DIGITAL URBAN DEVELOPMENT

Reconceptualising the smart city as a design challenge from an interaction design perspective

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Reconceptualising the smart city as a design challenge from an interaction design perspective

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Dansk resumé

I disse år udfordres de fleste byer af den stigende urbanisering og den digitaliseringsbølge der rammer samtlige sektorer, fagområder, organisationer og mange aspekter af hverdagslivet. En presset offentlig sektor søger at udnytte digitaliseringen til at automatisere offentlige services og optimere den eksisterende infrastruktur. Dette sker mens ressourceknaphed og klimaforandringerne indsnævrer løsningsmulighederne. Vi kan ikke længere udbygge den eksisterende infrastruktur. Det skyldes ikke mindst, at infrastrukturelle udbygninger traditionelt kræver store investeringer og mødes af miljømæssige udfordringer, og at et højt serviceniveau i den offentlige sektor vanskeliggøres af mangel på både hænder og økonomi. I den forbindelse præsenterer byer og offentlige myndigheder ofte begrebet smart city som en løsningsmulighed. I smart city-begrebet indgår informations- og kommunikationsteknologi (IKT) som et bærende element, men derover synes der i de mange divergerende udlægninger af begrebet at mangle et grundlæggende svar på, hvordan man gør byen smartere.Dette er specialets udgangspunkt.

Jeg indleder specialet med kort at redegøre for byens lag som fysiske, institutionelle og sociale, som udgangspunkt for at forstå de karakteristika, der kendetegner byens digitale lag. Derefter gennemgår jeg feltet interaktionsdesign, som et selvstændigt genstandsområde, med henblik på at kunne inddrage dette felt som et udgangspunkt for at besvare specialet gennemgående spørgsmål: Hvordan kan interaktionsdesign bidrage som et teoretisk og metodisk udgangspunkt for en operationalisering af smart city-begrebet i konkteksten af en specifik by?

For at kunne svare på det ovenstående, gennemgår jeg desuden smart city-begrebet, først ved at opridse begrebets genealogi, og derefter gennem en kritisk læsning af de mange udlægninger af begrebet i rapporter, salgsmateriale fra IKT-industrien, konsulenthuse og akademiske publikationer om emnet. Jeg afrunder denne gennemgang ved at argumentere for, at begrebet er grundlæggende

problematisk, på grund af en gennemgående teknologisk determinisme og naive forestillinger om en effektiv og optimal by som endemål. Samtidig peger jeg dog på at der er en begyndende tendens til at tænke byen i et mere holistisk perspektiv, samt et stigende fokus på at lade samfundsmæssige udfordringer – og ikke teknologiske muligheder – drive udviklingen.

Derefter etablerer jeg begrebsrammen digital urban development (digital byudvikling), med henblik på at afgrænse og operationalisere smart city-begrebet. I denne præsentation argumenterer jeg for, at byen som helhed er uden for rammen af design på grund af dens emergente natur og store kompleksitet. I stedet argumenterer jeg for, at vi skal tilgå byens konkrete udfordringen ved at iscenesætte design cases som en konceptuel ramme for digital byudvikling. Ved at igangsætte design cases med både et strategisk og operationelt orienteret perspektiv, kan den underliggende designproces danne rammen for undersøgelser af det eksisterende, udforskning og udfordring af vanlige måder at tilgå problemstillinger på, og endelig kan cases fungere som prototyper på fremtidens smarte by. Samtidig danner designcases ramme for deltagelse og involvering på tværs af byens sektorer. Jeg foreslår i rammen af digital byudvikling, at ved at løbende igangsætte mange designcases, der hver især dækker specifikke arbejdsområder og udfordringer, så er det muligt at udforske den lokale smart city vision og samtidige løse konkrete udfordringer med et bredt holistisk perspektiv.

