

# Smart Cities Cookbook



## Our Kitchen

Since 1985 Geodan has grown to become one of the leading Geo-ICT consultancies in the Netherlands. We specialize in providing spatial information and in the application of new, innovative technologies. Every day – and in various countries – we help customers solve diverse (complex) geo-information problems by providing consultancy, interim and project management, customized GIS solutions (desktop, web and mobile), geographical data and web services, application hosting, training programs and workshops.

The Geo-ICT sector is knowledge-intensive, for this reason, know-how is high on the list of our priorities. Geodan aspires to stay ahead in the world of technological developments around geo-information, anticipating new applications and opportunities along the way. Identification of new geo-trends and -technologies and deploying these effectively in innovative projects is our goal. As such, we attach great value to innovation and research. Our research team is constantly identifying and analyzing new developments in the field of GIS, geo-informatics (e.g. spatial semantic web), big data (spatial BI, internet of things, machine learning), Advanced User Interaction (e.g. augmented reality and Kinect), mobile applications (apps and lowcode), and open standards. To this end, we have a partnership with the VU University Amsterdam: in addition to Geodan S&R members of staff, research assistants are permanently involved in these projects.

## Foreword

Nowadays, in Europe and North America, around 80% of the population lives in cities. Asia and Africa, booming economically, are estimated to host 2/3 of their population in urban areas by 2050. Those figures are expected to increase in the next 30 years with a population growth rate reaching 5% a year or more in certain urban agglomerations around the globe. In that perspective, there are growing concerns on how to accommodate such a growing population and maintain a sustainable environment and a great quality of life in urban areas.

Governmental institutions will most likely face challenges concerning traffic congestion, housing shortage, crowded streets, waste management, pollution, social conflicts etc. In that context, smart cities are believed to help a decision maker in tackling such upcoming challenges with the support of newly developed information and communication technologies.

This smart city cookbook presents in simple recipes the necessary background information to better understand the current smart city movement and showcases the vision of Geodan on this domain.

# What's on your **Smart Menu?**



## **Dish #1 - Smart? City?**

- What is a city ?
- What is smart ?



## **Dish #2 - Smart City Infrastructures**

- Data collection infrastructures
- Data transmission infrastructures
- Data storing & processing infrastructures



## **Dish #3 - Smart City Data**

- Sources
- Integration
- Analysis
- Visualisation
- Digital Twin



## **Dish #4 - Data Policies**

- Privacy & Security
- Access & Sharing
- Openness



## **Dish #5 - Partnerships And Coordination**

- Public private partnership
  - Business model
- Workforce training



# Dish #1

## Smart? City?

The digital transformation of our society is growing at an exponential rate. Computers and related information and communication technologies (ICT) have facilitated the production, access and sharing of information and we are now witnessing a growing number of devices (smartphones, sensors, remote sensing devices etc) being released with the promise to capture “anything, anytime, anywhere” [1].

The pace and the extent of digital development is difficult for certain organizations to keep track. This is especially true for public organizations where, in a recent survey, “73% of state and local government officials (in the US) believed their organization’s digital capabilities were behind those in the private sector” [2].

## Dish #1 **Smart? City?**



### **Instructions**

#### **Understand your city**

A city could simply be defined by its industrial, commercial and political activities, its structured governance system, population aggregation and boundaries. In reality, cities are far more complex, they are dense, messy, uncontrolled and cosmopolitan and defining them in strict words is a delicate task.

Facing the question, many urban planners and cities' executives will approach the problem with the belief that a city is made of its communities and culture [3]; that to understand a city, you must first understand its people. One must implement new forms of engagement model that invite citizens into the loop.

#### **Beyond technology, smart is about people**

A common understanding is that the smartness of a project comes from innovative ICT, data analytics and artificial intelligence; the technologies that sustain a smart project. However, what makes a city "smart" does not solely stand on its ability to integrate ICT.

