing with the development of ICT in Philips, it is not difficult to imagine that the interests of Corporate IT in Philips were not served by Philips colleagues promoting 'open standards' (like Internet Protocol (IP), Simple Mail Transfer Protocol (SMTP), Transfer Protocol (FTP), and Hypertext Transfer Protocol (HTTP), etc.). From Corporate IT perspective, a global leader such as IBM was guaranteed to provide a lower risk (technical and career) and more reliable solution than a startup company from San Francisco (Cisco).

Yet these changes, in all their complexity, had the advantage of being new in an emerging product or service category in the market. Linux was another Operating System (OS). The iPod a new MP3 player. The iPad the first successful tablet PC.

Smart Cities do not have the luxury of a single-category deployment. At the level beyond working towards making the existing infrastructures smarter, the efforts become truly complex. Imagine e.g. starting to work at reducing CO2 emissions. Rapidly such an ambition evolves into holistic approach beyond introducing Electric Vehicles. Making urban spaces more inviting to bicycle riders is also smart. Thinking about how challenges appear once you start examining them from outside of the existing silos, the city becomes a wide spectrum of public and private domains that interact, as envisaged in the Smart City Wheel below<sup>21</sup>.

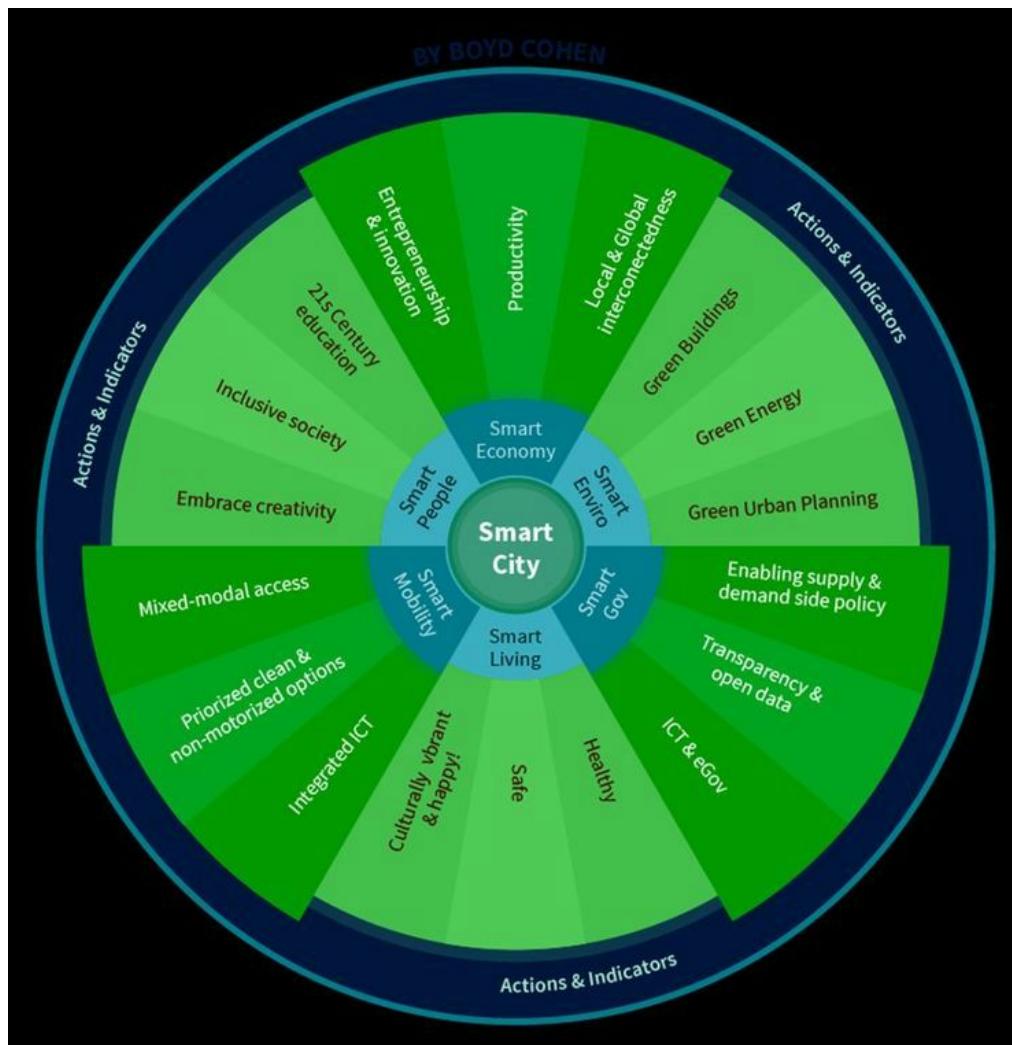
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<sup>19</sup> Linux History retrieved from: <https://www.cs.cmu.edu/~awb/linux.history.html>

<sup>20</sup> Isaacson, Walter (2011). *Steve Jobs: The Exclusive Biography*. New York: Simon & Schuster.

<sup>21</sup> Boyd Cohen, Smart City Wheel. Retrieved from:

<http://www.fastcoexist.com/3038818/the-smartest-cities-in-the-world-2015-methodology>

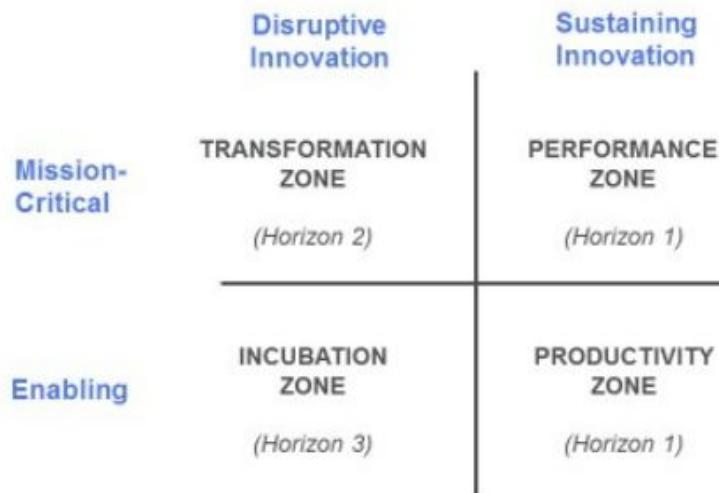


Clearly in Smart City developments the situation is complex. In addition to the existing infrastructures remaining fully operational, new additions need to be put in place at the same time as people arrive at conclusions that what they are putting in place actually does not fulfill the potential they are learning to appreciate. Managing such a complex reality is being addressed by Geoffrey Moore in a to be published chapter of his new book: [Chapter 2: The Four Zones](#).

Geoffrey Moore makes a distinction between mission-critical and enabling roles as well as between disruptive and sustaining innovation. Disruptive innovation is innovation that changes reality, that disturbs existing positions of power and that introduces discontinuities to how people perceive reality. Sustaining innovation are those efforts that continue to strengthen the reality that exists such as improved marketing plans, more efficient production, etc.

Mission-critical means: those activities directly related to what the organization is doing, namely executing its mission. ‘Enabling’ refers to not being directly but indirectly relevant to the company’s operation. This results in a 2x2 matrix with four zones with different characteristics (see picture).

## The Four Zones



The Performance Zone is the zone in which a company's or city's current operational focus is concentrated; this is the zone in which current activities, revenues and profits are generated.

The Productivity Zone are those activities that make ongoing work in the Performance Zone more effective or efficient. This is where Quality programs yield process improvements.

Most organizations have a focus exclusively on the right-hand side of the matrix which is where the current revenues come from and should be professionally managed . They conduct their ongoing affairs and seek to improve their way of working. All classical bureaucracies behave as such, innovation not being an important focus and citizens not being regarded as customers with emerging needs. Note that both zones in the right-hand column take place within 'horizon 1' timeframe (about 1 year forward).

The left-hand column is of a different nature and should be focus of the organization's leaders (not managers). This is where new ideas are born, different from reality as we know it. Ideas appear to be quite far away, removed from business as usual, residing in 'Horizon 3' (time frame 2-5 years out). This is the realm of the Incubation Zone. This is the zone in which Steve Jobs asked his network of innovators to throw ideas at him. This is the zone from which Linus Torvalds wanted ideas for future Linux features. The organization's leader should initiate, foster, terminate or transform the ventures in this zone.

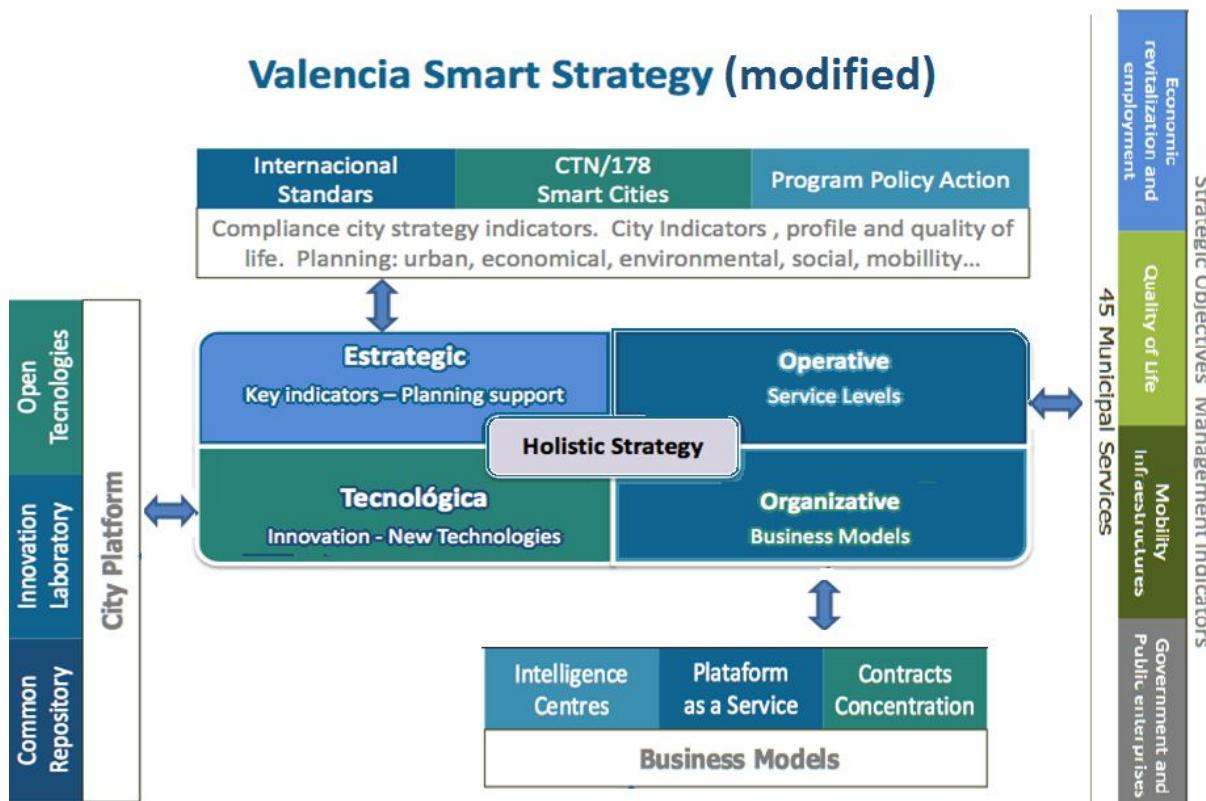
The Transformation Zone is of strategic importance. Here one selected idea is transformed to an innovation that will be critical to the company's or organization's mission and future. This is the phase in the transformation of idea to innovation that gave Steve Jobs the nickname<sup>22</sup> 'Mr. No!'. This is where Steve Jobs illustrated he had an unparalleled ability to select those ideas that would

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<sup>22</sup> ['There are a thousand no's for every yes'](#)

make it to the market with almost unprecedented success. When Apple created the iPod, the whole company moved it from Incubation through the Transformation Zone into the Performance Zone with a speed and quality of execution that gave Apple a magical aura. Repeating that stunt with the iPhone was truly amazing. Then they executed it again with the iPad. Apple now is the highest valued company in the world, only disappointing slightly because without Steve Jobs at the helm it does not seem able to repeat that amazingly well executed idea-to-innovation transformation yet another time.

How can a bureaucracy organize to allow the leadership required for innovations to develop<sup>23</sup>? That is as much a question for a bureaucracy like Philips, which by now is well over 100 years old, as it is for the municipality of Eindhoven. Yet when it comes to dealing with Smart City challenges, Valencia's approach needs only a few minor adjustments to provide an interesting approach.



Interestingly, Valencia's holistic strategy reflects Geoffrey Moore's four zones. Operationally (Performance Zone) the municipal services are executed. The Productivity Zone has a smarter focus, by introducing possible improvements to business model impact: are new services being generated (e.g. Platform as a Service or new Intelligence Centres provided with new products or services), can contracts be concentrated?<sup>24</sup>

<sup>23</sup> This is challenge #6 (organizing for leadership to emerge) that has to be dealt with when a city starts to think about establishing improvements at a level where thinking beyond existing silos is required and where the interests of citizens and local entrepreneurs starts to become part of the picture.

<sup>24</sup> We are aware that combining the Smart Strategy from Valencia with the Four zones from Geoffrey Moore is perhaps a bit too pragmatic. It may well be the case that Valencia has not intended its use of e.g. 'technology' the

Using a City Platform new ideas can emerge and can begin to find a translation into technologies. What is a 'city platform'? Valencia specifies it as a common repository, an innovation library and open technologies. The repository will contain software elements, (open) data and in all likelihood also an Application Programming Interface (API): the digital instructions by which applications can be made to communicate.

FIWARE specifies it in far more detail (see Step 2 in this chapter); yet also already allows for elements of the platform being developed later. We believe that working with a well-developed API even different parts from the platform might not need to have the same maturity level (i.e. some could be more experimental than others). This would allow for a heterogeneous architecture (as opposed to a homogenous one encompassing all installations with the same level of maturity) from which an Incubation Zone ('Tecnológica'), enabled by a City Platform with an API, could test ideas that could subsequently enter a Transformation Zone where they would be evaluated against strategy, based on indicators and a match with already articulated ambitions and developments elsewhere.

Note that we do not advise to develop any City Platform as a homogenous system, but as a heterogeneous architecture creating an Incubation Zone, a Transformation zone and allowing for implementations to mature towards services delivered in a Performance Zone. A heterogeneous architecture also has the advantage that by definition it is more open to incorporate efforts already ongoing.

Connecting Valencia's Smart Strategy to Geoffrey Moore opens up new potential. Geoffrey Moore has been publishing for that emerging part of the industry for quite a while; his books 'Crossing the Chasm' (2000), 'Dealing with Darwin' (2005) and 'Inside the Tornado' (2009) are well-known in venturing and corporate venturing startups. Since 2010 interest in startups has noticeably increased in- and outside of The Netherlands. A number of incubators have been founded. Even a company as old as Philips has ventured into corporate venturing. Kickstarter is well-known across the globe, as are accelerators like Startup Bootcamp HighTech XL in Eindhoven.

Living Labs are a useful way of innovating, realizing new ideas rapidly in environments with users present. It does seem as if many living labs are not disruptive enough. The majority of labs appear to be managed as advanced development centers rather than as incubation zones requiring insightful leadership.