Dette leder hen til en eksemplificering af begrebsrammen i form af specialets design-undersøgelser. Indenfor rammerne af et lokalt smart city initiativ, Smart Aarhus, har jeg deltaget som interaktionsdesigner i to design cases. Både Smart Aarhus og de to cases præsenteres i specialet, og jeg redegør for casenes bidrag både individuelt og i forhold til Smart Aarhus. Dette leder hen til en diskussion af digital byudvikling med udgangspunkt i de to design cases og perspektiverne i at udnytte design cases som en strategisk undersøgelsesform og løsningsforslag på et praksisnært niveau. I specialets afrundende diskussion udforsker jeg specialets bidrag og udfordrer grænsen for digital byudvikling.

Jeg konkluderer specialet ved at argumentere for, at design cases som et muligt udgangspunkt for at operationalisere smart city-begrebet kan udfordre og udforske det eksisterende og det mulige. Ud fra de to design cases bidrag til Smart Aarhus, konkluderer jeg endvidere, at det er muligt at åbne op for de mange data, myndigheder indsamler og inspirere til nye løsningsforslag. Den største udfordring er at gøre de specifikke erfaringer og udfordringer på det operationelle niveau tilgængeligt som viden på det strategiske niveau.

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1 INTRODUCTION

The computer has long since left the laboratories wherein it was conceived and has slowly been introduced to the work place, home and every aspect of everyday life (Grudin 1990; Bødker 2006). In accordance with Weiser's (1991) vision for the computer of the future, where sensors, information and communications technology (ICT) are increasingly becoming invisible and embedded in the world around us, the physical city is to a greater extent augmented by a complex digital layer of ICT infrastructure, IT-system, Internet services, and location-aware applications (Mitchell 1995; McCullough 2005; Komninos 2006). Even the facades of buildings are being transformed into interfaces with urban screens and responsive media facades (Brynskov et al. 2009), while the flow of the city is becoming more regulated by automated systems (Hall 2000). Personal devices, such as the smartphone, are increasingly the primary interface to the complex digital urban layers of the city (Satchell 2009; Dourish and Bell 2011). These devices enable us to locate a specific restaurant within walking distance, and at the same time our interactions generate vast amounts of data on the services we use. We all experience how ICT lets us communicate, search the internet and connect to public and commercial services from any point in the city, while at the same time we are unaware that we are interacting with, and generating input, to the increasingly complex and invisible digital urban layer (Greenfield and Shepard 2007; Greenfield 2006). This opens up for an apparently endless line of possibilities in regards to service innovation, city management, optimisation and automation, but also challenges the way we experience and use the city (Greenfield 2006; Brynskov et al. 2012).

Half of the world population lives in cities and the rapid urbanisation will continue in the future (UN-DESA 2012). This is challenging cities on almost all areas, as the pressure from the population growth creates environmental, social, and economic challenges towards sustainable urban growth (Cohen 2006; Keivani 2010). This means that resource scarcity, access to clean water and healthy sanitation is a dominant challenge for cities, as well as the rising pressure on the overall physical infrastructure (Cohen 2006; Washburn and Sindhu 2010). Cities are increasingly competing for investments, resources and attracting international business and talent globally (Keivani 2010). Furthermore, smaller cities with under half a million residents are both competing with the mega-cities (Giffinger et al. 2007), and projected to face most of the urbanisation (Cohen 2006). In western societies this is further expressed in demographic changes that will pressure the public sector (Steinert et al., 2011), while increased urban poverty is the key challenge in developing countries (Ooi and Phua 2007; Cohen 2006).

As a response to the challenges outlined above, cities, policy-makers, consultancies, industry and research communities are turning their attention to the smart city as a proposed solution. But the smart city term is ambiguous and eludes a clear definition; it is used in various contexts, by a diverse range of stakeholders. Thus the term stands out as pluralistic, both in interpretation and practice. A common focal point for the many interpretations is the utilisation of ICT as the key component in the development of the city of the future. In relation to smart city, ICT is staged both as a driver of economic growth (Arup 2011; Steinert et al., 2011), an instrument to manage the city (Kehoe et al. 2011; Arup 2010), a platform for increased social inclusion and accessing public information (Patridge 2004; Deakin and Waer 2011); and at the same time it represents a general technological fascination (Haubensak 2011; Hall 2000). The promise of a better and more efficient city, underpinned by ICT, is a prominent notion in the smart city. The consultancy Arup presents the following image of the future city:

> *"Imagine a real-time view of the city that simultaneously shows the flow of transport, electricity, communication networks and retail transactions. Such an integrated picture, magnified at the city level, reveals new social, economic and mobility patterns and drive efficiency gains and resource savings." (Arup 2011, p. 24)*

The underlying notions in the smart city term are far from unproblematic (Hollands 2008; Roche et al. 2012). The compelling vision presented above, is an example of what Dourish and Bell (2011) call technovisions – a proximate future where technical innovations almost magically solve present challenges. With the heavy emphasis on ICT, smart city is depicted as a *"wundermaschine"* (Rouche et al. 2012, p. 218), where integrated and complex networks of IT-systems and sensors, help city management ensure the uncomplicated and efficient flow of the city. This optimistic imagery often neglects the messy nature of the real world (Schön 1983; Bell and Dourish 2011) and ignores the complexity involved in developing and implementing IT-systems (Rouche et al. 2012). The increased focus on global competition, smart city benchmarks (Giffinger et al. 2007; Leydesdorff og Darkin 2011) and the overly optimistic vision creates a uniform and detached image of the city (Andersen and Pold 2012). Cities are far from identical, and focusing on the spatial and architectural 'form', while ignoring the local distinctions and social- and cultural heritage reduce the individual characteristics to apparent universal commonalities (Williams et al. 2009, p. 8). The smart city is primarily presented to and formulated towards decision-makers and city administration (see Washburn and Sindhu 2010; Arup 2011), innovation strategies (Arup 2011; Kuk and Janssen 2011), investments and the development of ICT clusters (Leydesdorff and Darkin 2011). There is a remarkable absence of a citizen-centred perspective and an understanding of social implications and excluding nature of technology (Star and Bowker 2006; Dourish and Bell 2011). Citizens are often depicted as a resource or factor (Nam and Pardo 2011), a parameter in a benchmark, (Giffinger et al. 2007), a measuring point or data source in the real-time city (Arup 2011), and a prototypical consumer of the services and opportunities provided by the smart city (Arup 2010). The simplistic description of citizens and the emphasis on

efficiency, administration and functions of the city, in turn neglects complexity and richness of everyday life lived in-between the buildings (Gehl 2007; Williams et al. 2009). While this quantitative view of the city is a consequence of the urban planners' birds eye perspective (Gehl 2007), digital technologies are beginning to dissolve the scales of the city, both for citizens, management and urban planners (Greenfield 2006, pp. 46ff.).

As a central part of the thesis, I argue that both the urban challenges leading to the interest in smart city and the inherent issues that challenge the term, resemble the kind of *messy* (Schön 1983), *wicked* (Rittel and Webber 1973; Buchanan 1992) and complex problems that are the fundamental subject matter of interaction design (Wolf et al. 2006; Stolterman 2008). This leads me to propose interaction design as a theoretical and methodological foundation for operationalising smart city concepts, with a focus on the following perspectives. Interaction design is about suggesting possible futures through scenarios, prototypes, and final products (Löwgren and Stolterman 2007). The result of a design process is at best suggestive and provisional (Brandt and Binder 2007), and a manifestation of the designer's interpretation of the design situation (Buchanan 1992). This means that the suggested designs and solutions are available for users, clients, and all stakeholders to interpret, discuss, use and re-appropriate (Krippendorff 1989; Redström 2008). Interaction design as a field has evolved and matured alongside new technological innovations, expanding the theoretical and methodological body of knowledge in accordance with challenges presented from new application areas and emerging forms of interaction (Grudin 1990; Bødker 2006). From a research side, interaction design is seeking new ways to address barriers, such as implications presented by ICT infrastructure (Edwards et al. 2010), as well as providing cases, methods and theories for understanding interaction design in an urban setting (Foth et al. 2009; Brynskov et al. 2012). Interaction design is user centred and departs from a basic awareness regarding the complex composition of stakeholders influencing design decisions (Nelson and Stolterman 2012). This is particularly central within Scandinavian system design, where there is a long

