Rotterdam School of Management
Erasmus University

Case Development Centre
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Digital City Rotterdam: Open Urban Platform

Introduction

The City of Rotterdam in South Holland, the Netherlands is a global port city. With 650,000 inhabitants, Rotterdam is home to a socio-economically diverse population (see **Appendix**) and aims to become a leading city in the areas of digital development and sustainability. The ambition is for Rotterdam to be a 'digital example city' by 2025; a city in which digitalization will make a major contribution to its social, environmental, economic and sustainability development goals.

Since 2017 there has been development and implementation of a lot of smart solutions in different city application domains such as energy, mobility, and waste management. Developed as stand-alone solutions for these domains, these 'siloed' solutions have led to a situation of diverse data formats and models with incompatible outputs. Consequently, there is very little sharing or reuse of data. These isolated applications and services do not serve to make Rotterdam the smart digital city it aspires to be.

To address this issue, in 2018 the City of Rotterdam started to explore the possibility of developing an Open Urban Platform (OUP) so that data within and across the city systems and services could be leveraged. Roland van der Heijden was the Digital City program manager at the Municipality of Rotterdam. He organized a brainstorming meeting in September 2019 with all the important stakeholders of the OUP project, focused on how to kick-start the platform. During the meeting many questions came up around such issues as the purpose, ownership, and governance of the platform; development costs and financing; and data sharing and privacy. As the meeting progressed, Van der Heijden became more and more aware that before the OUP project could start, much more knowledge and many more experiments would be needed to be able to make many important and complex decisions.

Next Reality and the Vision of the Digital City

Modern cities face numerous challenges that include growing populations, air and water pollution, and the management of urban mobility. By enabling smart solutions and facilitating collaboration and interactions among city stakeholders, digital technologies can support cities in meeting these challenges and achieving sustainable economic, environmental, and social development goals.

This teaching case was written by Dr. Samaneh Bagheri under the supervision of Dr. Tobias Brandt and Dr. Marcel van Oosterhout at the Rotterdam School of Management (RSM), Erasmus University. We would like to thank Tao Yue at the RSM Case Development Centre and Roland van der Heijden from Municipality of Rotterdam for their time and input. The case is part of the RUGGEDISED project.

Increasingly, digital technologies enable cities to collect a large volume of data from various sources (e.g., sensors, citizens, private and public systems) and to use this data for developing smart city services (e.g., e-mobility, smart energy management). Digital technologies, such as IoT and cloud computing, add a new dimension to the traditional socio-physical landscape of cities. They provide opportunities to make links between cities' digital, social, and physical aspects. However, digital technology is not only an instrument that we can use to solve our social-physical problems. It is also completely shifting our reality and our ways of dealing with a whole new set of opportunities and threats, as well as influencing existing ones like climate change, the energy transition, etc.

The City of Rotterdam has a vision of creating the resilient city of tomorrow by recognizing the importance of the impact of the new digital reality and by leveraging digital technologies. This is a city in which the dynamics between social, digital, and physical reality determine the characteristics of the smart and sustainable city (**Exhibit 1**). For instance, through the interconnection between the digital and physical world, i.e., through the *digital twin* concept[1] with 3D visualizations, the Digital City is enabled to know, and show, how environmental data, underground piping, thermal grids, bus lines, and a wide range of other city data are connected.

The 'digital twin' concept offers a possibility for a cross-silo connection of data, stakeholders and applications, through a common picture ('single point of truth') on the 'physical reality' of the city, described by data. In the future we will see the digital twin develop further towards a real 'digital urban community', in which all three realities are completely interconnected with each other.