A fundamental step in the development of smart city projects should be towards a core understanding of the citizens and stakeholders needs. One must develop their own understanding of their city by sourcing out citizens and experts that are concerned and fully involved in community developments, interconnections and welfare. It is essential to apply a participatory approach to create an inclusive, communities-centered city where citizens, learning institutions and private partners can actively participate in the city's improvement.

### **Ingredients**

*Citizens*

*Stakeholders*

*Requirements analysis*

*Engagement model*

## Chef's recommendation

*Geodan helps its customers to reflect upon the core needs regarding smart city solutions, through elaborated requirement studies.*



Information &  
visuals



Goal /  
stakeholders



Data  
sources



Accessibility



What else would  
you like to see?

*Through this requirement analysis, Geodan invites its customers to explicitly define the current challenges that need to be tackled and the stakeholders involved, to assure a user-centric implementation of smart city solutions. Such an approach is essential in the creation of a coherent and inclusive development plan that surely grants the project its "smartness".*



# Dish #2 Smart City Infrastructures

The increasing performance of Information and Communication Technology (ICT) allows us to monitor a growing number of metrics, eases the transmission of the information at a rising speed and offers the opportunity to process a large amount of data. ICT is already integrated into our everyday life and its applications are numerous, including in smart homes, smart energy grids, smart transportation, smart healthcare and other cities services. In 2016, there were around 16 billion connected devices worldwide for which fixed and mobile phones, computers and tablets accounted for around 60%. With an expected growth of around 30% from 2017 to 2023, Internet of Things (IOT) devices is expected to soon outnumber the number of “traditional” connected devices, with nearly 20 billion out of 31 [1]. Moreover, these devices create an incredible amount of data that needs to be transported, processed and analyzed. This requires advanced, robust and scalable smart city communications IT infrastructures. Once core requirements have been defined by the city, one can start thinking of the desired infrastructure to support its smart city's project.



## Dish #2 Smart City Infrastructures



### Instructions

#### Seek IoT that suit your project

Various domain-specific devices are now available from simple sensors such as temperature sensors to millimetre accurate laser scans, satellite imagery or CCTV cameras. Taken separately, those devices may not be sufficient to improve decision making in our cities. However, the Internet of Things (IoT) promises to bring together heterogeneous devices within one, interconnected network of “Things”. We are already counting a large number of IoT devices for smart homes (smart energy meters, virtual assistant, smoke detectors), smart transportation (speed and flow radars, traffic sensors, GPS tracking etc), smart health (air quality meters, smartwatches etc), smart infrastructure (smart electricity grids) and more. Note that beyond those technologies, it is most likely that devices are already in place. One must list what is already available in its city.

#### Take advantage of data transmission infrastructure

The IoT network is made possible by the integration of communication technologies more and more efficient and reliable (WiFi, 4G, 4G+, 5G, RFID, Zigbee, Bluetooth, LoRa, etc). The 5G with its theoretical speed of 10 Gbit/s is particularly interesting as it enables low latency data transmission, a well-needed feature for real time data stream. In addition, beyond the traditional human to machine interface, it introduces an improved possibility for machine to machine communication (M2M), useful for IoT networks.

### Ingredients

*Data collection infrastructure*

*Data transmission infrastructure*

*Data storage & processing infrastructure*

### Go with cloud infrastructure

In order to accommodate the volume and speed of data, the IT industry is turning toward cloud computing. Indeed, in recent years, cloud technologies have proven to be performant and reliable to deal with big data. It is currently the favored technology to host IoT data and process them. Cloud computing providers often present their product as a set of services that consumers can access such as infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS). Note that cloud computing is pushing toward edge computing where servers are geographically distributed, closer to the data sources, for an improved response time and to save bandwidth.


### Think ubiquity and seek ecosystem

A crucial characteristic of the smart city paradigm is its ubiquity, the creation of a single homogenous system. To do so, the hardware implemented must present capabilities to easily operate with other systems, including already existing infrastructure. This is also important for scalability as it eases the progressive integration of new components and services.