tradition of involving users as part of the design process (Ehn 2008; Iversen et al. 2010), and even taking side in an effort to democratise technology and empower the user, as was the case with the early participatory design initiatives (Bansler 1989a, 1989b; Ehn og Kyng 1992). Finally, there is an integrated understanding of the emerging nature of the design process and the necessity for an iterative approach (Gedenryd 1998; Löwgren and Stolterman 2007), where the designers move back and forth between seeking inspiration and concretising the design. These movements are manifested in the various representations, such as scenarios and prototypes, throughout the process as a means of expanding the understanding of possible designs further (Lim et al. 2008), probing (critically) into the context and situation being designed for (Dunne 1999; Fallman 2005), as well as an object for expressing ideas and communicating with stakeholders. While the above is my motivation for bringing interaction design to bear with the smart city concept, I am equally intrigued by the philosophical and theoretical curiosity the field exemplifies in its short history.

1.1 Thesis statement

The Smart City concept is diverse and open to interpretation and therefor difficult to operationalise in practice. However, in this thesis I will argue that the inherent challenges presented in the smart city concept and the movement towards a holistic and sustainable approach to digital urban development can be considered as a design challenge. This leads to the following research question:

> *How can interaction design provide a useful theoretical and methodological point of departure for operationalising the Smart city concept in the context of a specific city?*

1.2 Research methodology

The posed research question emerged through my participation in the smart city initiative Smart Aarhus and my work with two concrete design cases in relation to the initiative. The initial working hypothesis was *"How can interaction design contribute to developing a smart city?"* This evolved into the current research question through two key observations. First, the concept of a smart city seemed vaguely defined within the literature and an initial reading exposed the term as technologically deterministic, narrowly focusing on optimising and making the city more efficient, with a heavy emphasis on commercialisation. Through informal conversations and meetings with the participants in Smart Aarhus, they echoed my own returning question *"What is a smart city?"* Second, when reflecting on the prospective implications in the naive and optimistic presentations of the term, it prompted the question *"How do we make a city smarter?"* This question of 'how' emerged from the Smart Aarhus participants in their repeating request for the 'good' case, smart city solutions or an example indicating the business case and potential. Subsequently, this made me realise that operationalising smart city concepts and understanding what the smart city can be in a local context is a dialectic process.

Inspired by the design research approach put forth by Binder and Redström (2006) and Brandt and Binder (2007), I have adopted the notion of *questions, program* and *experiment* as my research approach. The authors have suggested a frame in which a research questions can be explored and exemplified within a larger (societal) context that resembles that of practitioners within the field. It is a useful way of grounding design research driven by interventions and experiments (Brandt and Binder 2007). They depart from the notion of a framing program, as the context for design experiments and interventions. The program is a concept from architectural and design practice, where a program is the brief or assignment describing overall goals, while leaving the approach open (Brandt and Binder 2007), opposed to the more traditional research programs within

academia (Binder and Redström 2006). Within the program, design researchers can engage in design experiments, interventions and subsequent evaluations among practitioners and peers. Within this frame design researchers can engage in research *in* and *through* design activities, as a means to providing theories for design, such as developing methods for practitioners, and theories on design, how and why we design (Fraylin 1993; Zimmerman et al. 2010). The approach differs from 'real' design in key areas. While doing design activities, the researchers are able to suspend commercial concerns, focusing on providing novel insights on design (Zimmerman et al. 2010). The design researchers are often more interested in critically exploring the program than providing a good solution to the problem statement. Design researchers thus uses the experiments and interventions as exploratory probes into the program, as a means to both understand the program and to make the research question open for examination and relevance (Binder and Redström 2006).