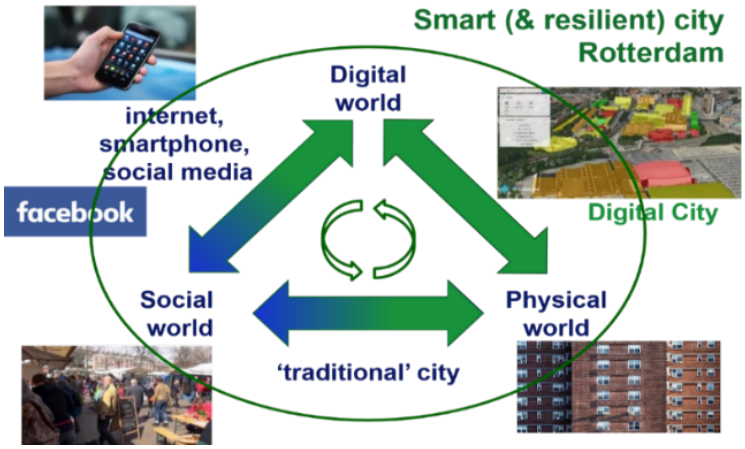


Exhibit 1. Three dimensions of Digital City Rotterdam

To realize this vision, the Rotterdam's Digital City program was initiated in 2017. At the core of the program was the notion of the development of an OUP with a 3D data

[1] A short video on urban digital twin: https://www.youtube.com/watch?v=kf3GwstdFVE

model of Rotterdam combined with 'real-time' data describing the functioning of the city. The primary aim of the Digital City program was to improve the efficiency and effectiveness of city processes and services by creating a digital environment that facilitates data exchange and reuse, as well as inter-operable interaction among different city systems and applications. Moreover, changes can be modelled, simulated, and visualized, providing fresh insights to improve our urban habitats. To fulfil this focus, an OUP that could integrate data streams across infrastructure systems, and facilitate data exchange among them, was required.

Open Urban Platform – Opportunities Created

From a technical point of view, the OUP focuses on collecting, aggregating, analysing, and distributing data from a wide variety of data sources. From a functional point of view, it aims to provide a city with a data infrastructure that will attract an ecosystem of users, citizens, governments, NGOs, and companies that will create both public (e.g., social, environmental) and private (e.g., innovation, profit) value.

By using open data standards, the OUP aims to interconnect Rotterdam-related application domains. In addition, the OUP of Rotterdam, based on geo-functionality and supporting real-time data exchange, will display a constant image of the current, measurable physical reality – for example, is that garbage container full? Is that parking lot occupied? How many cars are on the street? This digital image of reality provides a basis for many innovative applications.

A high-level abstract view of the architecture of the OUP of Rotterdam is illustrated in **Exhibit 2**. This three-layered architecture presents an overview of the stakeholders involved, variety of data sources (sensors, citizens, private and public sectors, etc.), the infrastructure components (datasets, open urban platform, 3D geospatial visualization, data marketplace), and some examples of Apps or use cases that can develop and act on top of the platform.

By using the data services of this OUP the City stakeholders (e.g., the Municipality, businesses, citizens, academics, etc.) can, for instance, make informed decisions, analyse emerging trends in energy consumption, or develop innovative apps (e.g., real-time monitoring of the city).

The City of Rotterdam planned to release an operational OUP in 2022. In a later phase (after 2022) the relation to social reality (for instance relevant social media posts and news) would become a part of the OUP. The development trajectory of the OUP would take place through prototyping several use cases, of which two – smart charging parking lots, and efficient and intelligent street lighting – were completed

successfully as a part of the RUGGEDISED project[2], and several features were included in the platform.