The industry is tackling such challenges by adopting common standards and protocols at every infrastructures' levels that will ensure a seamless ecosystem. In addition, consortiums and alliances have emerged intending to unify the IoT industry landscape

## Chef's recommendation

*Smart city projects involve various domains of expertise and it is likely that the hardware supplier differs from your data intelligence or front-end developer. In recent years, Geodan uses the cloud to host its solution platform, taking advantage of its various capabilities such as infrastructure as a service (IaaS) or platform as a service (PaaS) or software as a service (SaaS). However, standardisation and open solutions enables Geodan to deploy its solutions upon various hardware from various suppliers.*



# Dish #3

# Smart City

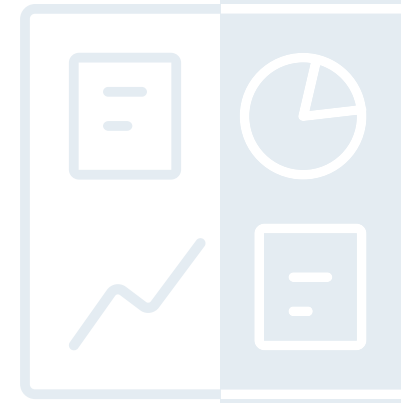
# Data

The extensive collection of data on energy, water, traffic, demographic, business, citizens and more enables an accurate assessment of the city's dynamic and helps stakeholders in making informed decisions.

However, the common picture of "data" as a homogenous entity could not be more wrong. In reality, data is encoded in different, often domain-specific, formats that have been implemented throughout the years. The smart city being at the cross-road of numerous domains, it is essential to create an interoperable data landscape where the information flows from one format to another, all the way up to the end-user.

In this section, we present the data layer of urban data platforms and the importance of a coherent data integration.

## Dish #3 Smart City Data



### Instructions

#### Check available data sources

Data sources can be classified into four main categories: existing data sources, Sensors Networks, Abstraction Models and the World Wide Web.

Sensor networks are collections of devices that sense (locally or remotely) phenomenon. For instance, it includes weather stations, energy meters, water flow meters, satellite & aerial imagery, Light Detection And Ranging (LiDAR) or photogrammetry observations and more.

Abstraction models are digital abstractions of the real-world environment such as Building Information Models (BIM) and spatial and geographic data. They are 2D or 3D models that capture objects, systems and people within an urban area.

With billions of online documents and web pages as well as RSS and social media feed, the World Wide Web has become a prized source of information. Through processes such as web data mining & crowdsourcing, we are able to leverage the WWW to collect information provided from people.

Geodan takes advantage of the data landscape that all these different sources offer when it comes to develop its solutions. Efforts are put on listing what is available, without undermining any categories, and on how to leverage them to bring intelligence.

#### Think forward with data integration

Data integration is about collecting and merging together all those heterogeneous sources into a single, homogeneous system.

### Ingredients

*Data sources*

*Data integration*

*Data analysis*

*Data visualisation*

*Digital twin*

Combining data from several sources often results in new insights and improved information. It is an essential part to bring pieces of information into a greater picture.

Geodan is specialised in spatial data information integration using open standards from the Open Geospatial Consortium (OGC), W3C and ISO. As Geodan relies on an open standards strategy, its solutions are not limited to a specific provider or vendor. This is essential as it enables projects to scale up and progressively integrate new features and data sources. Geodan integrated the IoT platform GOST (Go-Sensor Things). This IoT platform communicates with IoT devices, data and applications on the Web. GOST is an open-source, certified, OGC standard, that allows the storage and processing of the real-time data and makes it easily available to parties.



### Innovate in your Data Analysis

If some particular data are valuable pieces of information by themselves, in most cases, valuable insights are hidden inside the mass of all data. To help stakeholders to make the best-informed decisions, we must transform raw data into better insights. Activities may include: preprocessing data (e.g. dealing with missing values, removing outliers, labelling), exploring and synthesising the data (develop metrics, KPIs, graphs), analysing the data (use statistical tools such as mean, median, regressions, clustering etc), modeling the data (e.g. machine learning prediction models, flood model, fire model).