The program for my research is the smart city initiative Smart Aarhus. In a period spanning 17 months, from November 2011 until March 2013, I participated as part of the secretariat. The program has been explored through participatory observations (Flick 2006, p. 215ff.), informal conversations, as well as participating in interviews with key participants as part of the work in Smart Aarhus. Throughout my participation I have collected notes, reflected on meetings and observed the interplay between the participants, the different partners, and the development of the initiative. Within the program I have participated in two design cases as lead interaction designer and developer . During the underlying design process, I documented key events in the process and the outcome. Following each case, I did open ended interviews with a key participant, in order to understand how they experienced the process and outcome. These interviews have been transcribed and the central parts have been included in the appendix (see Appendix A and B) . The individual cases are design explorations in relation to Smart Aarhus and inform both the program and the posed research question.

In parallel, I have done an extensive literature review of the smart city term, critically examining existing definitions and related concepts in the convergence between ICT and the city. This influenced and informed the research question, my participation within Smart Aarhus and how I approached the design experiments.

1.3 Contribution

The main audience is interaction designer and practitioners within the realm of urban interaction design and the few researching and working in the cross section between developing, planning and designing in the digital layers of the city. Following this, the contribution falls within the following areas:

Digital urban development: The re-conceptualisation of the Smart city term in the context of interaction design is the main contribution of the thesis. By proposing digital urban development as a frame for operationalising the smart city term, I argue that it is a process in which practitioners shape the emergent smart city as well as their own understanding of the concept, through engaging in concrete design cases across stakeholders.

Smart city conceptualisation: In order to answer the research question, it is necessary to have some conceptualisation of what a Smart city is? Following the literature review on smart cities and outlining the genealogy of the term, I have presented and discussed the core definitions and inherent challenges in the term, as well as indicating the novelty in the smart city approach. I regard this as an independent contribution.

Smart city exemplars: The two design cases, and the resulting installations and prototypes, are a very concrete outcome of the thesis. They contribute as examples for the citizens, involved stakeholders and as a very tangible outcome of Smart Aarhus, showcasing some of the key aspects of the initiative. In that regard, they are design examples inviting further inquiry.

1.4 A note on structure

The thesis structure diverge somewhat from a classical approach in two areas. In a more traditional Danish approach, one departs from a research question and develops the point throughout the thesis – point last, while I have tried to expose my main argument and point from the onset in the introduction to the thesis – point first, and then expand throughout the thesis. This approach is partly motivated by own preference of writing, and partly because it is the dominant way of writing within the field of interaction design.I have structure the thesis as follows:

Section 2, Interaction design and the city, I introduce the notion of urban layers and the field of interaction design.

In section 3, I critically examine and conceptualise Smart city concept. This necessitates an examination of the genealogy is necessary partly because there is a lesson to be learned from preceding initiatives, and partly due to the pluralistic and immature nature of Smart city. This leads to an exposition of the smart city term through a critical reading of the publications provided from ICT industry, consultancies and recent research on the subject. Finally I sum up the section with a conceptualisation of the smart city term and setting the challenges for operationalising the term.

In section 4, I build up my reconceptualisation of the smart city term with theoretical and methodological perspectives from interaction design. The section begins with a brief examination of the relationship between digital urban development and existing urban planning traditions.

In section 5, I exemplify digital urban development, through the presentation of two design cases. This will lead to a presentation of the findings in relation to Smart Aarhus. This leads back to digital urban development in section 5.5 and 6,

to discuss the findings in a broader context.

In section 7, I will conclude the thesis by answering the research question and present the central findings. The presented research have raised more questions than it has answered, so I will end the thesis by presenting possible avenues for further research in relation to the core contribution.

1.4.1 Literature review

The thesis' key areas, the smart city and interaction design, both contain broad and interdisciplinary perspectives and subsequently spans a broad range of topics, such as technology, innovation studies, urban studies, geography, economics, urban planning, architecture and social science. In my review of the smart city related literature, I performed a broad review of the literature, with a primary focus on publications from consultancies, ICT industry and core academic publications, such as *Town Planning Review* and *Journal of Urban Technology.*
When pursuing related sources in relation to the smart city genealogy, I have based by followed the quotations and references from the (few) core publications on the subject.