Looking at the Modified Valencia Smart Strategy, it makes sense for local government to establish an Incubation Zone for its Smart City efforts, empowering startups or even people with less well articulated ideas to use the services of a Living Lab. This has the advantage of increasing the

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way we have interpreted it. Yet the possibility to combine the holistic perspective Valencia seems to use with Geoffrey Moore makes it too inviting not to use. See Chapter 5 for more discussion on this modification of the Valencia Smart Strategy.

potential that new business are created. Perhaps it even has the added advantage of attracting venture capitalists eager to invest in new opportunities<sup>25</sup>.

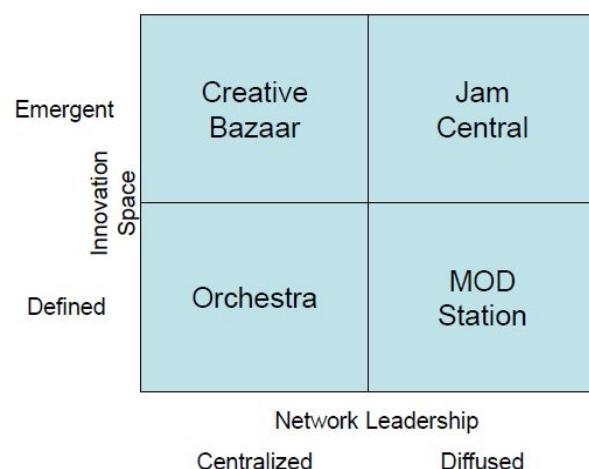
#### Step 4. Realize a co-created vision

Quite a number of cities stress the importance of involving citizens. The Smart Cities Readiness Guide even talks about the ‘citizen engagement challenge’ that needs to be ‘remedied’<sup>26</sup>; it refers to the situation in the US in the early 2000s when smart meters were rolled out by power utility companies without explaining to customers what their benefits were. Consumer backlash and resistance were the result.

Perhaps a bit of ‘semantic puzzling’ is appropriate. When someone needs to be involved, he or she actually is *not* involved up to the moment the attempt to involve him or her succeeds. Any attempt to ‘involve’ therefore means that the ‘*involvee*’ is not an owner of the process taking place. We think that the solution to the ‘citizen engagement challenge’ is one by which the process is co-owned by citizens *from the start*. Also by businesses and perhaps other stakeholders, by the way. In Addendum 1 we have incorporated the case study of Aarhus, who seem to have been doing this well, resulting a.o. in cross-city working groups on various topics (e.g. energy and mobility). in practical terms, the process of becoming a Smart City should not be one that involves stakeholders, but a process that is owned by all stakeholders across the city and in which they share ownership<sup>27</sup>.

There is no single solution to starting up such a process, nor are co-creation and/or participation the only direction in which the ‘citizen engagement challenge’ can be addressed. The Smart Cities Council e.g. suggests that 'Every parade needs a leader' and that it is visionary leadership that is required. Perhaps it is not necessary to choose a single way forward?

In the early 2000s the famous physics laboratory of Philips in Eindhoven, the Nat.Lab., removed the fence surrounding its property and began hosting other companies and organizations on its facilities. This signalled a major policy change, as the Nat.Lab. had been closed to outsiders since its start in 1914. This Era of Open Innovation was rapidly succeeded that the acknowledgement that removing a



<sup>25</sup> We believe that a heterogeneous architecture in the form of a City Platform can also serve to source a Smart City programme and perhaps even serve to help fund it. Both relate to challenge #7: sourcing and funding the Smart City effort

<sup>26</sup> Smart Cities Council Readiness Guide (2014): page 16

<sup>27</sup> Here we have started to address challenge #8: creating commitment and realizing participation.

fence actually only strengthened a practice already widely used in the research organization, namely innovating-in-networks.

The ‘Global Brain: Your Roadmap for Innovating Faster and Smarter in a Networked World’ (2007) by Satish Nambisan and Mohanbir Sawhney proved quite helpful. In their study of how the software industry emerged in the US they distinguished 4 approaches to innovating in a network coalition.

When the leadership of the innovation network is in the hands of one or two players and the innovation effort is defined, the situation is one similar to that in which an orchestra finds itself. As the coalition of Intel and Windows manifested itself as ‘Wintel’, it was clear to everybody that these companies owned the PC market, introducing the 286 processor with Windows 3 (and the 386 and 486), then the Pentium with Windows 7 and proceed with the X86 and Windows 8 and Windows 10.

The MOD station is different. The term ‘MOD’ is derived from the gaming term ‘modification’, meaning: ways to adapt a game without changing the central rules yet completely altering its appearance. In some games it is e.g. possible to change the season from summer into winter. In the software industry in the US, think about Google Maps: you can enter all kinds of Points of Interest, but those are the main dominant entries the system allows for. Everyone can contribute, but the contributions are all limited to that of a defined type of innovation.

The Creative Bazaar is a different situation. This is where e.g. Apple provides software to app developers, allowing them to basically build an app for everything while remaining the approval authority and the one controlling the apps that people can choose from.

Most rare is ‘Jam Central’, a way of networked innovation that uses the term ‘jam’ from Jazz. What is meant is that everyone is trying to find out together what exactly needs to be done. There is no conductor in front of the orchestra, there is no owner of the bazaar and there is much more to be done than simply modify what is already available. The Swedish City of Lund for example decided to pursue the vision of becoming an ‘attractive sustainable city’ as early as the end of the 1990s. Now that pursuit by all stakeholders involved has lead to the longer term LundaMaTs II strategy for transport and mobility (after its first update in 2006)<sup>28</sup>. When you share a vision and have very little ideas about who is involved (except ‘everyone’) and what should be done (except ‘a lot’), then ‘Jam Central’ is the approach to follow.

What is the point we are trying to make? Not all innovation processes follow the same logic, require the same roles and follow the same path. For some, it may be important that the parade has a leader. For a good old fashioned jamming session, wanting everybody to obey the conductor is not necessarily the best way to enjoy the music. We think there are cultural presets at work, favoring ‘leadership-driven’ approaches or ‘co-creation, participation-based’ approaches that many

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<sup>28</sup> <http://www.bsr-sump.eu/good-example/lundamats-ii-long-term-strategy-transport-and-mobility-lund>

not necessarily yield the best result for the innovation effort required. To stress how important semantics are, look at the example below from the European Union<sup>29</sup>.

Factors for success	Description
Vision	The study makes clear that inclusion and participation are important targets for successful Smart City programmes to avoid the polarisation between the urban elite and low income areas.
People	The case studies highlight the inspiring leaders ('city champions') behind many successful initiatives. Citizens should be empowered through active participation to create a sense of ownership and commitment, and it is important to foster participative environments that facilitate and stimulate business, the public sector and citizens to contribute.
Process	The creation of a central office that acts as go-between for Smart City ideas and initiatives, drawing in diverse stakeholders, is of vital importance and allows coordination of ideas, projects, stakeholders and beneficiaries. Local level coordination can also be important for uptake, to ensure the integration of solutions across the portfolio of initiatives. For example, many municipalities insist that information about public services be provided as 'open data'. This allows individuals and companies to process and recombine these and other available data in order to create useful resources for the public, for example real-time traffic information. It is important for cities to participate in networks to share knowledge and experiences, therefore promoting their own initiatives as well as learning from others and laying the foundations for future collaboration.

When talking about the vision, it is stated that inclusion and participation are important targets for success and to avoid polarisation between the urban elite and the low income areas. First of all, that does not say anything about vision. Secondly, it says something about 'people' which is the topic addressed immediately after 'vision'. Thirdly, it states that the vision should avoid polarisation between *the urban elite and the low income areas*. The EU thereby accepts that there a divide exists and that a vision is required to avoid that divide being polarized!

On the topic of 'people' the Directorate-General for Internal Policies recommends a.o. that 'citizens should be empowered through active participation' and that it 'is important to foster participative environments'. Since it is not quite clear how the 'active participation' should come about and who would create the 'participative environments', especially since that section deals with people, perhaps the answer lies in the recommendations related to 'process'?

Who will bring all this about? 'The creation of a central office (...) is of vital importance'. Clearly by starting from the statement that inclusion and participation are important targets, the final recommendation of putting a central office in place hardly seems the way forward to bring that about...

We think that putting a central office in place is a certain way *not* to create participative environments, *not* to succeed in bringing about participation and *not* to achieve inclusion. Is there

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<sup>29</sup> Mapping Smart Cities in the EU (2014): page 11

a better way? Yes. Networking-thinking is evolving into thinking about ‘ecosystems’. Taking into account the fact that working through hierarchies is not the most appropriate way to realize citizen engagement in today’s society, the bigger ecosystem becomes more eminent. Referring to an ‘ecosystem’ is a way of designating the many stakeholders working together without hierarchies, often according to an unwritten set of rules, based on a common history or culture. Ecosystems are not created by signing agreements. They result from a dynamic among several stakeholders working together to make the situation for each other and for all better. Simply put: think of it as a network in which the leadership is diffused (re-using the terminology from ‘The Global Brain’).

Yet jointly aiming for a shared vision makes sense. As the Smart Cities Council<sup>30</sup> puts it:

‘Vision is a clear picture of the ultimate outcomes, expressed in terms of citizen benefits. The vision should not be expressed solely as technical achievements but also as the lifestyle and workstyle improvements the technology makes possible. It is essential to build that vision with citizen involvement. First, you’ll get better and more diverse suggestions. Second, you’ll build consensus and commitment.’

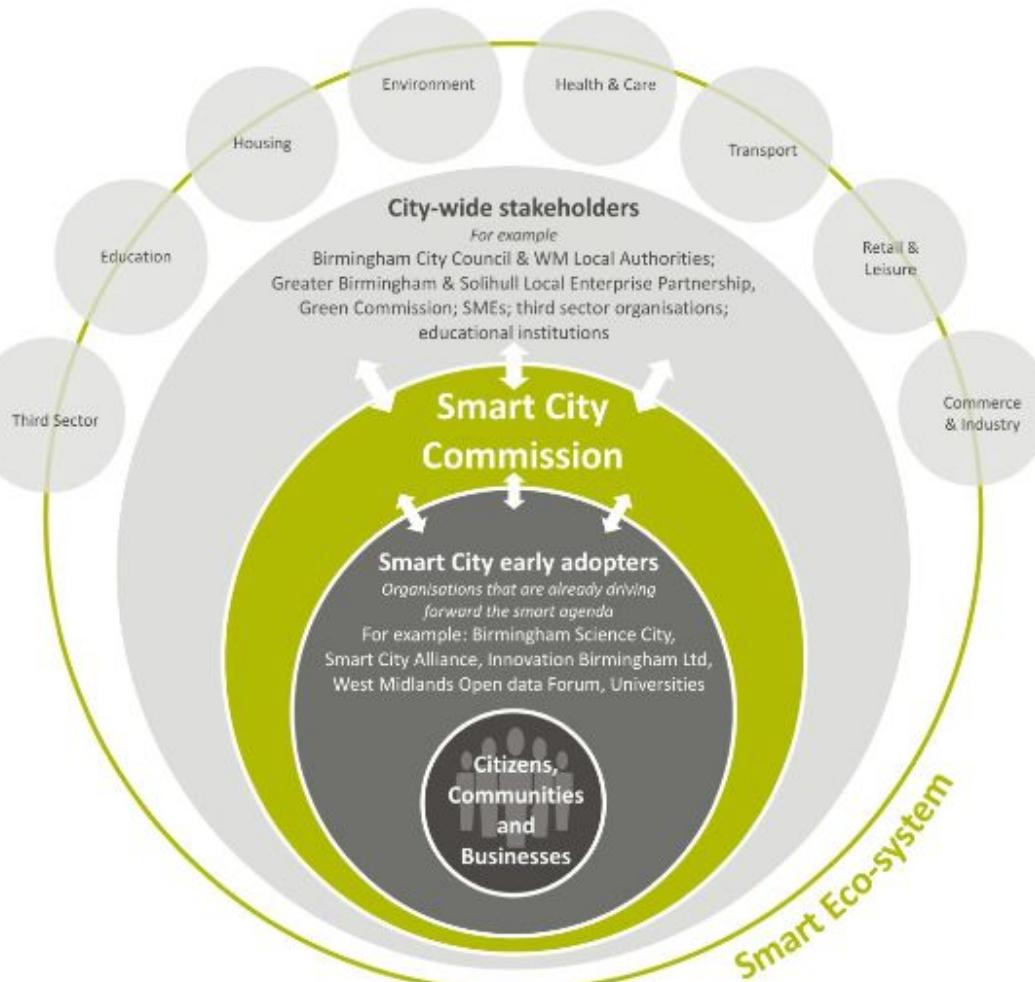
Without a vision, it is difficult to get energy going. When Bill Gates would not have foreseen what could be possible if he could convince IBM to use his software, if the City Council of Lund would not have decided to change how everyone was thinking about ‘mobility’, none of those innovations would have worked.

Knowing that a vision can play a role in an ecosystem, it is clear that a single uniting vision can result in multiple sub-themes, each of which needs to settle in its own peculiar mode of networked innovation. A good vision, one that has a chance of working, starts with leaders articulating what it is they want to realize for everyone. And from there the approach should evolve, much like Birmingham has visualized its approach<sup>31</sup>.

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<sup>30</sup> Smart Cities Council Readiness Guide (2014): page 244

<sup>31</sup> Birmingham Smart City Commission (2014). *The Roadmap to a Smarter Birmingham*. Retrieved from: <https://birminghamsmartcity.wordpress.com/2014/03/03/birmingham-smart-city-roadmap-launches/>; page 12



*By establishing a collaborative, interconnected smart city eco-system in Birmingham, we will work with all stakeholders to deliver long lasting benefits that future-proof the city against future demands*

Certainly one of the more advanced visions is the one on ‘Government 3.0’, out of Korea. As early as 2013 they proposed to convert government from an approach of policy-based evidence to one of evidence-based policy and to make government scientific<sup>32</sup>. Government 1.0 is defined as a government that works well. That becomes a government 2.0, a government that opens up to people and uses the web and apps for that. Out of that emerges a government 3.0, which is data-based, builds its thinking on that data and innovates its policy as a consequence thereof.

### Step 5. Partner on vendor-independent solutions

For any city developing, it is important to arrive at vendor-independent solutions. On tier 1 and 2 there may perhaps be already quite a few suppliers who can install utilities, smart or not. On tier 3 integration becomes the defining quality and the notion of ‘city platform’ arises. We have already referred to FIWARE as the most elaborate reference architecture, mentioned that Valencia has one

<sup>32</sup> Jong-Sun Hwang (2013). *The Korean Approach to Smart City and Smart Government* (presentation on Slideshare). Retrieved from: <http://www.slideshare.net/hjs0199/smart-city-and-smart-government-strategy-model-and-cases-of-korea>, slide 32

and shown how a city can connect to FIWARE and simultaneously pursue its own technological solutions.

We propose that a heterogeneous architecture gives quite a bit of freedom. That means: across all different parts of the Smart City innovation efforts no single architecture, but one based on what works best for that particular innovation effort. A shared API (a common interface) should guarantee interoperability, i.e. ensure all applications can work together. Open Data formats can make it possible for data to be interchangeable. Important questions remain: who decides who should have access to what? What is stored? Why? Where are the lines drawn between proprietary information and information to be shared openly? (Cisco will e.g. not share its deep layer routing protocols, as those are company secrets. Should a company supplying smart lampposts share all data? Including the sensor data of a snowflake being detected? Should only data on people's movements be stored? Including the IP addresses of their smart devices?) How are those decisions made? How can once made decisions be revisited? Who oversees the integrity of the architecture? How is the quality of the architects and architecture safeguarded? In short: how is governance set up?