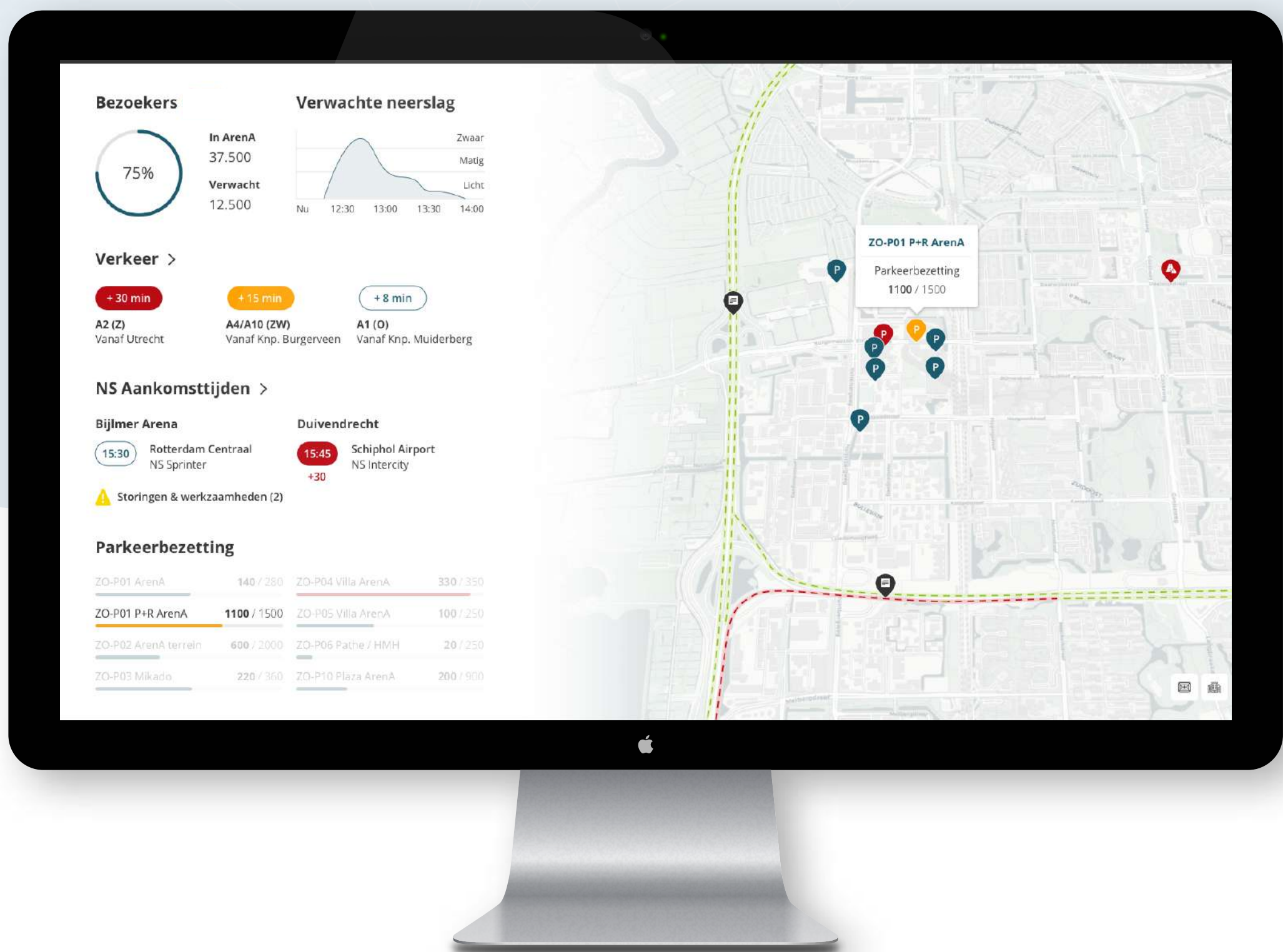


Geodans' emphasis is on the notion of actionable insights which serves as a guideline when it comes to developing valuable data analysis and KPIs.