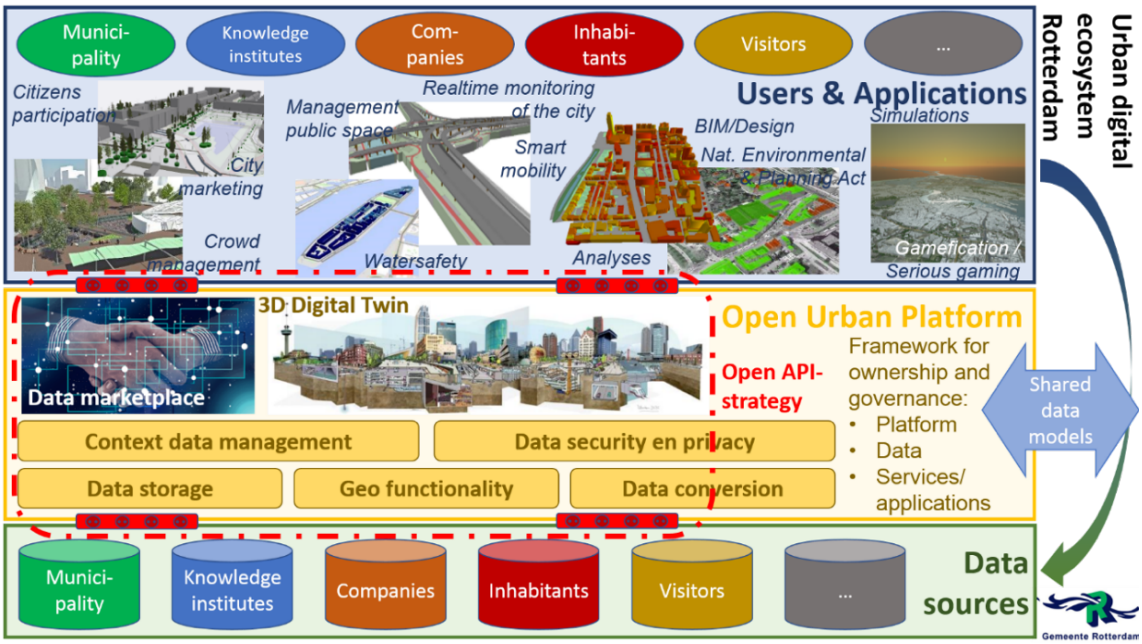


Exhibit 2. A high-level abstract view of the architecture of the open urban platform ecosystem of Rotterdam

Use Case 1: Smart charging parking lots[3]

The goal of this use case is to reduce peak loads by introducing smart charging at parking lots, powered with photovoltaic (PV) panels. Within the Heart of Rotterdam's South district, many PV panels are installed on the roofs of buildings. This will transform solar heat into AC (Alternating Current) electricity, which will be stored in AC batteries. Private electric cars parked in garages in the Heart of South district will be charged with electricity from the electric grid (**Exhibit 3**).

Using a 3D city model real parking lot data was collected; in 2019, negotiations with different operating companies and building contractors to install several charging stations and to build parking spaces for electric vehicles were launched and are ongoing. In the coming years, several thousand electric smart charging poles will be installed in City of Rotterdam parking facilities.

[2] These use cases are part of RUGGEDISED – a *smart city* project funded under the European Union's Horizon 2020 research and innovation program. It brings together Rotterdam, Glasgow, Umeå, Brno, Gdansk and Parma to test, implement and accelerate the smart city model across Europe. The RUGGEDISED project aims to develop and implement smart solutions in the field of energy, e-mobility, and ICT to create smart, resilient cities. The overall goals of RUGGEDISED are to improve the quality of life of the citizens, to reduce the environmental impacts of urban activities, and to create a stimulating environment for sustainable economic development.

[3] https://ruggedised.eu/project/materials/

Use Case 2: Efficient and intelligent street lighting[4]

The lampposts being used within the Heart of South area in Rotterdam retain, serve and enhance the principal compliant obligations of street lighting (wayfinding, public safety). These lampposts are equipped with LED lighting and a so-called Tele-management system (**Exhibit 4**). They are connected as a network, enabling system-wide controllability (e.g., a central management system), and the integration of sensors that extend services and have the power to enable continuous smart services 24/7.

In October 2019 the first 14 smart lampposts were installed in Heart of South. They can be controlled and monitored remotely and can provide insight into energy use. The energy use data can be fed into the 3D model of the city's *digital twin* to provide insight into the lamppost's performance. The aim is to spread this technology across the City of Rotterdam, which should lead to a 50% to 70% reduction of energy use city-wide.

There are some lessons learned from these use cases. First, the Municipality of Rotterdam does not want to be the owner of the data that is generated within one of these solutions. Second, there is now an understanding of how to prioritize functionalities (such as data storage, conversion, geo-functionality, security and privacy, marketplace, 3D digital twin) for an OUP.