Concepts from interaction design are based on an extensive reading of design philosophy, design theory, interaction design literature and a broad range of academic publications from the leading journals and conferences within the field, such as *CoDesign, DesignStudies, Journal of Information Science* and *International Journal of Design*.

2 INTERACTION DESIGN AND THE CITY

In the following section I will position the thesis within the interaction design field and describe the relation to the city as a domain for design. This leads to a brief examination of the themes that are increasingly inevitable for practitioners and researchers alike when working in the cross section between interaction design, the city and digital urban development. The main purpose is to expand my argumentation from the introduction on the applicability of interaction design as a theoretical and methodological foundation for digital urban development – essentially answering the question: *why is interaction design a useful approach to operationalising the smart city term?*

2.1 Urban layers

In order to get a preliminary understanding of the city in the context of interaction design it requires a brief examination of the different layers of the city and the role of the ICT and emerging digital layer(s). When approaching the city as a whole – an assembly of people, physical environment, technology and institutions – and trying to grasp its physical, institutional and social structures, the notion of urban layers is a useful abstraction[1]. Figure 2.1, shows a simplistic overview of the three urban layers in a hierarchical order to illustrate how each layer underpins the following.

[1] The notion of urban layers stems from multiple disciplines all denoting their individual view of the city (see section 4.1. I have not been able to find a single coherent description, but it is often used in relation to describing technology, information and services as digital layers (Brynskov et al. 2012).

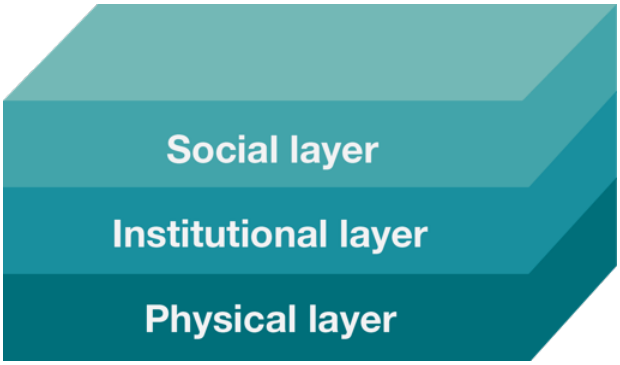


Figure 2.1: Urban layers

The physical layer of the city begins with the underlying geological layer. The condition of the geological layer, rivers and coastal lines has historically defined where settlements were made, the available resources and urban plan. The physical layer also contains the hard infrastructure, such as sanitation and electrical networks, as well as the streets, parks and buildings of the city. The institutional layer is where regulations, culture, financial, political and governmental structures are historically embedded. This includes the formal structures for working and collaboration across organisations and businesses. Finally, the social layer is comprised of communities, social relations and the everyday life unfolding in the city. This includes the informal social networks that cut across organisations and formal networks. The interdependency between the layers does not necessarily follow the hierarchical layout in the illustration above. The underlying geological layout and infrastructure clearly determine the continuous development of the city, and new infrastructure tends to follow the old infrastructure (Star and Bowker 2006). The above layers can still shape the physical layer, albeit with substantial investments and acceptance from both the institutional and social layers. Similarly, Gehl (2010) has pointed to this interrelatedness between the physical city and urban life, by noting, *"First we shape the cities – then they shape us."* (Gehl 2010, p. 19), referring to how the physical city determines how we move and socialise within the city. While the illustration and brief notes on the interdependence are very simplistic and deserves further examination, it is sufficient to proceed to the digital layer of the city.