Research and innovation should not be undermined and opportunities should be given to developers to innovate upon the data. In Geodan, a research department has been assigned with tasks such as developing AI solutions, predictions, new KPIs, improved 3D environment and more.

### Care for visualization

The overload of information can make it difficult for experts and non-experts to focus on the essential. Thus, there is a clear need to provide this information in the most transparent and user-friendly way. Dashboards are currently widely used for KPIs' visualization. Efficient dashboards require the integration of features enabling the visualisation of strategies with goals, alerts, analysis reports, enabling only the relevant visualizations for a specific role, and sorting them according to priorities. In addition, 3D models are likely to improve navigation and understanding of smart city components. They offer an immersive and user-friendly interface that anyone can apprehend.



## Chef's recommendation

*Geodan is the expert in integrating real time data in user-friendly dashboards, making it easy for stakeholders to quickly discover the most important information and actions to be taken. These actionable dashboards on e.g. mobility, sustainability and liveability are dynamic and interactive. They integrate sensor data in an insightful 3D environment creating a digital twin, for an enhanced user experience. (<https://vimeo.com/344054150>)*

*A digital twin is a digital environment that serves as an exact copy of the real world. Digital twins are based on advanced BIM and GIS technologies with real time data integration. This perspective on data management ensures a seamless data integration architecture, enabling data analysis and visualisation within its spatial context. It leverages game engines to create compelling 3D environments and VR experiences. Presenting data in their digital copy of the physical environment, will help in a greater understanding and decision making on urban topics.*





# ◎ Dish #4 Data Policies

Smart city projects aim at a better understanding of how people act and think. Profiling behaviours is an important part of urban analytics to understand needs and demands related to public services. Aspects such as health, daily journeys, incomes, energy profiles, will be monitored. However, if such insights are powerful to run successful smart city projects, they can also be used at peoples' expense for harmful purposes.

There are important concerns on privacy and security over the data. In the EU, the General Data Protection Regulation (GDPR) has been recently released. This regulation framework covers holistically data protection and privacy in the EU [1].





## Dish #4 Data Policies

### Instructions

#### Ensure Privacy & Security

With the GDPR, it is now clear that the processing of personal data is prohibited without an unambiguous consent from the owner unless it is expressly allowed by law. Consent should cover all processing activities and be explicitly given for each of them. Under such law, individuals have total sovereignty over their data. Mandatory activities include: pseudonymization and encryption of personal data; the ability to ensure confidentiality, integrity, availability and resilience of processing systems and services; the ability to restore the availability and access to personal data promptly; regularly testing, assessing and evaluating measures' effectiveness. To help in this task, it is advised to assign the role of Data Protection Officer who is responsible for checking if your organization acts in accordance with the GDPR.

Geodan has an extensive certified quality management system with regard to its services. For its implementation, Geodan has opted for a combination of three certifications, namely:

- ISO9001 (quality management and customer satisfaction)
- ISAE3402 (service management)
- ISO27001 (information security)

This combination of certifications ensures a "state of the art" risk and quality management system. In doing so, Geodan demonstrates that its procedures and processes have a significant higher chance at successfully maintaining GDPR compliance.



### Ingredients

*Data privacy & security*

*Data access & sharing*

*Openness*

### **Pay attention to access & sharing**

The data sharing and access with one or more organisations are defined by the data controller in compliance with the GDPR. It is the responsibility of the controller to inform, in full transparency, the data subject to all processing activities and processors involved.

### **Be open**

An open data strategy is currently praised by the EU as it is believed to open unexploited business and economic opportunities, improve sustainability and accelerate scientific progress and innovation.