The most prominent examples from previous technological developments that lead to bigger ecosystems, are those of Linus Torvalds (LINUX) and Steve Jobs (Apple). Torvalds welcomed all contributions but said 'I won't promise to implement them'. Steve Jobs became famous as 'Mr. No', rejecting many proposals but immensely successful with the ones he selected. Steve Jobs especially is an appealing example of an enlightened dictator who captured the imagination.

Is the enlightened dictator a good governance model to emulate? Maybe. But it is not likely to happen. Linus Torvalds emerged as a leader, was without doubt the right man at the right place with the right competences for what he was trying to do. Steve Jobs was an incredibly competent man, having co-started Apple in the first place. But then he got sent away. And returned to take Apple to even higher levels. Without any doubt, much of his success is owed to the hard lessons he learned along the way. The point is: there are not many Linus Torvalds's or Steve Jobs's around! And if you find them, they will in all likeliness be working for someone else or for themselves.

Under Step 4 we also highlighted that according to The Global Brain, there are (at least) four models to organize the effort: (1) the orchestra and (2) the creative bazaar both with the power in the network centralized and (3) MOD station and (4) jam central in a network where power is distributed. Clearly for every city acting on its own, working with a distributed network reduces their chances of becoming dependent on a more powerful party.

The shared vision will also be relevant to the issue of governance. If a tier 2 effort is e.g. focused on improving mobility, or reducing CO<sub>2</sub> emissions, than the way things are organized at that moment are not necessarily challenged. When a tier 3 effort relates to a vision of improving people's lives, there it is very well conceivable that the need for integration of silos will overrule existing structures keeping the silos apart.

We think an important lesson can be learned from Birmingham. Their Smart Ecosystem approach (see Step 4) has The Smart City Commission as a governing body, chaired by the Birmingham City Council Cabinet Member for Green, Safe and Smart City, meeting quarterly. The Smart City Commission encompasses citizens, communities and businesses and singles out only one other category: Smart City early adopters, organizations that are already driving forward the smart agenda<sup>33</sup>. Working with people already at work, stimulating them further and even perhaps enabling them to achieve more faster, certainly sounds like a smart way to stimulate growth of the early buds of an emerging ecosystem<sup>34</sup>.

### Step 6. Keep delivering meaningful financial and non-financial results

In July of 2013, in Bristol (UK), it became possible to start communicating to a lamppost, post box, telegraph pole, manhole, garbage bins and bus stops. Every piece of furniture with a unique identifier somewhere on its exterior. Before you think ‘Well... So can I’, here is the amazing thing: when you texted them, the street furniture across the whole city would reply.



Was it silly? Sure! Was it fun. Even reading about it is fun. Did you know people talked most to lampposts? Hello Lamp Post ran in Bristol from July to September in 2013. And was repeated in Austin, Texas from February 12 to April 27, 2015<sup>35</sup>, where it was an official art project at SXSW.

<sup>33</sup> Birmingham Smart City Commission (2014). *The Roadmap to a Smarter Birmingham*. Retrieved from:

<https://birminghamsmartcity.wordpress.com/2014/03/03/birmingham-smart-city-roadmap-launches/>; page 12

<sup>34</sup> Governance, which is challenge #9 in becoming a Smart City, can be easily imposed and as the example from the European Union suggests mentioned under Step 4, it is not difficult to start with the ambition to create inclusion and to nevertheless conclude with the recommendation that a central office needs to be put in charge. We recommend not to follow that course. If the Smart City development is to continue, a more organic effort towards an ecosystem will have more chances to prove to be an adequate governance approach.

<sup>35</sup> Retrieved from <http://www.hellolamppost.co.uk/about> and

<https://austintexas.gov/page/hello-lamp-post-austin>

In spite of all its silliness, Hello Lamp Post got people experiencing their city in a new way. People had to identify an object as being an instrument of play, had to search it for its identifier somewhere and then had to engage. Without any doubt Hello Lamp Post made people experience Bristol and Austin (and in April of this year in Tokyo<sup>36</sup>) in a completely new way.

It wasn't your average example of a Smart City. But could it have been a forerunner of how people could be experiencing a Smart City in the future?



Once the efforts to realize a Smart City get started, it is important to create momentum and to keep it going. According to Van Aken en Opdenakker that is how strategic momentum works: things do not get done because someone has a plan. Things get done, because energy got created and invested in things happening<sup>37</sup>. Which they do, until the momentum runs out. If the effort is to keep on going, time and again energy has to be generated and invested in the process.

There is another reason: if at some moment in the development of a Smart City tier 4 ambitions are pursued, crucial to that effort will be the active participation of people, visitors, residents and local entrepreneurs alike. How else can a Smart City become a social city? How else can it really pursue any sustainable outcomes? Engaging with people in the process at the moment there are results to share can help strengthen the efforts communicative competences early on.

Can the importance of engaging with people, sharing meaningful results with them, be found? In its Smart City Framework Cisco mentions the word 'people' 1x. In its publication 'Innovation Network; Morgenstadt: City Insights', Fraunhofer uses 'people' 3 times. IBM devotes one tab of 6

<sup>36</sup> Retrieved from <http://www.hellolamppost.tokyo/en/about>

<sup>37</sup> Van Aken, Joan and Opdenakker, Raymond (2005). *Strategic Momentum: the Immediate Outcome of an Effective Strategy Formation Process*. Technical University of eindhoven, retrieved from: <http://core.ac.uk/download/pdf/6625732.pdf>

on its Smart City website to ‘people’, spelling out its solutions for social programs, smarter care and education<sup>38</sup>. From its roadmap to a smarter Birmingham, ‘people’ is one of the 3 sections of the roadmap, in between ‘technology and place’ and ‘economy’, covering nearly 20% of the 65-page document. Clearly getting people’s attention, sharing with them the results achieved through Smart City efforts and securing well in advance of tier 4 ambitions an eagerness to cooperate (challenge #10) is not the most well developed challenge in Smart City programmes to date.

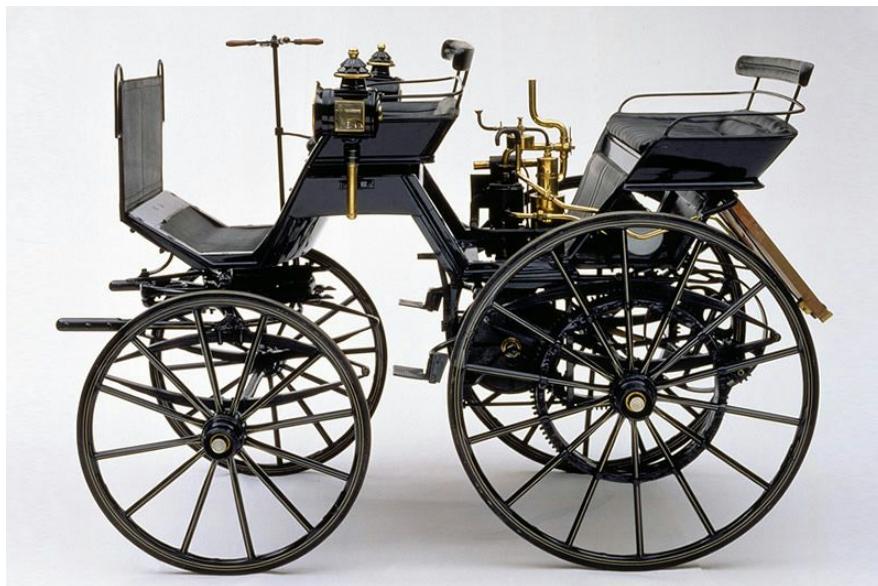
### Step 7. Set up an evidence and metrics-based continuous improvement process

Once Smart City initiatives are deployed and operational, we recommend to continue looking for improvements. This should be supported by a metrics-based continuous improvement program.

Becoming a smart city is a continuous and time-consuming process; it involves a vast amount of stakeholders and citizens with various backgrounds. There’s no one-size-fits-all pathway to the smart city; all cities need to find their own trail. Virtually all cities are already making their way, as ‘Smart City’ is increasingly becoming synonymous with ‘Future City’. Being viewed as a Smart City is a key objective of quite a few of municipal communication professionals. In this report we assume they are right: ‘Smart Cities’ is not a hype, it is one of the latest chapters in the ongoing trend of ‘digitization’. Not only phones are going smart, not only homes or watches, cities too.

Six of our previous steps have served to help people begin. We also recommend to constantly be on the look out for ways to improve. But with a word of warning.

As with all innovation, predictable patterns emerge. The ‘horseless carriage syndrome’ will make itself known. And the ‘innovator’s dilemma’ will make itself felt. What is ‘the horseless carriage syndrome’? The explanation starts with the question: what does the picture below depict?




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<sup>38</sup> Retrieved from: [http://www.ibm.com/smarterplanet/us/en/smarter\\_cities/human\\_services/](http://www.ibm.com/smarterplanet/us/en/smarter_cities/human_services/)

The answer: it was the world's first gasoline-powered four-wheel car<sup>39</sup>. The very first horseless carriage, an auto-mobile, developed by Gottlieb Daimler in 1886. The reason why we are calling such a vehicle an 'auto' these days, is because of that name, 'auto-mobile'. Why did they ever give this invention that name? Because it was the first vehicle that moved without being drawn by horses!

Marshall McLuhan has called this process of perceiving the future through a rear-view window the 'horseless carriage syndrome'<sup>40</sup>: the first horseless carriage came to be an 'auto' because it didn't require horsepower to make it move. Which also explains why we have been expressing the power of a motor in horsepowers for over 100 years. And incidentally why the content of the internet in the beginning was 'hypertext', since it was a book with links. And why the first Philips broadcasts from the Nat.Lab. were radio plays registered with cameras. The old habits dictate the terms by which the innovations are perceived, which is also why a policy advanced by the European Union can use words like 'inclusion' and 'innovation' yet practically advance top-down deployment and centralized control as we have seen before.

We have stressed how important it is in any innovation process, including the one of becoming a Smart City to simply begin. Not without thinking. But not by making huge, long-term plans that allow for all those habits that will require changing in the process to find a firm ground and articulate themselves. The Smart City, as with all revolutions caused by digitization, cannot progress in a hierarchical top-down way. Its success depends on making the right connections, operating in peer-to-peer networks, creating synergies, sharing resources, opening universally accessible interfaces. Top-down is not the way to go. Bottom-up is simply a mirrored version along the wrong dimension. The right dimension is 'forward', towards the realization of a co-created vision. This is why we have created a 7-step programme: to simply begin and to learn by doing. Yet, keeping the horseless carriage syndrome in mind is not a bad idea!

The making of a Smart City strategy and roadmap is not uncharted territory anymore. The Scottish Government, the Smart City Council, the EU and the BSI (British Standardization Institute) have created quite sensible reports and tools, the one smarter than the other, offering cities support in the process of building a Smart City. The Scottish report offers the previously referred to Smart Cities Maturity Model and Self-assessment tool. The Smart Cities Council has a Smart Cities Readiness Guide, called 'The planning manual for building tomorrow's cities today'.

The steps are:

1. Assessment - know where you stand and listen to citizens and other stakeholders
2. Vision - co-create a shared vision and define success in clear objectives
3. Focus - select focus themes/domains, create roadmaps and milestones
4. Organize - the key enablers for the smart city. Create a technical and organizational platform to coordinate and accelerate. Accommodate innovation with support and mindset.

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<sup>39</sup> Daimler. The birth of the automobile. Retrieved from:

<http://www.daimler.com/dccom/0-5-1322446-1-1322466-1-0-0-1322455-0-0-135-0-0-0-0-0-0-0.html>

<sup>40</sup> McLuhan, M. & Q. Fiore (1967). *The Medium is the Massage*. New York: Bantam.

5. Design and Deliver - make useful products and services, and keep measuring.
6. Measure - iterate vision and processes continuously based on data
7. Be proud - share the successes and celebrate milestones! Make people proud!

In any city nowadays, in Eindhoven as well as in all other cities, someone will already be working on a Smart City projects. Clearly It is important to have an overview of what is already going on and what kind of resources are available in the city. The Scottish maturity model is a helpful tool for an assessment of the current state and budget in each domain and project. Once an assessment has been created, from that point onwards it can be determined how to move forward in each domain and with each project to achieve the ambitions set out.

Or can it? And is the Scottish maturity model a helpful tool?

Innovation is characterized by the horseless carriage syndrome. If people not involved with the innovating effort do the assessment, what are the chances they arrive at a good appreciation of the effort? The answer is: chances are small indeed. This is what Christensen has called the 'Innovator's Dilemma'<sup>41</sup>: the realization that the innovation at this moment will not be beneficial to the organization, but ignoring it and not pursuing its benefits will definitely hurt the future of the organization. Or rephrased in terms of the Four Zones of Geoffrey Moore: managers performing well in the right hand column of sustaining innovation are ill-suited to make the right decisions when evaluating breakthrough innovation. Which is why two columns are required, not one. The same holds for listening to consumers. How can they articulate what it is they want? When they are not involved in the innovation process, they can simply not be able to answer that question sensibly.

Our experience in dealing with the digital revolution in creating one of the first technological infrastructures of a corporate intranet, developing the operational User Interface on it (i.e. developing the Philips corporate intranet), helping Philips Semiconductors to adopt its culture to that of a 'digital company', creating the first digital Integrated Circuit Architectures, making Philips consumer products digital, helping Philips Nat.Lab. adapt from an old-fashioned closed-research organization to Philips Research working through Open Innovation, consulting Philips Lighting on how to deal with digital architectures (which for them is a challenge, as their previous technology - light bulbs - was still based on vacuum technology) and consulting VisitBrabant on how to realize digitization in the public domain of leisure has taught one thing: the people not engaged in the innovation process have little understanding of what the effort is trying to realize. We therefore recommended to begin with Step 1: employ capable staff. An assessment by the wrong people will push the entire effort backwards.

We also pointed out that Birmingham seems to have the same starting point at the realization of their ecosystem approach: work with the people already innovating!

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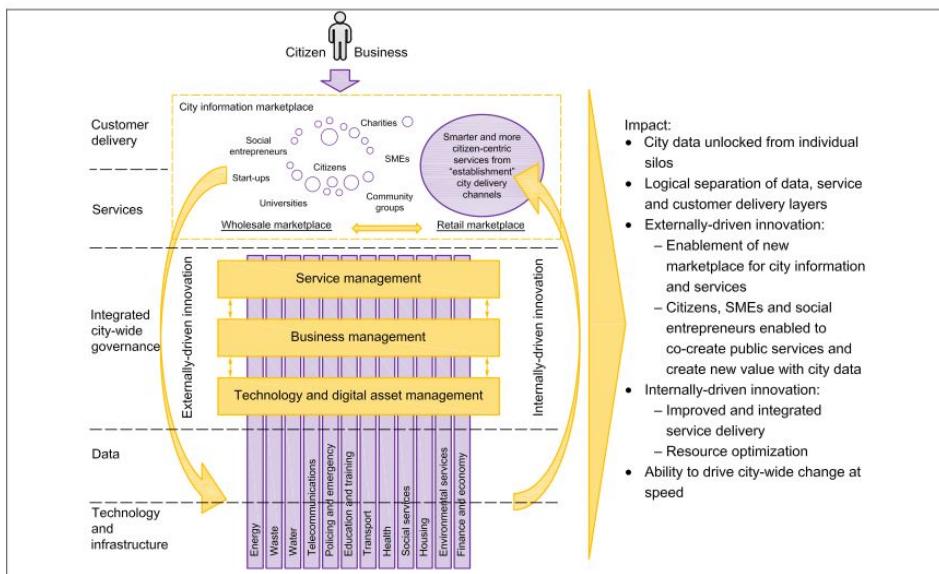
<sup>41</sup> Christensen, Clayton S. (2000). *The Innovator's Dilemma*. New York: HarperCollins Publishers Inc.