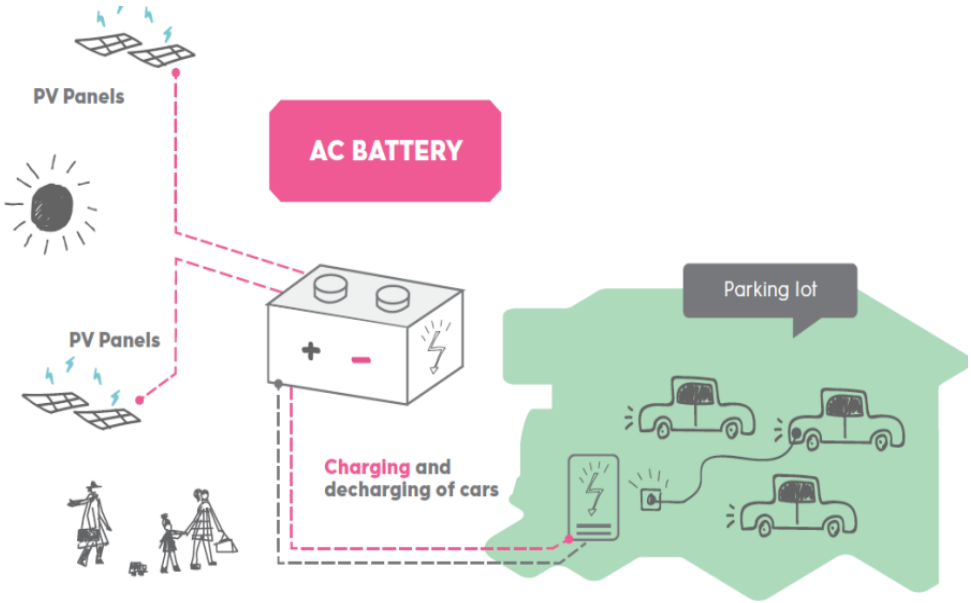


Exhibit 3. Smart charging parking lots

[4] Ibid.

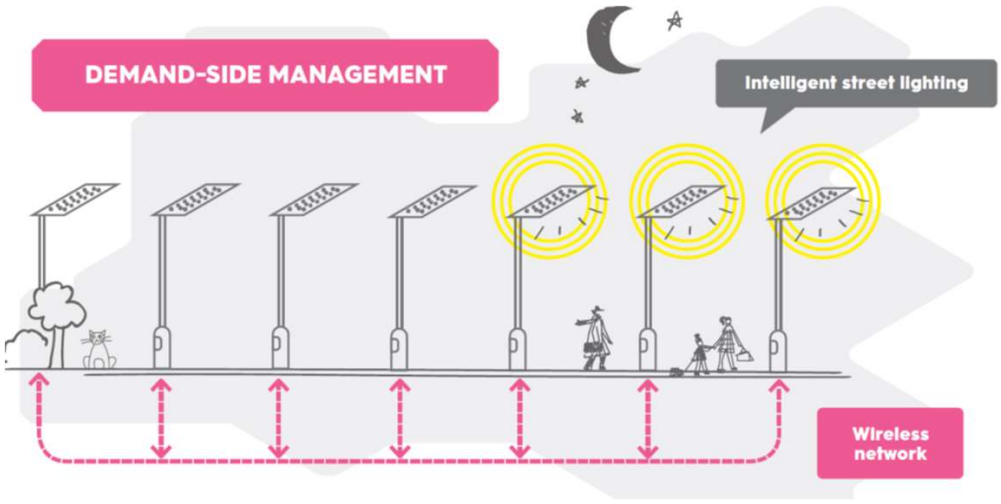


Exhibit 4. Efficient and intelligent street lighting

Part II: The Panel Discussion

The representative experts attending the online panel discussion with Digital City program manager, Van der Heijden, in September 2019 to discuss Rotterdam in the journey to develop OUP were Danial Kou, OUP strategist from the Municipality of Rotterdam; Peter Houvers, a technology manager from the private sector; Martin Powel, a data-driven business developer from the private sector; Niko Rafaat, social science specialist; and Bert Psaki, smart city expert from a knowledge institute. Van der Heijden started the meeting once everyone introduced himself.