2.1.1 Digital urban layer

A digital counterpart increasingly augments the urban layers introduced above. In Mitchell's *"City of Bits"* (1996), he explains how existing institutions, shops, banks, libraries and public institutions often mirror their existing services online. He sees the movement as a recombination of the virtual and architectural elements – *facade / interface, schoolhouse / virtual campus, hospitals / telemedicine* (Mitchell 1996, p46ff.). McCullough (2005) continues this observation, noting that just as the technological layers of the past, *"[. . .] architecture has acquired a digital layer"*, extending its reach (McCullough 2005, p. 47). Similarly, Brynskov et al. (2012) discuss this notion of a digital urban layer as the habitat for digital urban living through multiple cases and interdisciplinary approaches. The physical space converges with the digital and a complex digital layer comprised of infrastructure augments the urban life, services, information and interfaces (Aurigi 2006[2]), which Greenfield describes as *everyware* in his investigation of this new technological landscape (Greenfield 2006[3]). This digital layer is already entering the urban space, and it does not require a smartphone or another device to see it; it is visible through the signs, stickers and posters that promote wireless access or give cues to further information online, through identifiers depicted either as links to websites or various types of scannable barcodes (Pold and Andersen 2011).

I will briefly present two characteristics of the digital layer that, to some extent, disrupt the structure of the existing layers. One important characteristic is that the digital technologies dissolve notions of both space and time, in the sense that we can access the digital layer from anywhere at anytime asynchronously (Mitchell 1996, p.8 ff.). This is often expressed in the notion of the digital layer as something that is placed above or augments the existing city, and as such the layer spans the *vertical* dimension of the city and the existing urban layers (see figure 2.2). Another

[2] While Aurigi (2006) deals with the augmented city and electronic layers, his analysis on how this challenges urban planning and policy resembles many of the challenges described here (see section 4.1 .

[3] In recent lectures and through personal communication, Adam Greenfield has put forth the notion of the *urban stack* to illustrate the many urban layers, their interdependency and the resources required to reconfigure each layer. He also includes a digital layer in the urban stack.

important characteristic of the digital layer is how visibility in the physical space presented by Pold and Andersen (2011) implies a *horizontal* dimension. This means that the ICT infrastructure, IT-systems and sensors penetrate through the existing urban hierarchy and the digital layer increasingly dissolves notions of scale. Greenfield (2006) points to *everyware's* ability to span the scale of the room, plaza and urban space (Greenfield 2006), and it is exceedingly possible to change scale instantly on digital maps, add specific layers, such as traffic patterns or restaurant reviews provided by social networks, and compare information across the layers. Professional tools provide access to geological, geographical, environmental, statistical, demographic and social data, as well as the ability to display the information on geographic information systems (GIS), and even overlay the information in the urban space with augmented reality technologies. As such, the urban digital layer does not enter into the existing urban hierarchy as a layer from above, nor does it place itself at the side as a specific virtual space. Rather, it penetrates and spans the city along the vertical and horizontal dimension, as indicate in the illustration below. It is everyware as Greenfield notes and seeps and penetrates the existing city on every scale. Despite the beginning visible signs pointed at by Pold and Andersen (2011), the digital layer is, in its whole, intangible, elusive and invisible. As a 'material', it is a without qualities and can take any form and has little to no 'structural' limitations (Löwgren and Stolterman 2007, p. 3), and as such, it is often a challenge in itself.