There are quite a few methodologies available. But like the policy put forward by the European Union and the steps proposed by the Smart Cities Council, although they have many smart things to say and they articulate them very well, on the topic of offering very practical advice on which steps to take, we believe their logic reflects that of right-column habits and not left-column innovation experience. They will simply not do; although making the decision to adopt them will be more easy for right-column oriented decision makers.

Is there no other model, next to the examples offered by Aarhus, Valencia and Birmingham, that does make sense? Desk research has uncovered at least one. Once a programme to become a Smart City is under way, what should be looked at is some of the excellent work done by the British Standards Institution (BSI). Their Smart Cities Framework (SCF) on the one hand is simple, is quite complete, it allows for local governments to take a new role and become a team player on the field and it addresses talent, ecosystem, community development. It is by far the best approach we have found for any Smart City Programme to benchmark itself against, once our initial 7 steps have helped it move forward.

All not-yet-fully-smart-cities work with silos, in one form or another. Yet beyond having an infrastructure (tier 1 projects) and projects aimed at making those silos smarter (tier 2), additional ‘smartness’ comes from the integration of the silos (tier 3). Tier 4 projects, actually working on have a Smart City evolve as an ecosystem for the benefit and with the included cooperation of its citizens and businesses, operate differently. Citizens and businesses drive the development of new services, BSI point out that, once a Smart City realizes what it is about, citizens and business are actually the focus of the effort. it all starts with them. In this operating model there is therefore an explicit introduction of the words ‘customer delivery’.

New services for them are created, based on an integrated city-wide governed platform, supplying data, run on the existing infrastructure.



**Figure B – New integrated operating model: where smart cities are moving to**

This also means that, next to a thorough technology orientation, this operating model introduces a

design focus. Smart Cities should start with their users and should work towards their satisfaction. This immediately raises the question: where are examples in Smart City programmes elsewhere related to Smart Business (i.e. connecting ICT to not make infrastructure but business practices smart)? Where are the examples of universities making their knowledge available in a smart way, so that innovators can be aware of the latest developments in their own region when it comes to working on new environmental solutions, new mobility innovations? Where is the recommender that gives entrepreneurs a hint as to where interesting new projects can be funded? Where are examples of smart innovation events, where the visitors can vote for those innovations they truly believe in? Oddly enough, we seem not have been able to find any of them. Although there are numerous Smart Cities projects and programmes, there apparently is still some room for pioneering new innovation spaces. ‘Smart Business’ certainly seems to be one of them.

The logical of all cultural change programmes is simple: just do it. If you want to create a Smart City that is social and sustainable, do *that* and don’t do something different. If a Smart City will have an operating model putting citizen-residents and resident-business center stage, focus on them *now*. Don’t talk about involving, work with them. Right now. Ensure you do. As with any lean effort, make sure you create the evidence that it has been done. Then any vision of a social and sustainable Smart City will be realized earlier than anyone could have imagined.

## Chapter 3. Four of the Smart City pilots in Eindhoven

As in any city many developments take place in parallel and it is hard to keep up. In the 1st half of 2015 the [BeyondData Event](#) has taken place as a part of the Knowledge Society Forum of Eurocities, the fifth edition of what started as the national Open Data Congress. Eindhoven hosted the Dutch Technology Week, themed 'Think Tomorrow'. At the High Tech Campus Eindhoven the fourth edition of the Internet of Things event took place. And the Smart City Lighting Event brought together research executives from the industry, leading designers from Mexico and elsewhere and political decision makers to reflect on the future of lighting.

Eindhoven is not a big city, although it is the 5th largest city in The Netherlands with over 220.000 inhabitants. Taking its adjacent villages (Veldhoven, Waalre and Helmond) into account, the bigger agglomeration accommodates 365.000 people. Eindhoven has an industrial past, thanks to Philips Electronics having started their firm near its city center in 1891. That original site now is the Philips Museum.



One of the centre's post-industrial landmarks, Grand Café Usine (located on the ground floor), once housed the world's largest lighting factories. Strijp-S, a district near the city center, was once a Philips area restricted to personnel only. It housed the Philips Nat.Lab., the physics laboratory, which after moving to the south of Eindhoven has evolved into the High Tech Campus Eindhoven.

For this report 4 Smart City pilots were studied in more detail:

1. Living Lab/Stratumseind 2.0
2. Strijp-S
3. The Smart Lighting/Smart Grid tender
4. AiREAS

These four, highlighted below, do not present a full overview of the Smart City developments in Eindhoven<sup>42</sup>.

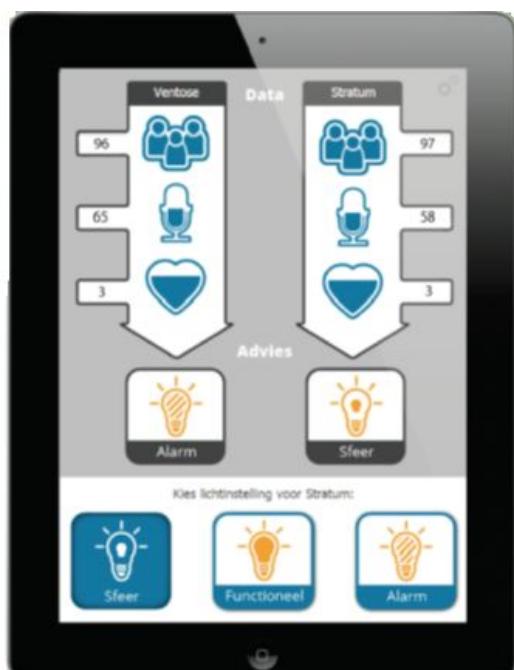
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<sup>42</sup> Even in the course of this study it emerged that there are (at least) 3 Big Data initiatives in Eindhoven, each of the three unaware of the other two.

### 3.1 Living Lab/Stratumseind 2.0

The Living Lab and Stratumseind 2.0 are two distinct projects, according to [Tinus Kanters](#), the project manager. He and [Jorrit van Hoof](#) are two of the key members of both. What are the two projects and what are the differences? And where did it all start?

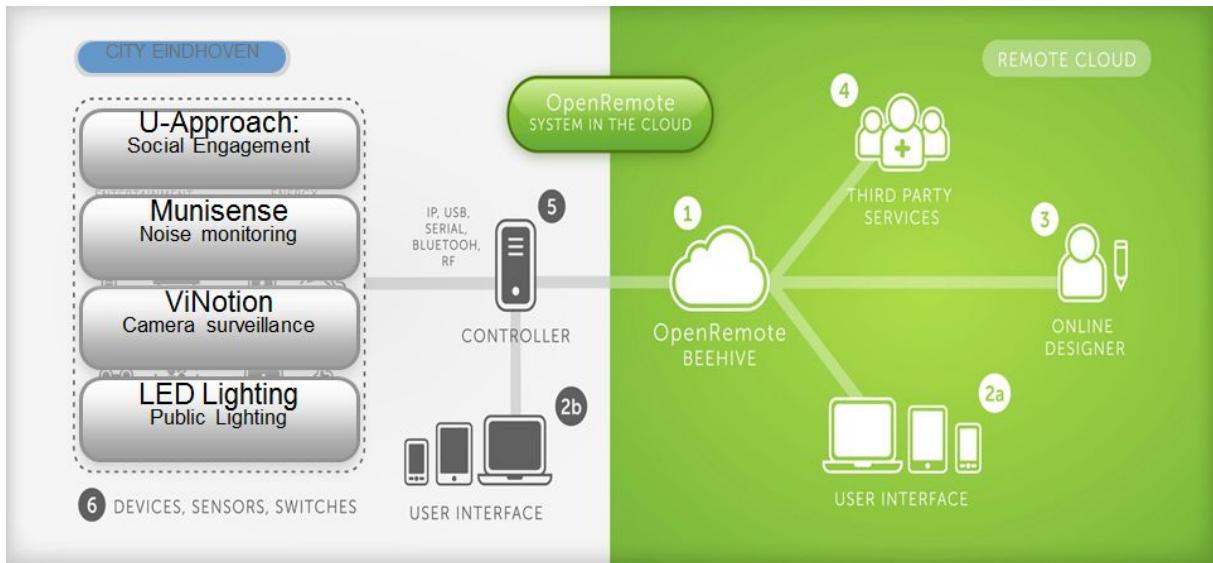
Stratumseind is the name of a street in Eindhoven. It is the most vibrant street in The Netherlands, with over 50 bars and nightclubs visited by over 15.000 every weekend<sup>43</sup>. Enforcing city governances and regulations used to be a challenge: regulators were required to physically visit the locations and measures sound volumes and other possible infringements in person. ICT put an end to that. It became possible to install wireless microphones, constantly measuring volumes - even across all 360 degrees. It also became possible to transmit these measurements onto the tablets of regulators, now capable of regulating from a distance. An even further step was taken, when automatic alerts would go to pubs infringing signalling them to take measures to keep sound nuisance in check. Now continued infringement even automatically leads to a ticket with the appropriate fine.



In 2012 Tinus Kanters (involved with the innovations in regulation enforcement) used the occasion of GLOW, the Light Art Festival of Eindhoven, to demonstrate how an integrated system could work. A Real Time Testing Ground was opened to look at Eindhoven from an Internet of Things perspective and to explore what 'Crowd Management 2.0' could look like. Cameras were put in place, providing real-time video analysis. 2D and 3D sound sensors were installed. An API was created with the eSphere, a platform for visitor participation in GLOW (visitors could give points to art works or comment on them), so that social engagement could be determined. Everything was connected wirelessly based on open standards and provided with an experimental interface (see image). After the event, cellphone data

<sup>43</sup> Retrieved from: <https://www.youtube.com/watch?v=oBTmsVwqZqc&feature=youtu.be>

were analyzed to provide a parallel count of the number of people as well as to determine their location of origin. Actuators could control the levels of public lighting and the idea was to enable further experimentation and increase control of the experimental setup through further development based on an programmable interface

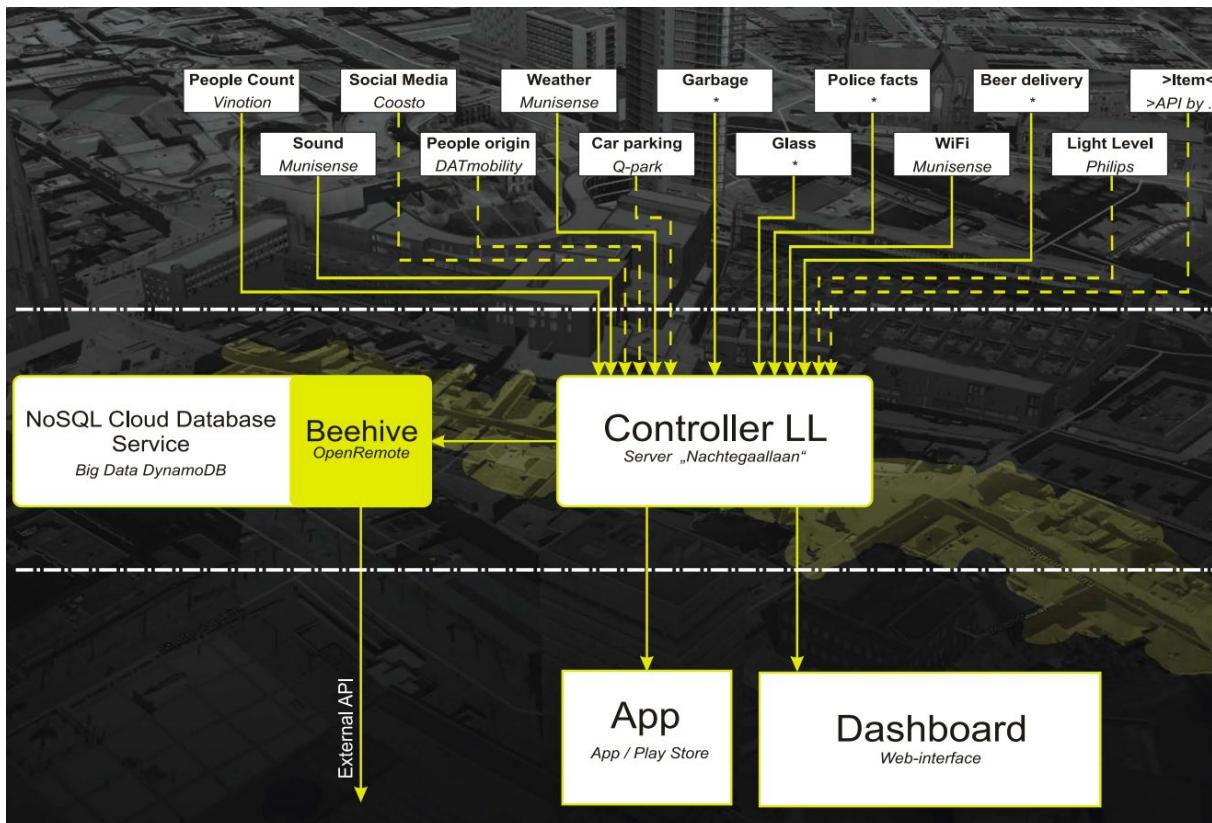


Sound measurements worked and clearly indicated when the event started and ended. Disturbances (e.g. a fight) were clear to recognize as well. Tracking people by ‘recognizing’ heads and following those onscreen textures across video segments, indeed allowed for crowd density to be measured and evaluated. The notion of incorporating ‘social engagement’ was welcomed and being able to determine the location of origin was immediately useful to the organizers of the festival. Although it also became clear that certain technological improvements had to be made, the results yielded so much insight that participating partners and visitors from municipalities abroad (i.e. Belgium) responded with so much enthusiasm that there could only be one conclusion: to continue experimenting. This enthusiasm has by now resulted in a number of additional partners: the Eindhoven University of Technology, ATOS and the Dutch Institute for Technology, Safety and Security.

The Living Lab is the current technical setup installed in Stratumseind, to a large degree with the same technology partners as the original Testing Ground was constructed with. It has additional functionality: social media tracking and analysis, a prototype of a real-time dashboard, a data storage solution to name but a few (see picture on the next page). The current wish list includes technologies such as voice recognition, stress detection and including actuators that influence scent.

Stratumseind 2.0 has taken the idea of social engagement further, aiming to involve people in efforts to actively improve the atmosphere in the street and thereby the (nightlife) experience. Its project leader is [Vera Gielen](#). Next on the agenda of Stratumseind 2.0 is the ambition to be able to translate Quality of Life parameters into economic ones.