Van der Heijden, Digital City program manager: "As we are in the early days of OUP development, we need to talk and create a shared understanding of its **purpose**. In your vision, what should be the purpose of this platform?"

KOU, OUP strategist from the Municipality of Rotterdam: "I think to deliver excellent public services and citizen security online. OUP should be about enabling the exchange of city data to provide all needed information for public policies and government decision making. It should also provide a testing ground for data-led innovation."

POWEL, Data-driven business developer from the private sector: "While we used to think of traditional public-driven forces to improve government services by using open data, we know that a digital platform brings much more possibilities. OUP should facilitate an open, trustworthy and effective data marketplace and thus facilitate citizens to live and work in the urban environment."

HOUVERS, Technology manager from the private sector: "As 'city' denotes more than just the 'municipality', OUP should facilitate sustainable, resilient enrichment of urban life and opportunities. Any decision should be based on a business case. The biggest issues of cities involve the environment, housing, mobility, safety. Thus, the incentive to initiate OUP should be to be better equipped to alleviate these issues. This is also true because it (OUP) needs to be understood by citizens."

RAFAAT, Social science specialist: "I understand your point and agree with that. OUP must improve the quality of life – this is a public as well as a private goal."

PSAKI, Smart city expert from a knowledge institute: "A central hub for re-use data for new services. OUP should utilize data to manage the city better (with regard to all societal issues) and improve the lives of citizens and businesses."

KOU, OUP strategist from the Municipality of Rotterdam: "Besides the purpose, one of the most pressing issues we are facing from a governance point of view is determining the owner and manager of OUP. What is the best way to govern the OUP, and who should do it?"

POWEL, Data-driven business developer from the private sector: "Jointly-owned and managed by the public and private sector, as we want to prevent a full government control we might see in [...] or the market dominance/power by big commercial platforms such as [...]."

Van der Heijden, Digital City program manager: "OUP is public infrastructure, so government should take the lead and facilitate the development of OUP. If ownership or initiative is taken solely by the market then you basically get Facebook, Google-like monopolies forcing the public sector to eventually use them, which is something we should *not* want as a society. Government leadership mitigates the tendency towards vendor lock-in."

HOUVERS, Technology manager from the private sector: "I believe the Municipality of Rotterdam plays a central role in facilitating the collaboration between stakeholders, whereby the private sector develops, manages, maintains, and further develops the platform. A joint public-private setup would be the best scenario to ensure optimal data availability, accessibility, quality, security, affordability, and reliability."

RAFAAT, Social science specialist: "It is important that the Municipality of Rotterdam is in the lead, as the 'owner' of the platform that works for the city."

PSAKI, Smart city expert from a knowledge institute: "The private sector tends to create a monopoly; data platforms are thus monopolistic efforts that need to be under trusted control. However, in any case, governments should get involved in the initial steps of the development of OUP."

Van der Heijden, Digital City program manager: "In the continuation of your point, I want to add that the public authorities (in this case the Municipality of Rotterdam) should initiate the OUP, as they can align OUP with the city priorities, and retain control and affordability of vital city services."

POWEL, Data-driven business developer from the private sector: "I think that for the success of the OUP initiative, the traditional division of roles of client and contractor is necessary. The Municipality of Rotterdam has a directive role in the goals that the City of Rotterdam has set for itself, but it also can act as a supervisor or as a user; while the private sector provides advice, realization, support and maintenance of the OUP."

HOUVERS, Technology manager from the private sector: "The OUP cannot be initiated and managed by the Municipality of Rotterdam alone, as industry players have demonstrated clear leadership and skills in leveraging the data for developing new services."