In practice, there are principles that open government should consider when it comes to data:

- Completeness
- Primacy (originate from primary source)
- Ease of access
- Machine Readability
- Non-discriminatory access
- Commonly owned or open Standards:
- Licensing (part of the public domain and thus without restriction in its use)
- Permanence (available in perpetuity)
- Usage Costs (free or minimum costs)

During the data integration phase, Geodan seeks for data sources that can support its solutions, also making use of open data sources. For instance, data on Public Transport, Traffic, Weather, Energy originated have been taken from open datasets and/or APIs to integrate in our actionable dashboard for the city of Amsterdam. Our organisation values open data and believes that opening certain dataset is a key enabler for smart city project democratisation.



# Dish #5

# Partnerships & coordination

Despite the confidence in the technological readiness of the smart city paradigm, one of its biggest challenges remains human in nature. Indeed, smart city projects aim at improving decision making in various domains and bring together different actors around the development of a common solution.

Public organizations, private sectors, citizens, non-profit organizations and more are required to collaborate to make it work. This collaborative perspective is challenging and presents many concerns related to communication, exchange of information, business model etc.

## Dish #5 Partnerships & Coordination



### Instructions

#### Build strong partnerships

Cities' executives are in the best position to lead the smart city movement. However, they cannot do it on their own and must outsource expertise and assets in the private sector. Public-Private Partnerships are believed to enable public organizations to rely on private actors expertise, capabilities and innovations while providing a better risk-sharing among parties. For the private sector, it gives them the opportunity to collaborate with the largest collector, holder and producer of data related to citizens, organizations and public services. This can lead to innovation and new business perspectives.

A first step in the creation of such a collaborative perspective would be simply to re-considered the status of each party. Indeed, a recent survey has shown that 32% of business executives complained that "cities tend to treat companies as suppliers or service providers rather than strategic partners" [1].

Geodan has a strong record of partnerships around smart city projects. Geodan is the innovation partner for Brainport Smart District and several municipalities. Furthermore, Geodan is involved in a strong solution partnership with Huawei and the Johan Crujff ArenA in the development of the actionable dashboard solutions.

#### Attract partners with a compelling business model

The financial aspect is a key aspect that will determine the level of engagement from the public and private sector. There is currently a growing gap between infrastructures' capabilities and public need which generates losses. Several strategies can be implemented to generate value such as user fees, taxes, impact fees, revenue from advertising spaces, increased value of the land, development rights, monetizing value-added data etc. In PPPs, cities and private organizations share both risk and reward involved in the projects.

### Ingredients

*Public-Private partnerships*

*Business model*

*Workforce training*

In its development, Geodan works together with its partners using the Agile methodology, in which there is room for experiments and proof of concepts, focussing on maximizing the value stream. Besides, strong from a detailed planning of its activities and deliverables, Geodan divided its budget within several licences corresponding to a number of products the company is responsible for.

### **Involve citizens, educate smart people**

One of the current concerns around smart cities development is the lack of human resources and skills to perform its implementation. In recent years, education institutions have progressively followed the demand with a growing provision of specialized educational tracks. Beyond professionals, digital literacy among the population is an important matter. Educate citizens toward digital services and data can bring trust among the population as well as empower citizens and generate individual initiatives.

In a recent survey, 73% of business owners stated that they were keen on facilitating citizens' engagement [1]. Efforts are already being done to bring the smart city domain to the people through the implementation of hackathons, FabLabs or public meetings & seminars. Geodan supports this vision and deploys efforts to bring its expertise to the public. For instance, it developed tools such as EcoCraft, a game developed on the basis of Minecraft, enriched with models and scenarios in cities or EduGIS, an educational and digital platform to support GIS education.

Besides, Geodan participates in events such as the WeMakeThe.City Festival with the aim to involve citizens and raise awareness on sustainable development goals.



*WeMakeThe.City Festival*

## Chef's recommendation

*A smart city project should be connected, aware, responsive and innovative which is the essence of Agile thinking. Consequently, the methodology is well suited to integrate smart city projects. Indeed, it is believed to help to deliver products faster while reducing the risk of poor quality.*

*In its project implementation, Geodan opts for working with Agile / Scrum methodology. In this way, the product owner is closely involved in the realization of the deliverables. This iterative approach allows flexibility and refine the value of the product.*

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## Meer weten?

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