According to Tinus, both serve a purpose. The Living Lab serves the purpose of testing new technologies and rapidly setting up experiments. Stratumseind 2.0 experiments with ways of involving citizens in municipal development and decision making processes. For those efforts, what is currently being looked into is the '2nd screen': people have smartphones, tablets. Can they play a role in community building, in playing a game. What can be done with Augmented Reality, with Virtual Reality? For such efforts, when they come to directly influence the marketing & branding of Eindhoven, its marketing organization EHV365 is in the lead.



Jorrit explains that this setup was created to enable experiments to be added and conducted as easily as possible without unnecessary overhead effort. Testing takes place continuously, especially focused on analysing for optimization of the dashboard. Sensors occasionally malfunction, always requiring some effort as the nature and cause of the malfunction is not something the system can currently detect. Measured at all times are 10 parameters, out of a potential of 52 coming out of a project with the NHTV Breda University of Applied Sciences. A standardized API (interface) has not yet been developed, as the 'lean system' has not yet required it. ATOS, one of the new partners, is currently using its CityPulse software to build a new version of the dashboard which may prove to be a step forward towards an API.

Quite important in the near future Tinus expects the role of data will become. Giving data back to citizens and business, e.g. at peak events like King's Day, is something the Living Lab aims to accomplish. That would make the effort transparent and verifiable. Yet further coordination with

efforts related to Open Data or Big Data is required. For that reason the Living Lab will increase its level of cooperation with the Data Science scientists of the Eindhoven University of Technology.

Through its collaboration with the Dutch Institute for Technology, Safety and Security (DITSS), the main focus of the Living lab is on law enforcement: noise disturbance, fighting crime and potentially even terrorism. This has led Guus Sluiter (director of DITSS) to conclude that the Living Lab is the only operational field lab for such issues. In the area of Safety and Security it is known that tests are being conducted in Singapore However, as far as the Living Lab associates are aware, the Singapore setup does not look at the measurements in an integrated fashion.

It is not the intention that Stratumseind system will be in the driving seat. It may detect that an area has relatively many people, that the sound volume is significantly high, that the noise indicates stress and will then report to an officer for his or her evaluation. Camera analysis by ViNotion could even indicate people running, or faces all turning in the same direction. All that information could be presented on a new type of app to the police.

The Living Lab also serves as a storefront. The question ‘What is a Smart City?’ suddenly becomes a lot clearer when you sit in the Basecamp of the Living Lab, seeing the data poor in and realizing what the potential is (see adjacent picture of presentation in May of 2015 to different departments of the Dutch National Police).



The Living Lab not only functions as a test environment, where people can learn and academic research can be conducted. It is also a storefront, attracting quite a bit of attention nationally and internationally (even from Turkey, Serbia, Albania).

According to Tinus, one of the success factors is the rather unorthodox way the Living Lab came into existence. It has grown ‘organically’, based on the energy it generated with its participants. Whereas in other places such an experiment might have failed earlier, in Eindhoven tests are allowed to fail. It also definitely helps that the Living Lab is located at Stratumseind, as that is a location optimally geared to inviting people to stay longer in a social setting. Meaning: it’s easy to grab a beer, catch up socially and then to continue the high quality conversation with a few good business arrangements.

One of the main concerns and structural weaknesses, almost a logical consequence of that key success factor, is the lack of embedding of the Living Lab. It would be better for an experimental setup like the Living Lab to be guaranteed at least a 2 or 3 year period for experimenting, rather

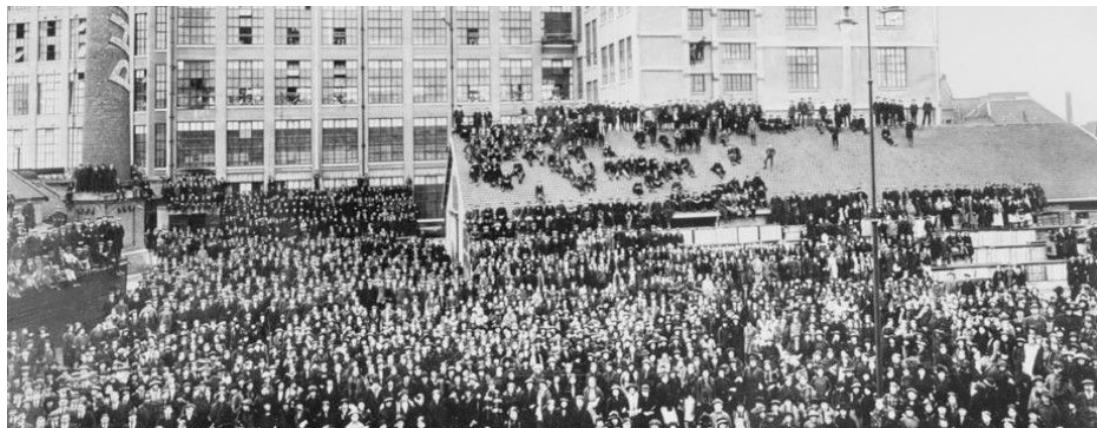
than being confronted frequently with existential uncertainty. That uncertainty quite often scares potential new partners...

The lack of embedding also extends to current rules and regulations. Procurement regulations e.g. are counterproductive to innovation, for the simple reason that innovations cannot be described up front. If you know what the outcome of the effort is in advance, there can be little experimental about the activities you are going to perform.

Another problem that frequently occurs, is the fact that too much is new. People visiting frequently have no point of reference, requiring Living Lab to revert to the strategy of 'seeing is believing'. Then it sometimes also happens that the execution is so professional, even for an experimental environment, that a visitor gets the impression such a technological innovation is trivial (especially to those people without a background enabling them to understand the significant complexities). Referring to Crime Scene Investigations (the TV series CSI) and the movie Minority Report are sometimes the only ways to make the Living Lab understood. At the same time, the need to inform others and actively market the Living Lab never ends.

### 3.2 Strijp-S: TRIANGULUM

Strijp-S is one of 3 former Philips Campus sites in the district of Strijp (hence the 3 names: Strijp-S, Strijp-R and Strijp-T; only Strijp-P did not exist). Philips started producing lamps in the center of Eindhoven in 1892, manufacturing glass themselves as of 1916 on the first factory at Strijp-S<sup>44</sup>.



In 1914 Philips employed Gilles Holst who started conducting physics experiments. His work evolved into the Nat.Lab., the Natuurkundig Laboratorium (physics lab). In 2014 100 years of research at Philips was celebrated<sup>45</sup>. In the 60s the Nat.Lab. migrated to the south of Eindhoven

<sup>44</sup> Retrieved from: <http://www.strijp-s.com/history/>

<sup>45</sup> Retrieved from: <http://www.research.philips.com/research-100/history.html>

where, having embraced Open Innovation, the campus is now known as High Tech Campus Eindhoven.

Whereas Strijp-S had first served to supply manufacturing requirements for its lighting business, the site developed into more manufacturing facilities for consumer devices; mostly relying on technologies emerging from the Nat.Lab. In the 70s it became the home of Philips political centre: the Consumer Electronics Division. During the 1992 Winter Olympics the life tests on the first European attempt at High Definition TV were broadcast from what nowadays is called the VideoLab<sup>46</sup>.

For the longest time Strijp-S was surrounded by a fence with barriers. Although entire neighbourhoods (like Drents Dorp, village for people from the province of Drenthe) were erected for Philips employees and facilities like the Philips leisure centre (Philips Ontspannings Centrum) and the Philips Soccer Stadium of PSV, the Philips Soccer Association, no one was allowed in without a Philips badge.

Park Stijpbeheer is the Public-Private Partnership (PPP) of the Municipality of Eindhoven and Volker-Wessels, a Dutch concern employing 15.000 through 120 companies operating in civil engineering, construction and real estate and railway and road construction. As a PPP, Park Strijpbeheer is the owner of the site and one of its developers. Strijp-S is 27 hectares in size, has app. 1.000 people living there, more than 500 entrepreneurs have settled in the district, populating 92.000 m<sup>2</sup> of office space and the annual number of visitors is roughly 1,5 million. Strijp-S is a mixed high urban environment, aiming to combine working, living and leisure. It won the national Golden Phoenix award for a transformation project<sup>47</sup>. Together with [Thijs van Dieren](#) (Volker Wessels) is [Alwin Beernink](#) (Gemeente Eindhoven) one the two directors.

Strijp-S allowed for a number of innovative projects, among others Sanergy. In collaboration with ARCADIS, Sanergy combined sustainable energy generation with an accelerated degradation of soil contaminants<sup>48</sup>. Mobility-S was also set up, intended to reduce the original number of 6.000 parking places planned in the 2005 Masterplan down to a more sensible and affordable number. The point was to exploit continuous use (in the daytime by entrepreneurs working, at night by people living there), locally optimized central parking areas and above ground construction phased in with the site development. Also ICT was to be exploited, e.g. by creating a smart app guiding you not only to parking places but also into the relevant building<sup>49</sup>.

<sup>46</sup> Personal conversation with [Rick Harwig](#), former CEO of Philips Research and CTO of Philips.

<sup>47</sup> Retrieved from: <http://www.volkerwessels.com/nl/projecten/detail/strijp-s>

<sup>48</sup> Retireved from:

[http://www.arcadis.nl/projects/Sanergy\\_de\\_synergie\\_van\\_2\\_werelden\\_Bodemenergie\\_en\\_grondwatersanering.aspx](http://www.arcadis.nl/projects/Sanergy_de_synergie_van_2_werelden_Bodemenergie_en_grondwatersanering.aspx)

<sup>49</sup> Retrieved from:

<http://www.gebiedsontwikkeling.nu/artikel/10643-sessie-d-strijp-s-eindhoven-de-s-van-strijp-en-smart-city>

Light-S was also one of the earlier innovative projects<sup>50</sup>. With Lorna Goulden (then at Philips Design) as creative supervisor from 2008 onwards and Serge van den Berg (Het Energiebureau) joining as programme manager in 2010, Strijp-S began piloting new lighting solutions. Users of the public space should be enabled to influence their experience, that is the conviction at the heart of the vision on the role of light published in the book 'Strijp-S: Creating a public lighting experience' by Lorna Goulden. This makes the public space at Strijp-S a location for experimentation with new forms, interactions and applications of light. And as such, a Living lab for research. A particularly intriguing concept is 'If Light Could Fly': the idea of having light fly to accompany you during your activities in the area, rather than you entering a space that is permanently lit, regardless if you are there or not. If light could fly, it could direct you to the person waiting for you. And once you've met, one of the two drones could return to the entrance awaiting a new visitor. 'If Light Could Fly' was tested during GLOW Eindhoven in 2013 at GLOW Next (the innovative part of GLOW at Strijp-S, exploring future possibilities away from the more appealing art works visited by 100s of thousands of visitors).



Light-S also stimulated collaboration on many fronts. BLISS (Better Lighting in Sustainable Streets) was one such collaboration. Another collaboration: an interregional exploration of Public Lighting Strategies for Sustainable Urban Places (PLUS).



Out of the efforts also came the unique lighting setup along the Torenallee, using the overdimensioned broadband network for individually addressable lamps (supplied by Schreder<sup>51</sup>) to be able to tune the lighting.

<sup>50</sup> Retrieved from: <http://www.light-s.nl/about>

<sup>51</sup> Retrieved from:  
<http://www.schreder.com/nls-nl/Nieuws/Pages/The-Teceo-lights-Strijp-S-an-urban-campus-destined-to-be-leader-in-sustainable-public-lighting-innovations.aspx>

As one of its two directors, Alwin Beernink looks back on an interesting period in which Strijp-S proved its role as a Living Lab, where development could take place beyond the traditional scope of housing and plumbing by also taking ICT into account (for which Light-S was one of the drivers). Now there are 12 kilometers of fibre optics waiting to be utilized more fully, in any case already at work directing 5-channel LED lighting and the parking meters. Strijp-S has proven itself as a valuable Living Lab; it is now open to join any coalition, big or small, technical or creative.

Why hasn't the infrastructure become more fully utilized? Why haven't e.g. more sensors been already put in place? The difficulty there lies in answering the question: which services do people at Strijp-S need or want? Focus so far has been on (i) safety, (ii) the Park Strijpbeheer projects regarding energy, mobility and office and (iii) ways of making Strijp-S more fun<sup>52</sup>. For safety the next project is to supply neighbourhood patrols with ICT-enabled local alerts, so that when a super microphone provided by one of the companies residing on Strijp-S picks up the sound of glass being smashed at night, the nearby patrol is alerted. Light on Strijp-S: can it be adapted to the weather? Can it be further enhanced to truly create an experience? From an office programme wishlist, the current ambition is to take the fibre *into* the home (i.s.o. *to* the home). During construction that may even be cheaper. And the resulting internet connections will be faster.

Alwin states that it is currently difficult to get advice on the type of services that should be developed next. No market party is giving advice that is free of a clearly identifiable self-interest. Whether it is a telephone company, like KPN, or an internet multinational like Cisco, as soon as they voice an opinion their interests appear at the surface. KPN is a traditional telco provider, seeking to find a new reason to exist and to continue exploiting its network. Cisco is promoting a layered approach (simplifying to the max: making a distinction between a passive layer, an active layer and services), offering as it were, a service catalogue closely resembling an order form. For Strijp-S, at the moment, it is too difficult to determine what the next services should be.

A further complication in the ongoing development of Strijp-S as an effort towards making Eindhoven a Smart City, is its scale: Strijp-S is simply too small, its critical mass insufficient. It makes it nearly impossible to see which services should be developed, it makes it hard to distinguish vendors and suppliers and take out their own interests from the equation; the lack of critical mass stops everyone from making a genuine turn towards integration and considering the benefits from a truly ICT-based approach. Development now seems to freeze at isolated showcases.

When the scale of Smart City efforts is increased, at least the city center should be included, also increasing the role of Living Lab/Stratumseind 2.0. Should perhaps the appropriate scale for a

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<sup>52</sup> For the latter the notion of '[clickable festival](#)' developed at STRP Festival (in 2010 and 2011, at the time one of Europe's largest festivals for Art & Technology) with NXP Semiconductors and Eindhoven-based start-up U-Approach was expanded into that of 'clickable city' (see the video at <https://vimeo.com/77170602>). In June of 2015 this resulted, in combination with the desire to have the 'district' communicate with the visitors, in the transmedia production '[The Forbidden City](#)' created by the Fontys Transmedia Storytelling Lab, also in cooperation with U-Approach. Bluetooth beacons were deployed to use the latest technology to make the area 'clickable'.. The original objective of using a 'fun' layer to uncover needs and requirements has not yet been realized.

genuine Smart City effort be on a national scale, Alwin asks himself. That could add credibility in the eyes of the European Union. Plus it allow for room to be created in order to scale up the required expertise and competence to an independent level, reliably a-political. It would also allow for the resulting effort to add Amsterdam as a 'sexiness'-factor. And what if the ambition level really is 'health and wellbeing', perhaps even improving healthcare through prevention? What scale would it require to genuinely strive to realizing that ambition? Stretching the scale up to that size, another question can be asked: in a neoliberal climate, when 'small government' is always better than a bigger government, who will take the lead in that effort? Is the public responsibility of such an innovation drive best served with a government eager not to get hands-on involved?