RAFAAT, Social science specialist: "A public-private model with a consent-based architecture, implemented and managed by the government, and with the innovation ecosystem development and expansion led by private industries, will be a balanced model."

PSAKI, Smart city expert from a knowledge institute: "I believe that the Municipality of Rotterdam must have the confidence to take the companies' ideas into account but must rely on its own vision about the purpose of the platform and its governance."

KOU, OUP strategist from the Municipality of Rotterdam: "While I see your concern, we also need to take into account that OUP is costly and complicated to develop/maintain, and local governments often can't afford such a big investment. How should OUP be **financed**?"

Van der Heijden, Digital City program manager: "We see a mixed approach where the core platform is financed by the city's local government, but projects can be funded by universities, the private sector, and other entities."

POWEL, Data-driven business developer from the private sector: "Right, OUP can be financed through multiple Public-Private Partnership models with the equity of each partner decided based upon the risk-reward ratio. It depends on the Municipality of Rotterdam's own agenda to determine whether this is appropriate."

HOUVERS, Technology manager from the private sector: "With private investment… and the government pays for the use of the OUP."

RAFAAT, Social science specialist: "But that is a decision for the city. So, I think it should be financed by public funds in order to safeguard public values."

PSAKI, Smart city expert from a knowledge institute: "By public funds. Other services can be funded through public or private investment, but the OUP should be financed through internal (tax) revenues in order to ensure public ownership."

Van der Heijden, Digital City program manager: "In addition, another critical concern is related to how to improve **trust** in OUP. Trust seems to play a crucial role in the functioning of OUP. How can trust be fostered, and who needs to be trusted?"

KOU, OUP strategist from the Municipality of Rotterdam: "Mutual trust between public and private sectors is needed to develop the platform and engage with all ecosystem stakeholders. The private sector is distrusted, for instance, because of their 'single-minded pursuit of profit'. Trust in the private sector by the government can be increased by improving the integrity of companies, i.e., the perception that companies have principles (e.g., accountability, inclusion) that are acceptable to the government. Also reducing the self-centeredness of companies, i.e., contributing to society beyond the profit motive, could enhance trust."

POWEL, Data-driven business developer from the private sector: "I would like to make a distinction between trust in OUP itself and mutual trust between public and private actors who are involved in OUP development and operation. How do we ensure that users trust in our platform? I think platform openness and transparency are key for trust in OUP itself, while using analytics on collected user data to offer services to those users can create distrust in OUP. Regarding mutual trust, there used to be a high level of trust in the public sector, but in the past few years that has become less and less; vice versa, the private sector finds the public sector not very reliable. It could be a challenge to change that mindset. I think trust in the government by the private sector can be increased by improving the government's capabilities, i.e., the skills, competencies and leadership characteristics in the domain of OUP."

HOUVERS, Technology manager from the private sector: "You [POWEL] raise a valid concern. I think trust is something that must be developed between the involved private and public actors. I personally don't have any upfront feelings of (dis)trust towards private partners. The other way around, I can imagine companies distrust the government to be a trustworthy development partner. I believe trust in the government by the private sector can be increased by creating collaborative experiences with the government."

RAFAAT, Social science specialist: "There is a lack of trust because society knows that data is used as a currency; but there is little transparency in how data is used. Transparency on data usage, ownership, consent, and appropriate control by data owner is key in the trust discussion. In addition, there is a legacy of disappointment

and mistrust, but both sides recognize or can understand the reasons for that, and are likely positive about doing better."

PSAKI, Smart city expert from a knowledge institute: "Thank you [RAFFAT] for bringing this issue up. The experience is that (local) government usually seems to lack competencies, funding skills for these disruptive innovations. If private OUP are endorsed by the government, this improves trust. Besides trust, citizen engagement is also seen as desirable and important for the success of OUP. But why does it matter?"

Van der Heijden, Digital City program manager: "Yes, citizen engagement is definitely needed for OUP to be successful. The citizens are the owners of much of the data, and they are the targets for much of the service delivery. Thus, engaging citizen enables data generated by citizens to be fed into the platform. We also see involving citizens as entrepreneurs and/or helping them to monetize their personal data."

KOU, OUP strategist from the Municipality of Rotterdam: "Citizen engagement is pivotal. The Open urban platforms are being developed primarily to enhance public services for citizens and develop new services. A supply-side approach without having citizens actively engaged at each step is bound to fail."

POWEL, Data-driven business developer from the private sector: "I disagree with your opinion; citizen engagement is not required for making public services work. I think this is more about businesses and the public sector being able to deliver the right services and products to citizens (as inhabitants as well as employees) than citizens having a very clear role in getting OUPs to work."

HOUVERS, Technology manager from the private sector: "For the success of OUP, I believe that it is important to engage citizens in the design of the platform itself as well as in the co-design of the services and apps that use the platform."

RAFAAT, Social science specialist: "Engaging citizens is not only to engender trust and to help manage their social communities but also to help define citizen needs, and it is a source of innovative ideas. For instance, think about a representative of the citizen-run energy cooperative that has just installed solar panels in a certain neighbourhood and that, as a follow up target, wants their neighbourhood to be carbon neutral in five years and reduce pollution and waste."

Van der Heijden, Digital City program manager: "It is, indeed, and I think citizen engagement is an issue that needs further discussion, but as the time is up, I want to thank you all for the fruitful discussion and close this session."

Part III: The Decisions

After the panel discussion, the Digital City program manager, Van der Heijden, went back to his office and scrutinized the main questions the City of Rotterdam would need to answer to effectively develop, implement, and operationalize the OUP.

First, Van der Heijden thought about the purpose of OUP. **Do we really know what ambitions for OUP are?** While all panel members indicate that the OUP is somewhat envisioned to achieve social value, environmental sustainability, and economic development, it remains to be decided as to which purpose should be the starting priority of the Municipality, or if all purposes should be included from the beginning – and whether the OUP is the right instrument to achieve such goals.

His *second* question was **what the appropriate form of governance for OUP** is and why the Municipality of Rotterdam should be involved in the platform, whether as the platform manager, platform owner, or both. Also, the public authority needs to decide which roles (e.g., owner, gatekeeper, investor, and/or user) the Municipality should play in the different stages of the development and implementation of the OUP.

Third, Van der Heijden thought about **how the costs of development and operation of OUP are financed**. As discussed in the meeting, what financing approach would be best for the OUP of Rotterdam?

Forth, Van der Heijden considered **what factors contribute to trust in OUP**, as well as how to improve mutual trust between the public and private sectors (and vice versa) in the development of OUP.

Finally, Van der Heijden wondered if we really understand **why we want citizens to engage with OUP.** What role do we see and facilitate for them: consumers, entrepreneurs, or co-creators?

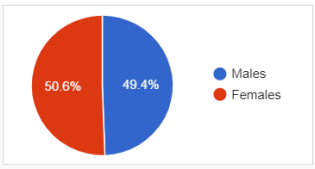
Appendix: Further information about the city of Rotterdam

Demographics of Rotterdam population

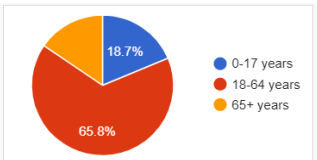
The municipality of Rotterdam is part of the Rotterdam-The Hague Metropolitan Area which, as of 2015, covers an area of 1,130 km^2, of which 990 km km^2 is land, and has a population of approximately 2,563,197. As of 2019, the municipality itself occupies an area of 325.79 km^2, 208.80 km^2 of which is land, and is home to 651,168 inhabitants. Rotterdam is diverse, with the demographics differing by neighbourhood. The city centre has a disproportionately high number of single people when compared to other cities, with 70% of the population between the ages of 20 and 40 identifying as single.[27] Those with higher education and higher income live disproportionately in the city centre, as do foreign-born citizens. Fifty-four percent of city centre's residents are foreign-born, compared to 45% in other parts of the city, while in the city centre 70% of businesses are run by foreign-born people. Nonetheless, this is not a comment on income, as 80% of homes in the city centre are rentals.[5]