Now the TRIANGULUM project starts. 'TRIANGULUM, initiate, demonstrate, replicate' will see Eindhoven, Manchester and Stavanger address energy, mobility, innovation and (open) data in an effort to improve the quality of urban living in general and of sustainable energy and mobility in particular. TRIANGULUM is a five year € 25 Million project funded by the European Union<sup>53</sup>. The German technology institute Fraunhofer IAO will manage the project, will ensure co-creation among the participants, will guarantee the innovativeness of their solutions and will make it possible for other cities to emulate those. For that reason also the cities of Sabadell (Spain), Leipzig (Germany) and Prague (Czech Republic) are included in the project as follower cities. In Eindhoven Strijp-S will be combined with the district Eckart-Vaartbroek, two lighthouse areas'. One of the TRIANGULUM related activities will be to involve innovative entrepreneurs at Strijp-S in the development of smart applications in the areas of safety, mobility and energy<sup>54</sup>. In September of 2015 that call is scheduled to be announced publicly, in partnership with the InnovationLab of the Technical University of Eindhoven and the startup facilitator Brightmove. TRIANGULUM will also work with citizen-driven initiatives: Morgen Groene Energie foundation (focused on facilitating the energy transition for citizens) and STIR Foundation (focused on tackling global issues like air quality, climate change and health through cooperatives)<sup>55</sup>.

Clearly TRIANGULUM has the potential to be highly instructive when it comes to engaging with citizens and with innovative entrepreneurs. It's pursuit of sustainable solutions seems very worthwhile. At the same time it is clear that Manchester to a significant extent works with solutions from Siemens, which potentially adds another complexity. Yet the ambition of TRIANGULUM is not the smallest: 'The Triangulum project will demonstrate how a systems innovation approach based around the European Commission's SCC Strategic Implementation Plan can drive dynamic smart city development.'<sup>56</sup> And although Fraunhofer is no KPN nor Cisco, the question is how likely it is that Fraunhofer will also have its own interest. In any case, Fraunhofer IAO has great expectations of the ICT architecture that is one of the important deliverables of the project: 'At the heart of our project is an ICT architecture that will be used in all three flagship cities. It is the foundation that enables the individual technologies in the city to be connected and

<sup>53</sup> Retrieved from: <http://www.seed.manchester.ac.uk/research/impact/triangulum/>

<sup>54</sup> Retrieved from:

<http://www.volkerwessels.com/nl/nieuws/detail/volkerwessels-bouwt-mee-aan-br-smart-city-eindhoven>

<sup>55</sup> Retrieved from: <https://eu-smartcities.eu/commitment/4875> Jean-Paul close from STIR Foundation is also one of the two men that set up AiREAS (see paragraph 3.4).

<sup>56</sup> Retrieved from: <https://eu-smartcities.eu/commitment/4875>

coordinated with each other,' says Alanus von Radecki (lead project manager of Fraunhofer IAO). Fraunhofer expects this standardized architecture to ensure that it will be possible to subsequently transfer the concepts to other cities – as will be demonstrated when the project moves to its second phase in Leipzig, Prague, and Sabadell<sup>57</sup>.

Note! During the researched period, Strijp-S was struggling with a number of issues in the process of finding new solutions. A number of answers to important questions will be available in October 2015 in a publication of a Strijp-S specific vision of itself as a smart district. This publication will address how Strijp-S aims to make progress at tier 4, through initiatives to make Strijp-S more social and more sustainable.

### 3.3 Smart Lighting/Smart Grid tender

"A number of years ago," says [Rik van Stiphout](#), "around 2008, 2009, it became clear that the introduction of Solid State Lighting in the public domain was stalling." As Advisor for Light & Culture Rik is one of the key members of the Smart Lighting/Smart Grid procurement team, next to advisor [Arhur Noordhoek](#) and project manager [Irmo Kaal](#). The purpose of the project is to implement the Roadmap for 2030 of Urban Lighting in Eindhoven; it's immediate goal: to implement a joint transnational pre-commercial procurement procedure in the field of public lighting<sup>58</sup>. As a consequence of the realization that stalling was taking place, in collaboration with LUCI, the international network of cities on urban lighting, the PLUS-project was started (see previous paragraph): an exploration into Public Lighting Strategies for Sustainable Urban Spaces<sup>59</sup>. In essence PLUS was a benchmark with 11 cities to develop new strategies making it possible to overcome the stalling taking place. Out of the same reasoning came the initiative to create a roadmap Urban Lighting 2030 for Eindhoven. Which may not have been the best name for it, since it actually addressed the question: what is it that should be done with public lighting? In hindsight a better name could have been 'roadmap Smart Grid'. Regardless of the name, the roadmap urban lighting is the most advanced roadmap of the municipality of Eindhoven. It's main objective: to improve Quality of Life.

Irmo explains what is happening now. A competitive dialogue process has been started up, out of which a best value procurement will be created. The purpose of the exercise is to enable continuous and ongoing open innovation, ensuring that whatever market party is selected they use a Living Lab approach and collaborate with other businesses, knowledge institutions, government and residents. The procedure will have 3 phases:

1. Selection Phase
2. Dialogue Phase
3. Registration and Award

<sup>57</sup> Retrieved from:

<http://www.iao.fraunhofer.de/lang-en/business-areas/mobility-and-urban-systems-engineering/1112-eu-sponsor-s-sustainable-city-concepts.html>

<sup>58</sup> Retrieved from: <http://www.enigma-project.eu/en/>

<sup>59</sup> Retrieved from:

<http://www.sofia-da.eu/en/past/plus-project-public-lighting-strategies-for-sustainable-urban-spaces/185-activities/287-international-conference-%E2%80%98light-up-your-cities%E2%80%99.html>

Selection has already taken place. Dialogue is now being conducted with 4 potential suppliers, 3 of which are consortia: (i) Hoeflake Infratechniek B.V./Grontmij Nederland, (ii) Philips Nederland B.V./Heijmans Wegen B.V., (iii) Vialis B.V./KPN B.V. and (iv) ZIUT B.V.

Ten areas have been designated for the first phase of the implementation of the roadmap (see image). Each contestant will have to select a number out of those 10 (depending on their size and the consequent impact on the available budget) and argue why they would be the best party to realize phase 1. Their assignment will be to create a smart lighting grid, to manage and maintain that infrastructure and to develop services based on a business model they themselves propose.

Some of the functions that need to be delivered should always be relied upon. Others might be more experimental. How the relationship should work and how infrastructure and services should be organized, 'governance', should also be part of the proposal. After 5 years the results will be evaluated, scaled up to cover the entire city and lead to an extension of partnership to 2030.



So what decisions have already been made? What are the business models parties are coming up with? What emerges from the dialogue, in any case the first round of dialogues, is that no one, not the municipality of Eindhoven (or its partner cities) nor the market parties have a clear idea of what the future may bring. The conversations are interesting, because sometimes ideas can almost be seen being born. At the same time, it is also quite clear that for companies supplying solutions to public lighting, innovation does not necessarily come easy. Adding an internet connection to a lamp post might intellectually be easy to grasp, but in reality the most appealing examples, like the one from Los Angeles, come from far away.

The City of Los Angeles owns and operates the 2nd largest street lighting-system in the US with 210.000 street lights along 7.200 kilometers<sup>60</sup>. From the intended 70.000 units by January 2013 73.114 had been replaced. The results? Over \$ 5.000.000 savings in annual electricity bills and 63,3% electricity savings (whereas 40% had been expected). Negative response from the

<sup>60</sup> Retrieved from:

<http://www.forbes.com/sites/justingerdes/2013/01/25/los-angeles-saves-millions-with-led-street-light-deployment/>

community had been expected and in reality had been mostly positive. Crime had gone down by 10%<sup>61</sup>.

Indoor lighting seems to have been working with connecting to the web for some time now, yet apparently there is little cross-over of the obtained knowledge into public lighting. Light-as-a-service already is a widely accepted business model for indoor lighting. Why hasn't it emerged yet in street lighting? Does it perhaps simply take time for knowledge to come into being? It may also be that it simply is a struggle to translate what is technologically possible into an application that makes sense, especially in the public space which, by some, is regarded as the last 'free' space in society. In that space a discussion on technology can occasionally even turn into one on ethics. In Grenoble it even put a mayor in office, having promised to ban all advertising as voters did not want paper billboards to be replaced by digital screens<sup>62</sup>. Even in a city without advertising, what is the value of a smart sensor that can detect you, or perhaps your phone number? Especially when it is connected to a system covering space along all streets? Concepts like 'Open Data', 'Open Source', 'Platform', what do they mean? What will they mean when lamp posts get 'smart'? Will that understanding be eroded quickly, as technology continues to evolve at light speed (pun intended). Any trend analyses conducted half a year ago by now is already outdated...

What if the entire city is a Living Lab? What if it should be an open system, storing all data in an open format yet not necessarily accessible to all? There is very little known about the policy for or the framework within which such thinking should be structured (even before it could be negotiated). So where does the leadership role reside, who is to direct such an effort? What if the entire grid is to be the backbone of all things 'smart' in the city? How can a siloed organization like a normal contemporary municipality address the eventualities of integrated perspectives? What if that smart grid should be able to cope with local energy generation, people supplying to the grid? How do you deal with the scenarios of when that grid starts to reach outside of city limits? How do you anticipate the moment that citizens want to have a say, want to be able to have an opinion on who would be the owners of such an infrastructure or of the data it generates? Isn't the generation deciding now the generation that is actually too old? Should not younger generations be involved in the process; it is their data that will be generated, their IP addresses that may be stored, stored longer than they would like.

As much as this procurement procedure is about technology, it also clearly is not. It raises questions about the type of society we are becoming, the type of society we want to be and the government required for it. That is also one of the spin-off this project is generating: those are the lessons being learned now. It is pure pioneering work. In five years perhaps it will be possible to compare reality to the ambitions articulated. Will the municipal organization have developed along with the emerging reality of the 'smart city'? And what is it we want to do by then in and with that 'smart city'?

<sup>61</sup> Retrieved from: [http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/msslc\\_la2012\\_ebrahimian.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/msslc_la2012_ebrahimian.pdf)

<sup>62</sup> Retrieved from: <http://www.euronews.com/2014/11/26/grenoble-europe-s-first-ad-free-city/>

### 3.4 AiREAS: ILM (Innovatief Lucht Meet-systeem)

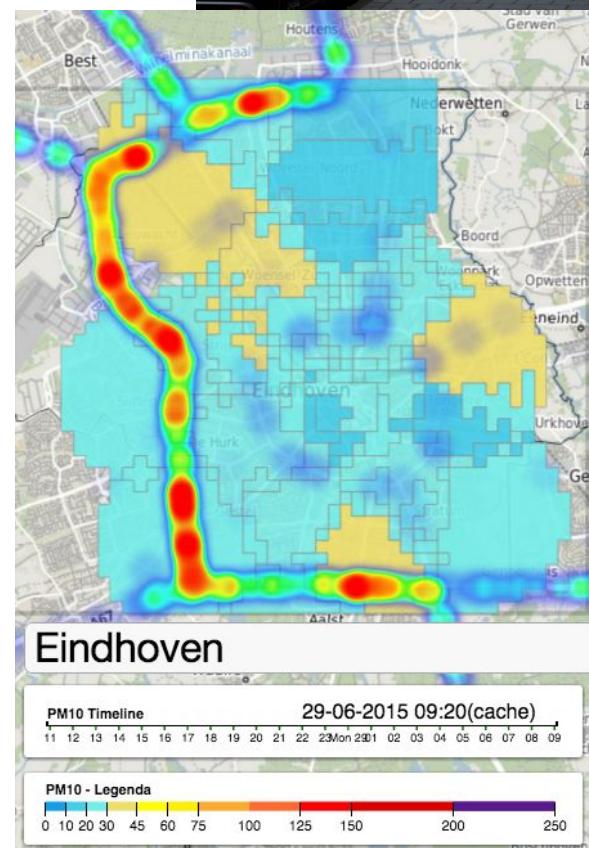
AiREAS is quite a different project from the previous ones. Its focus is not primarily on any advantage hardware can offer or any breakthrough smart technology can bring. Primarily AiREAS is a project related to what people can achieve together.

AiREAS is a cooperative, founded by [Jean-Paul Close](#) and [Marco van Lochem](#), both experienced in high tech and international business. AiREAS has no one on its payroll. Projects, like the ILM (Dutch: Innovatief Luchtmeet-systeem; in English: Innovative Air Measurement System), do not have a project leader.

Participants take place at a round table, together determine if collaboration makes sense and individually contribute. Why projects do come about? Because projects are worthwhile. ILM for example is specifically dedicated to improving air quality. Its contributors are, among others: Royal Philips, ECN, the Municipality of Eindhoven, the Province of Noord-Brabant, Utrecht University, University of Twente and Axians. What participants receive in return? Innovative insights, new relations, positive energy and a sense of purpose and achievement.

ILM consists of 32 Airboxes put in place on lamp posts across the city of Eindhoven in fall of 2013. An additional 6 are mobile and can be used during events or calamities or for specific research purposes. They constantly take measurements of particulate matter, ultrafine particulate matter, NO<sub>2</sub> and ozone. In June of 2015 an experiment was conducted with 12 volunteers carrying for 5 days a rucksack with measurement sensors testing their individual exposure. For partner TNO this is an experiment to complement the sensory network input with measurements from representatives of 3 particular groups of people, e.g. with increased risk profiles because they have chronic asthma.

A data platform is in place to store and share data. Utrecht University combines collected data with other inputs and conducts research into health effects. The University of Twente adds its geo-modelling competence and the result is an overview of air quality in Eindhoven (see image).



A personal drive to make the world a better place lies behind Jean-Paul's efforts<sup>63</sup>. His earlier experiences, when he was involved with the International Center for Sustainable Excellence (ISCE) taught him that genuinely disruptive innovation is bound to lead to conflict with the powers that be. Making the invisible visible on the topic of air quality provided a new opportunity which appeared to both be important as well as not to upset an existing power balance. Having put 30 Airboxes in place in the Fall of 2013, the fireworks on December 31st immediately proved the capabilities of the created sensor network.

Jean-Paul stresses that the long term purpose of the AiREAS efforts is not economic. The purpose is ecological: to find multidisciplinary approaches to be able to give an integrated answer to the question whose responsibility it is to ensure our health. What is needed, according to Jean-Paul, is a 'new societal model' that secures (sustainable, non-financial) scalable value creation for everyone. ILM has no business model, it is not intended to create a profit. It rather seeks to be an instrument in undermining economic money-driven dependence and supplanting that with health & safety as a basis for social interaction. Such an ambition has little precedent, which is why explorations in AiREAS always start with a period of creative freedom. Once potential partners start to zoom in, a workgroup is created on a specific theme. Then a concrete POP project starts, aiming to deliver a Proof of Principle (POP).

Are his efforts influential? Next to putting AiREAS in place in Eindhoven, interest into both the approach as well as the Airboxes recently came from China.

### 3.5 Overview

In the table below an attempt has been made to highlight the most significant characteristics of each of the projects.