Composition of Rotterdam's population

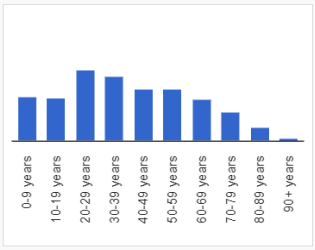
Rotterdam consists of 14 sub-municipalities: Centrum, Charlois (including Heijplaat), Delfshaven, Feijenoord, Hillegersberg-Schiebroek, Hoek van Holland, Hoogvliet, IJsselmonde, Kralingen-Crooswijk, Noord, Overschie, Pernis, and Prins Alexander (the latter being the most populous sub-municipality with around 85,000 inhabitants).[6]



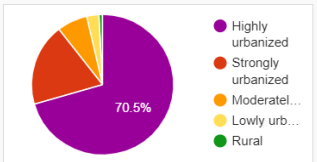
Gender (E 2021)	
Males	322,040
Females	329,591



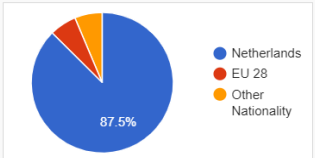
Age Groups (E 2021)	
0-17 years	121,710
18-64 years	429,068
65+ years	100,853



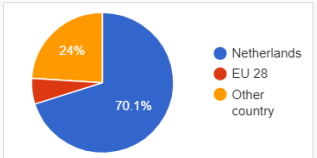
Age Distribution (E 2021)	
0-9 years	69,616
10-19 years	67,965
20-29 years	111,734
30-39 years	101,158
40-49 years	81,795
50-59 years	82,732
60-69 years	65,569
70-79 years	45,206
80-89 years	21,114
90+ years	4,742



Urbanization (E 2020)	
Highly urbanized	459,210
Strongly urbanized	123,360
Moderately urbanized	45,050
Lowly urbanized	18,170
Rural	5,370



Nationality (E 2020)	
Netherlands	570,084
EU 28	40,119
Other Nationality	40,954



Birth Country (E 2020)	
Netherlands	456,361
EU 28	38,705
Other country	156,091

Source: City Population[7]

[5] https://en.wikipedia.org/wiki/Rotterdam#Demographics

[6] An overview of the 114 neighborhoods and boroughs in the municipality of Rotterdam can be found at https://allcharts.info/the-netherlands/overview-municipality-rotterdam/

[7] https://www.citypopulation.de/en/netherlands/admin/zuid_holland/0599__rotterdam/

Municipal budgets, 2021

			2010	2015	2020	2021*
Municipal budgets in 1 000 euros	Total property tax	**1 000 euros**	164,394	227,889	254,028	260,855
	Sufferance tax	**1 000 euros**	22,627	23,300	22,692	21,984
	Tourist tax	**1 000 euros**	2,680	3,637	11,988	13,216
	Sewerage charges	**1 000 euros**	61,081	61,275	76,736	82,176
	Waste collection charge	**1 000 euros**	80,438	106,043	101,754	105,271
	Administrative fees for civil affairs	**1 000 euros**	13,478	11,769	8,382	8,525
	Burial charges	**1 000 euros**	4,761	6,627	4,964	4,858
Municipal budgets euro/inhabitant	Total property tax	**euro/inhabitant**	279	365	390	400
	Sufferance tax	**euro/inhabitant**	38	37	35	34
	Tourist tax	**euro/inhabitant**	5	6	18	20
	Sewerage charges	**euro/inhabitant**	104	98	118	126
	Waste collection charge	**euro/inhabitant**	136	170	156	161
	Administrative fees for civil affairs	**euro/inhabitant**	23	19	13	13
	Burial charges	**euro/inhabitant**	8	11	8	7

Source: Statistics Netherlands, CBS[8]

[8] https://opendata.cbs.nl/statline/#/CBS/en/dataset/83643ENG/table?ts=1628414415009