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<sup>63</sup> AiREAS is one of his many initiatives, next to foundation STIR create to shape the City of Tomorrow, STIR Academy in which knowledge is shared, FRE2SH to stimulate regional self-sufficiency and collaborative productivity when it comes a.o. to food and energy. Retrieved from: <https://stadvanmorgen.wordpress.com/>

	Living Lab/Stratumseind 2.0	Strijp-S	Smart Lighting/- Smart Grid Tender	AiREAS
Started in	2010 / 2012 (1st integrated field trial during GLOW Eindhoven)	2008	2014	2011
Originated from	Automation of noise disturbance for regulatory enforcement; crowd management; integrated multi-sensory surveillance of nightlife district	Development of district into expanded/additional city centre; high urban mixed environment for businesses, inhabitants and retail	Need to overcome the stalling of adopting LED Lighting in public lighting	The belief that non-financial sustainable approaches to improving health in the city need to be co-created
Application Areas	Crowd management (audio, video), safety, security	Lighting, mobility, safety, 'experience'	Lighting, data grid, services (yet unknown)	Air quality, health, non-financial cooperation, mobility, living green, social cohesion
Current strengths	Large field experience; pragmatic approach; attention power; low cost; large range of suppliers; Living Lab for crowd management	Many years experience in 'smart areas'; over-dimensioned broadband network; project organization; international network; high potential; financed	High-quality process; interest from all over Europe; raises fundamental issues and concerns	Collaborative approach, non-financial added value model, Airboxes, partnerships, international interest
Current weakness	Limited finances; no structural link to scale application; not architectured for reuse; Not directly usable elsewhere	Progress lags potential (slow); no pragmatic involvement approach	Dependent on outdoor lighting industry for which smart technologies appear to be quite new	Unknown technical specifications compared to other air quality sensors. New way of working requires effort
Reusable technical components	Combination of standard solutions (eg WiFi) with central controller	Not directly usable elsewhere	No technological decisions have yet been made: none	To be determined: Airboxes, data platform, geo-models, academic research

				on particulate matter in relation to health
Potential function	Pragmatic Living Lab for experiments	Living Lab for integration with the living environment of the city; pilot role in the context of TRIANGULUM for engagement with residents and entrepreneurs; possibly for resulting architecture	To determine the way Eindhoven will create a Smart Grid; Smart Services for citizen-residents and resident businesses; new partnerships with Smart Solution providers	First Eindhoven pilot project on tier 4 (Social and Sustainable Smart City)
	Living Lab/Stratumseind 2.0	Strijp-S	Smart Lighting/-Smart Grid Tender	AiREAS

## Chapter 4. Analysis and recommendations

There are a number of good things happening in Eindhoven when it comes to becoming a Smart City. Obviously the existing efforts can be improved or strengthened, but there is no reason to be less than proud about what is being done and what has been achieved so far.

### 4.1 Framed in four Zones

Technologically the current pilots provide more opportunities than risks. Although Stratumseind 2.0 does not have a technologically sophisticated approach, that allows it to make speed with experiments. It also generates a lot of attention in The Netherlands and abroad, simply through the novelty of technologies it does have in place and its scope of inquiry. If it would have been designed as a Living Lab, chances are that decision making would have also preferred an eclectic approach to technologies favoring rapid experimentation, much like the situation that exists now (although perhaps with a different choice here or there).

Framed in the four zones of Geoffrey Moore, Stratumseind 2.0 fulfills a good role in the Incubation Zone. Given the lack of structural funding and institutional embedding, that achievement is remarkable. From within the Modified Valencia Smart Strategy, it does however not come anywhere near the function a City Platform should have. That function resides somewhere else.

### 4.2 Towards a City Platform

How about Strijp-S? it has a number of things going for it, notably its infrastructure. it has a broadband network with a significant overcapacity, it has new LED streetlights that can be individually addressed via the internet. It has GLOW Next to explore new lighting possibilities. Park Strijpbeheer, the developer of Strijp-S, has even had the resources to engage with Cisco to learn how to become more smart. As a mixed district (housing houses startup companies, creatives and techies, cultural organizations such as Baltan Laboratories and VPRO Media Lab, people live there) it could be a Living Lab on a bigger scale than Stratumseind can.

Although impressive results have been achieved, it seems that development at Strijp-S is struggling to maintain its momentum. Even with the resources available, choices have to be made. And realizing its scale has insufficient critical mass, suppliers giving advice have clear self-interests, it is difficult to uncover the parameters for next level services. Those choices are nevertheless required if progress towards a City Platform (as suggested by the Modified Valencia Smart Strategy) is to take place.

What we see in both Stratumseind 2.0 and Strijp-S is the ‘paradox of the pioneer’: although pioneers can go where none (or very few) have gone before, they can only go as far as their limited resources allow for. Pioneers are not famous for the settlements they succeed in establishing; they are known for the progress they achieve.

Yet TRIANGULUM might bring in new partners, new perspectives. Certainly the focus on sustainability in efforts Fraunhofer is involved in seem higher than in projects of other players in the market. Fraunhofer's project manager has stated that an architecture allowing TRIANGULUM achievements to be shared with the follower cities will be a deliverable of the project. If such an architecture would be developed at Strijp-S and if it would also serve to mobilize resident-citizens, visitors, resident businesses and others (e.g. through a concept already visualized by Strijp-S as '[Clickable City](#)'), a City Platform may find its form.

### 4.3 Living Labs

Strijp-S could play a bigger role in Eindhoven developing into a Smart City. It makes sense to more fully exploit its infrastructure, its installed hardware, the mixed environment of business, retail and people living there and its events like GLOW Next as a Next Level Living Lab. Meaning: at a level beyond the efforts right now, as those are mostly focused on making parallel infrastructures smarter (tier 2). Its function could be to stabilize experiments conducted elsewhere (a.o. at Living Lab/Stratumseind 2.0). In both the strategic approach to new business by Geoffrey Moore and in deploying the Modified Valencia Smart Strategy, it could play a role in the strategic evaluation required for transformation and help to determine if the more stable, longer term trials practically yield the strategic goals aimed for. If so, that then qualifies them to be moved into the Performance Zone. In other words: is Strijp-S the most suited Living Lab for experimenting with integrating Smart City efforts (tier 3)?

How do Stratumseind 2.0 and Strijp-S relate to the Smart Lighting/Smart Grid tender? The current lighting infrastructure obviously belongs to the municipality's Performance Zone. It therefore seems logical to think that the new lighting infrastructure that will emerge from the tender process, as it is to replace the previous infrastructure, also belongs to that zone. We think that would be a mistake.

Given that the tender process is still in full swing, it is unclear what the actual decisions are that will be made. Requiring of the outcome of that process to yield only fully stable, fully operational implementations seems ambitious. It might also be a lost opportunity. Out of the 10 available sites some will end up being chosen. What if a number of them would be selected to be positioned in the Transformation Zone? Here they could serve as stabilising development labs, maturing into fully functional Performance Zone implementations over time. Yet also selecting a number of them to operate, next to Stratumseind 2.0, as additional Living Labs, might decrease the expectations that need to be met and increase the chances of new technologies being tried and subject to transformation. We shortly suggest that none of the ultimately selected sites in the tender process be treated as belonging to the Performance Zone. Some of them should become Living Labs (in the Incubation Zone) and others Development Labs (in the Transformation Zone). In case a single innovation goes through different stages (of Incubation, Transformation and Performance) on a single site, provisions have to be made so that people (including residents and bypassers) have the expectations appropriate to the particular phase the innovation is going through.

#### 4.4 Within a shared vision

How does AiREAS fit in? To a large extent Stratumseind 2.0, Strijp-S and the Smart Lighting/Smart Grid tender can be seen at first glance to be related to 'livability' in daytime or at night. Stratumseind 2.0 is a Living Lab for crowd management, designing out crime, automated enforcement of violation of regulations and ordinances all aiming to improve the quality of life in a well-known nightlife district. Strijp-S, transforming itself from a once forbidden city into a Smart and Sustainable District. In the context of the implementation of the Urban Lighting Roadmap the Smart Grid/Smart Tender team is working with market parties to explore the types of services a Smart City could use. AiREAS is driven by a vision of people helping to make their planet cleaner, more sustainable and less financially dependent.

Becoming a Smart City not only has to do with deploying smart technologies or even integrating them. To truly be a Social and Sustainable Smart City, people will also have to work together, connect, stimulate each other, help each other manage their problems, face their challenges and care for the environment. Citizen-residents and resident businesses need to be part of the development.

What is needed, is a way to engage with them. What is needed, is a movement for them to participate in. What is needed, is a platform to share, contribute, enjoy and celebrate. The best example we have found to be inspired by, is Birmingham. What can be learned from them?

#### 4.5 Summarising our findings

Stratumseind 2.0, Strijp-S, the SmartLighting/Smart Grid tender and AiREAS all pursue different solutions, have differing approach and are dissimilar in their way of working. For each, a quite serious and urgent point of attention seems to be to improve technological solutions for data access, security and authentication. Due to a limited commonality, integration of these pilots into a homogenous architecture does not seem directly possible.

Whereas it would be easy to conclude from these findings that these pilots pose a dead end in a Smart City exploration, examples from other cities and insights from business literature have lead us to suggest the opposite. It makes sense to bring the investigated pilots together in a heterogeneous architecture, addressing three innovation horizons (horizon 3: Incubation Zone; horizon 2: Transformation Zone; horizon 1: Performance Zone and Productivity Zone). Then 'livability' becomes one of the consistent innovation focuses across all four pilots, three of them from a hardware/service orientation (Stratumseind 2.0, Strijp-S and the Smart Lighting/Smart Grid tender) and AiREAS from an environmental people-driven interest.

#### 4.6 Recommendations to improve the pace

The following recommendations are based on the examples we have collected from Smart City efforts elsewhere (chapter 3), our analysis, our own experience and quite a few discussions.

**Step 1. Employ competent staff to orchestrate and build the system**

- Set up an Eindhoven Smart City Architecture team to review, approve and oversee all smart city projects from an architectural integrity and continuity perspective
- Staff with senior, experienced persons to play leading role in technical alignments with smart city initiatives at local, regional, country and European level to foster cooperation, learning and reuse
- Staff currently involved in Smart City initiatives could be the pool for initial selection of staff

**Step 2. Build on technical standards that are open, clear and stable**

- Ensure that all future projects be based on common reference architecture to facilitate integration, reuse and new combinations (mashup's)
- Select vendor independent, non-proprietary architecture based on open standards and specifications to:
  - Support heterogeneous and evolving infrastructure and components
  - Build security and authentication a uniform way
  - Be extensible to incorporate and integrate vertical proprietary solutions
  - Flourish as a public-private ecosystem of suppliers, developers, citizens
  - Become an effective community supported with professional development kits, software tools, component libraries and infrastructure
  - Be supported by strong consortium that fosters open innovation
  - Deploy across multiple cities in Europe
  - Share Open Data - storage and access and ownership. Default is public ownership. Data format, ownership and access to be formulated and agreed upfront
- Base operational programs on common architecture and platforms. Options to evaluate:
  - FIWARE - Future Internet middleware for Smart Cities
  - Collated and integrated open sources components managed by a Public-Private consortium approved by the Steering Board

**Step 3. Organize for leadership to emerge, allow for clear and informed decisions**

- Following strong businesses, like Apple, an Eindhoven Smart City Steering Board should be set up. Its purpose is to allow a leadership team to emerge, initiating, approving, fostering and terminating Smart City projects
- As leadership will have limited time and energy, consider supporting it with a Smart City Program Management team. Authorize competent staff to monitor and evaluate all Smart City projects acting as liaison between project teams and Steering Board

- All projects with funding from the Municipality to be collated on central repository and website. Each project to report on progress to Steering Board every quarter after review with Program Management team
  - Goals and objective of projects to be quantified and ring-fenced
  - Metrics to evaluate effectiveness

**Step 4. Realize a co-created vision and keep on iteratively updating that vision collaboratively**

- A structured approach is needed to drive the initiative and engage the citizens
  - It is about design, rather than technology (technology is an enabler)
  - Make 'Light' leading; i.e. use the headstart the Smart Grid/Smart Tender already has
  - The next level will address air quality and more social and sustainable ambitions
- Include stakeholders from industry, academic/research and Eindhoven Municipality. The municipality has veto right and final decisions on roadmap and strategy. Consider setting up a Public-Private Partnership for that purpose.

**Step 5. Work with competent partners and suppliers on vendor-independent solutions and ensure the competence and ability to evaluate their work**

- Define and ratify regulations for:
  - Data ownership and access. By default the Gemeente decides on access and is owner of data obtained with public funds
  - Authentication and security. By default access is closed access but open on a merit basis for limited and defined period to be approved by Steering Board. Much more stringent restrictions on access and control with systems containing actuators
  - Intellectual Property (IP) ownership. By default the Gemeente is owner of IP generated from publicly funded development
- Set up an independent Security and Risk Assessment audit team for all operational smart city projects. Define guidelines to have security embedded into solutions from beginning. All project to be approved by audit team and ratified by Steering Board before wide-scale deployment

**Step 6. Ensure the resulting applications have (financial and non-financial) meaningful results on the short, mid and long term**

- Each project publicly funded should provide visibility into results and targets in common, central repository and report quarterly to Steering Board
- Consider combining the different Smart City projects into one single 'drive', adding other efforts in Eindhoven to it and elevating it from to an orchestrated effort towards a Social and Sustainable Smart City

- Make Eindhoven a hotbed of open innovation for Smart Cities targeting citizens and entrepreneurs with primary interest leisure, education, health, business, etc through open innovation drives, hackathons, funding, etc

**Step 7. Continuously improve, evidence-based**

- Developing an ecosystem out of Smart City efforts comes down to stimulating the type of behavior that fits with the 'digital culture': connecting, sharing, speed, experimenting, learning-by-doing, scrum, lean, iterating, evaluating. The improvement process should therefore be treated as an evidence-based cultural change programme. The success of any such programme is simple: have we just done what we set out to realize? Are we connecting? Sharing? Experimenting? Learning-by-doing? As zen-master Johan Cruijff stated: "If you want to score, shoot at the goal". Here that means: don't try to change the culture of anything. Just do it. Differently.

## Chapter 5. Conclusion

When it comes to becoming a Smart City, is Eindhoven doing something wrong? Our study leads us to conclude that no, it doesn't. The efforts we have studied seemed to have evolved organically and the major challenges that should be addressed next are the ones the projects are about to face. A City Platform should connect all smart projects and technologies and it looks like that will be one of the deliverables of TRIANGULUM. New ways of working with new types of partners, involving citizen-residents and resident-businesses in innovation efforts should be tested. That is what is taking place in Living Lab/Stratumseind 2.0, AiREAS and in the context of the realization of the Urban Lighting Roadmap of Eindhoven.

Could Eindhoven do more or better? Standardizing on a technical architecture is not one of the improvements that should be considered. The current processes are not mature enough to start reducing options (so standardizing at this moment seems unwise). Finding the right reference architecture to start working towards would be a better option. FIWARE, the Future Internet middleware for Smart Cities seems to be the best conceptual candidate. In practice, one could conclude it has not sufficiently proven itself yet but should be closely followed.

Eindhoven appears to be at the forefront of a number of Smart City challenges. Living Lab/Stratumseind 2.0 is perhaps the only Living Lab related to Integrated Crowd Management or the type of positive energy investment by people on a night out one could perhaps call 'Smart Sustainable Leisure'. AiREAS may not be the only project with air sensors in Europe, but there are quite unlikely to be more to have been set up without a financial model.

Strijp-S may be continuing its development with perhaps less momentum than before, unable to determine which input from suppliers giving advice can reliably be followed up on. However, it has already created quite a few meaningful innovations, the most visible one (by night): the LED Lighting on the Torenallee. The conclusion drawn from its efforts that, even as a district, it lacks critical size and this should also be taken into account by the Smart Lighting/Smart Grid tender. Here again, Eindhoven is pioneering in a new style of procurement to arrive at a new Smart Solution.

In all likeliness that forefront of the effort to become a Smart City will shift. At some moment, when parallel infrastructures have become smart, connecting them will be necessary and will make sense. The more successful efforts on tier 2 are, the more pressing the need to succeed at tier 3 (integrating them). In the Smart Lighting/Smart Grid Tender project, the procurement team is already going through the thought experiments. Their awareness is growing that integration of parallel smart infrastructures will require the municipal organization to adapt.

One thing is also clear: when smart parallel infrastructures become integrated, software will play an important role. Once that effort has stabilized into solution which we refer to as a 'City Platform'. Since most of the efforts in the researched projects have had a hardware bias, there is

probably a shortage of software competence in (the municipality of) Eindhoven in this area. As software is of key importance for the integration and for such a platform this is a serious challenge.

So what could Eindhoven do better? Not focus on standardizing the architecture at present. Rather start working towards a heterogenous vendor-independent reference architecture. Consider remaining at the forefront of Smart City development, by focusing more on tier 3 developments. This requires increasing the software competence in Eindhoven capable of playing a role in the development of a City Platform. Reaching further, trying to bring 'tomorrow' closer today could also lead to results...

AiREAS represents a new type of Smart City project, a relatively small one, energized by a drive to make a difference in how people engage with their (natural) environment and organized to pioneer new non-financial ways of innovating collaboratively. As citizen-residents and businesses will become involved with the TRIANGULUM efforts to make more districts in Eindhoven sustainable, with the Smart Tender/Smart Grid efforts to create Smart Lighting solutions in a number Eindhoven districts within the next 5 years, does it make sense to combine the efforts on tier 4 as well as tier 3? If citizens get involved, why not increase their need to be involved? Why not put Eindhoven ambitions to be a socially sustainable city center stage?

Even when Eindhoven focuses its efforts on tier 3 and/or tier 4 efforts to become a Smart City, it will likely still lack critical mass. There is a potential to gain more mass by elevating the Smart City efforts in Eindhoven to a bigger combined effort and to invite contributions of startups, pilots from businesses, experiments from multinationals, all aiming to create new business. At the same time, no single city in The Netherlands is a match for the power of a global player like Cisco. Especially as all cities are addressing most of the challenges related to digitization in parallel. What is needed is not only to connect the different efforts locally; they should also be connected regionally, nationally and internationally within the EU.

We have concluded Smart City projects around the world are happening at 4 tiers, ranging from putting a basic infrastructure in place to working on a social and sustainable smart city. We have sketched how yet unpublished business literature may provide a framework to use Smart City efforts to generate more new business. We have highlighted 11 challenges cities face in becoming smart and have provided a 7-step programme to deal with them. We have analyzed 4 of the pioneering projects of Smart City Eindhoven and have made recommendations to strengthen the efforts.

Eindhoven is well on its way to be a Smart City leader. And may even be doing that smarter soon. Especially by focusing on three improvements. First, co-creating a holistic vision and strategy for 'Smart City Eindhoven'. Second, there will soon be a need for a platform, an architecture, a heterogenous technological framework to align and speed up projects. Third, stimulating innovation and new business development. That will require even more talent, leadership and partners, within the city, the region and with international public and private partners.

## Chapter 6. More information

### Smart Cities Case Study Examples

Amsterdam

<http://amsterdamsmartcity.com/>

Barcelona

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<http://connectedsmartcities.eu>

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Peterborough

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DIRECTORATE GENERAL FOR INTERNAL POLICIES POLICY DEPARTMENT A: ECONOMIC AND SCIENTIFIC POLICY Mapping Smart Cities in the EU

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SMART CITIES COU READINESS GUIDE, The planning manual for building tomorrow's cities today  
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### CISCO Smart City Readiness

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### IBM smarter Cities Challenge

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- European Parliament : Mapping Smart Cities in the EU :  
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- PricewaterhouseCoopers '[Cities of Opportunity](#)' index
- Forbes -  
<http://www.forbes.com/sites/peterhigh/2015/03/09/the-top-five-smart-cities-in-the-world/>
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## ADDENDUM 1 Additional case studies

### Smart Aarhus

Smart Aarhus is the name of a project launched in the Danish city of Aarhus in January 2012. The project's first aim is to lay out the visions of the future digital city of Aarhus. Line Gerstrand Knive, a member of the secretariat of the Smart Aarhus initiative: 'It is important to stress that the Smart Aarhus initiative is a *city* initiative, and not just another project from the *municipality*.'

What Smart Aarhus should realize is co-created with the city's citizens, members of the academic community and entrepreneurs. Jonas Kroustrup, also a member of the secretariat of Smart Aarhus: 'Instead of basing new development on narrow political decisions, we try to adopt a much more open and democratic approach to the big questions surrounding the development of the city. In the Smart Aarhus initiative this is done by creating a number of different working groups, which consist of citizens, researchers and businesses, who together try to address some of the common challenges we face.' Smart Aarhus has working groups on 'smart supply', 'open data', 'digital entrepreneurship', 'sustainable development', and 'public-private partnerships'.

Putting the working groups in place is only the latest step in an ongoing process which Aarhus initiated in order to become a Smart City. Since 2010 the city has actively promoted research on how to integrate ICTs into the city fabric. This is being done through a research program called Digital Urban Living at the University of Aarhus. Another crucial player in Aarhus' quest to become smarter is the Alexandra Institute, which is a private company working in close collaboration with the municipality and the university to promote research-based, user-driven innovation in the field of ICT.

Among other initiatives, the Alexandra Institute has set up a Smart City Lab with the explicit aim of promoting Smart City solutions and strategies. Furthermore, the Smart City Lab is engaged in several EU-backed projects relating to Smart City developments, such as the OUTSMART project, the Internet-of-Things project, and the Smart City Santander project.

According to Line Gerstrand Knive, member of the secretariat of the Smart Aarhus initiative, the ultimate aim of Smart Aarhus is to inspire the citizens of Aarhus to take responsibility for their city: 'In the long run, we hope to move some of the responsibilities of the public sector and the services that the municipality delivers onto society. We want to create a city together, where it is natural to take responsibility.'

The effort made by Aarhus to become smarter was recently rewarded when the city was ranked second in Europe only to the city of Luxembourg in a survey of seventy medium-sized European cities.

More info:

- [www.smartaarhus.dk](http://www.smartaarhus.dk)
- [www.digitalurbanliving.dk](http://www.digitalurbanliving.dk)
- [www.alexandra.dk](http://www.alexandra.dk)

## Malmö

Malmö was covered by Mashable (a leading global media company that informs, inspires and entertains the digital generation) in March, together with the smart cities of Masdar (United Arab Emirates), Songdo (South Korea) and New York (USA)<sup>64</sup>. Mashable describes that 'Malmö used to be a polluted industrial center that was home to nuclear power plants. Since 2000, however, city officials have closed both plants and pledged to make Malmö both carbon neutral by 2020 and able to run on entirely renewable energy by 2030.' Their explicit longer term goal has shorter term objectives. City officials have stated that by the end of 2015 Malmö's fleet of municipal vehicles is expected to run on either hydrogen, electricity or biogas.

The focus on sustainable energy is clearly visible. In the Western Harbour district the Bo01 development has been nicknamed the 'City of Tomorrow'. Here a wind turbine occupies space that used to be part of an abandoned shipyard. It already provides electricity for parts of the city. The turbine also pumps rainwater in and out of an aquifer storage system to heat homes in the winter and cool homes during the summer.

## Smart Cities in Germany

In Germany 'smart city' is not a concept used as often as it is in the Netherlands. This does not mean that there is no urban technology development going on in cities. Companies in Germany have a long history in mobility (BMW, Volkswagen) and electronics (Siemens, Bosch). Today they build the future city upon this history. BMW is turning car mobility into a service. Siemens is one of the major partners in Masdar city. Siemens also developed the City Cockpit, a prototype of which has already been realized in Singapore.

### Siemens City Cockpit

State-of-the-art information and communication technology (ICT) enables the mayor and other decision-makers to track and analyze processes in their city in real time. All of the important information flows into a central system that processes the data for convenient display and indicates to what extent specified objectives are being met. The computer on whose user interface all the data of a fictitious city converge and are displayed is located in Siemens' 'City of the Future,' a demonstration center for future solutions that Siemens established two years ago in Singapore with support from the government of the city-state.

<sup>64</sup> <http://mashable.com/2015/03/05/future-cities/>



Non-German major industrial players can also be seen to be at work in Germany. Hamburg has signed an agreement with Cisco under the umbrella of Cisco's Smart+Connected Communities program and Internet of Everything. The press release states that Cisco and Hamburg share the vision that the future prosperity of cities lies in embracing the benefits of connectivity. Building on the Internet of Everything and innovative technologies, Hamburg aims to improve the quality of life for its residents by enabling greater mobility, efficiency, safety and sustainability.

Perhaps also significant is the fact that In Germany citizens are highly engaged through what is called 'Bürgerinitiative' ('citizens initiatives') in which citizens become active, quite often against political decision-making. A well-known one was the anti-Atomkraft (anti nuclear) initiative. In all likelihood this has contributed to Germany becoming leading in 'turning around' it's energy system ('die Energiewende'). On some days 75% of the energy used in Germany is renewable, on average it's almost 20%<sup>65</sup>. It therefore also makes sense that in many cities and regions the development of sustainable energy systems is high on the agenda. Only a few cities (e.g. Berlin) focus on information and communication technologies, which appears to be a more common focus in The Netherlands.

Carsharing, ridesharing and bikesharing (The German Railroad company has an extensive bike-program) have meanwhile become part of all day life in German cities. Deutsche Post is innovating in parcel and post delivery with electrical cars and drones. It seems that developments in Germany originate less frequently in cities and more from industries and from national organizations. Although some regions also appear to be quite active, as e.g. the Ruhrgebiet. In InnovationCity Ruhr | Modellstadt Bottrop an interdisciplinary team is working together with scientists to develop a more sustainable city. The aim is make the city more climate friendly. CO2-Emissions must be reduced to half of what it is today and the quality of life should improve. The project also serves to create new opportunities for local industry.

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<sup>65</sup> Eurostat,  
[http://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable\\_energy\\_statistics](http://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics)

## Smart Cities in India

India is urbanizing at an unprecedented rate and estimates suggest nearly 600 million of Indians will be living in cities by 2030, up from 290 million as reported in the 2001 census. Not many villages will be left India at the end of this century.

Today the older Indian cities such as Mumbai, Chennai, Delhi face significant challenges: increasing populations, unreliable services, environmental issues, declining tax bases and budgets and increased costs. In particular, the older cities are struggling to provide reliable basic services such as water, electricity, waste disposal, etc. However, as the cost of Information and Communication Technologies (ICT) is plunging, this makes it economical for the government to deploy ICT to address the service problems. So the focus of projects in older cities is to bring basic services to the level of the developed world.

With increasing urbanization and the load on rural land, the government has realized the need for cities that can cope with the challenges of urban living and also be attractive for investment (in special investment regions of zones with modified regulations and attractive tax structures). So in addition to the improvements in older cities (which will be slow and complex) emphasis is being put on greenfield initiatives. The Indian government has launched a parallel greenfield program: the '100 Smart Cities' program announced by Prime Minister Modi. Its goal is to develop 100 new smart cities and modern satellite towns around existing cities under the smart city program<sup>66</sup>. Wave Infratech e.g. is building a 4,500-acre Smart City on a new suburb of Delhi, which will be managed by a central command center. The proposed facilities include automated traffic signals, electricity and water meters custom-made to reduce bills, buses which will send text messages to inform residents of their arrival, mechanized garbage control, fiber optic connectivity, 24X7 security, panic buttons and CCTV surveillance systems.

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<sup>66</sup> The cities with ongoing or proposed smart cities projects include Kochi in Kerala, Ahmedabad in Gujarat, Aurangabad in Maharashtra, Manesar in Delhi NCR, Khushkera in Rajasthan, Krishnapatnam in Andhra Pradesh, Ponneri in Tamil Nadu and Tumkur in Karnataka.

## Modern Living

What to Expect From Upcoming Projects

	WAVE CITY	PALAVA CITY
 SECURITY	Hotlines, panic buttons, analytic-enabled CCTVs, vehicle identification monitors, electronic access cards .	A smart card will work as access card and e-wallet. Use of electronic access, fire alarms and CCTVs.
 WATER MANAGEMENT	Smart meters to enable remote monitoring and detect leakages. pH meters will be used to monitor the alkaline levels of water. Smart manholes will track sewer flow levels.	Rainwater harvesting, maintaining of water table to ensure sustainability and reuse of water for landscaping and other purposes.
 TRAFFIC MANAGEMENT	Intelligent traffic signals will provide real-time information on jams, monitoring devices will track location of buses and guidance parking systems will update message boards about space availability. Real time data of fleets via the internet will be sent to the city command centre and to other interfaces for citizens.	System enablers will predict traffic and inform road users about alternative routes through communication channels and digital signages to prevent jams. The fleet management system will ensure efficient operation of bus services, waste disposal trucks and emergency response vehicles.
 WASTE MANAGEMENT	Solid waste management plants	Will reuse at least 80% of all household and city waste. Waste water & by-products to be used for landscaping, flushing needs.
 ENERGY	Ambient light detectors to trigger street lights. Smart meters to remotely monitor usage and performance. Smart grid to detect pilferage and enable self-healing.	Solar power to meet 10% demand of public places. The city will also use smart pre-paid meters that will allow residents to monitor their electricity usage and get alerts.

India's Smart City efforts play into the larger agenda of creating Industrial Corridors between India's big metropolitan cities. These include the Delhi-Mumbai Industrial Corridor, the Chennai-Bangalore Industrial Corridor and the Bangalore-Mumbai Economic Corridor. It is hoped that many industrial and commercial centers will be recreated as 'Smart Cities' along these corridors. The Delhi-Mumbai Industrial Corridor, which is spread across six states, seeks to create seven new smart cities as the nodes of the corridor in its first phase.

Interestingly, these corridors are developed by the Indian Government in collaboration with foreign governments who are keen to find their domestic private enterprises new avenues of investment. Japan is helping India develop its smart cities by investing \$4.5 billion in the first phase of the project through loans from the Japan International Cooperation Agency (JICA). JICA has also taken up master planning for 3 'smart cities'- Ponneri in Tamil Nadu, Krishnapatnam in Andhra Pradesh and Tumkur in Karnataka - in the Chennai-Bangalore Industrial Corridor. The United Kingdom (UK) is collaborating with India for developing the Bangalore-Mumbai Economic Corridor project with the help of private companies from Britain. India has also got into an agreement with Singapore to use its expertise in smart cities and urban planning for developing the '100 Smart Cities'.

Also instrumental in the development of Smart Cities are partnerships with technology firms like IBM and Cisco. IBM prepared the ICT Master Plan for Dighi Port Industrial Area and also provides for the establishment of an Intelligent Operations Center.

Cisco has prepared the ICT Master plan of four smart cities Dholera in Gujarat, Shendra in Maharashtra, Manesar in Haryana and Khushkera in Rajasthan. In Bangalore, Cisco is converting a 5 square km area around Electronics City into a Smart City. Cisco aims to leverage the experiments it carries out in the 'Living Lab' in Electronics City for its projects in other Smart Cities.