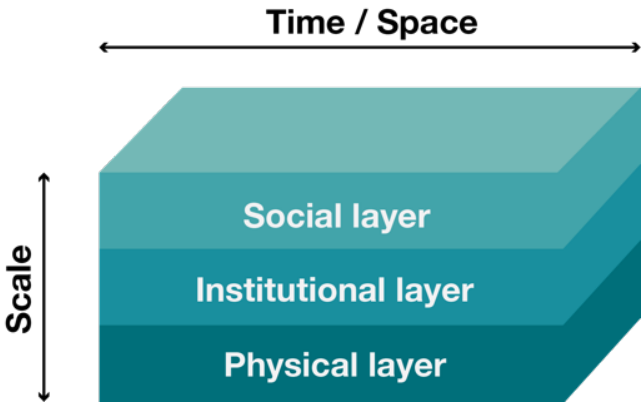


Figure 2.2: Dimensions of the digital urban layer

While many of the preliminary accounts of the digital urban layer are beginning to indicate some of the its characteristics, the digital layer itself is still emerging as a heterogeneous layer of digital technologies, layers of information, services and interfaces, provided by an equally diverse set of private and public stakeholders on varying platforms. The urban digital layer, with all that it holds, is still emerging and will manifest itself in the coming decades. While many are trying to understand what this entails for the city and urban life from different positions (Mitchell 1996; McCullough 2005; Greenfield 2006; Foth et al. 2009; Brynskov et al. 2012), interaction design will play a critical role in this exploration, in the combination of providing examples and probing into urban layer (see section 2.6). I will return to the role of the digital layer in relation to urban planning and its role in the smart city and digital urban development (see section 4.1).

2.2 From Human-Computer Interaction towards Interaction Design

The field of interaction design originates within Human-Computer interaction (HCI). This field initially emerged from a rising interest in the interaction between the early computers and the people operating them, and the first efforts in improving the interaction came from areas related to optimising the ergonomic and cognitive aspects of the relation between the operator and the computer (Grudin 2005, p. 47). As computers got more advanced and were able to process larger amounts of information, the focus shifted from the ergonomic studies towards studying cognition as the central element in the interaction, based on the premise that human information processing is similar to computational information processing. The ideal was to optimise the relationship between the two models in order to accomplish the specific goals and help solve concrete tasks (Harrison et al. 2007, p. 4). Following the first Computer-Human Interaction (CHI) conference in 1983 (Grudin 2005, p. 50), and the general uptake and success of the workplace computer, the sub-field of Computer-Supported Cooperative Work (CSCW) emerges in 1984 (Grudin 1994). The computer was increasingly a working tool and the theoretical focus of HCI is expanded from the narrow one-to-one relationship between the user and the computer, towards including the social

context of the work setting and the various activities supported by the computer (Grudin 1990, p. 264). This general movement within HCI has been identified as a transition from the first 'wave', with a focus on ergonomics, cognitive models, human factors and performance metrics, towards a second wave, with the focus on group settings, and collaboration in a work context (Bødker 2006; Harrison et al. 2007[4]) – expressed in Bannon's (1991) seminal publication titled *"From human factors to human actors"*. With this transition followed a similar widening of the theoretical and methodological scope. Particularly in the second wave and onwards, anthropology and ethnographic techniques influenced HCI (Dourish 2006), mainly through CSCW and the Scandinavian strand of participatory design (Asaro 2000), as a way of studying the social context around the technology (see for instance Heath and Luff 1992).

As computing became less confined to the workplace and the desktop, and various devices have been introduced into our homes, schools and increasingly the urban space, the third wave of HCI emerged (Bødker 2006). Harrison et al. (2007) describe this as a shift from seeing interaction as communication, to understanding interaction as situated action (see Suchman 2006), with an interrelated shift from emphasising objective and general knowledge towards recognising the role for subjective and situated knowledge (Harrison et al. 2007). The epistemological examination of the waves in HCI presented by Harrison et al. (2007) indicates a turning point in the third wave towards interaction design as a specific field apart from HCI. Winograd (1997) similarly recognises this transition, from seeing technology as the point of departure, towards taking the situation and the experiences of the users into account in relation to technology. In the movement from designing interfaces to understanding and working with 'interspaces' – and their open-ended and emergent nature – Winograd (1997) implicitly notes the same change in knowledge from rational and general

[4] Harrison et al. (2007) borrows the term paradigm from Kuhn (1996) to describe the transition within HCI. I prefer the wave terminology used by Bødker (2006), as the different strands within HCI are not replacing each other consecutively, as implied by the notion of a paradigm. They 'coexist' and should be seen as an expansion of the field and subject matter of HCI.

knowledge as a foundation for design, what Simon (1981) proposes as the science of the artificial, toward looking at situations, subjective impressions, human needs and values (Winograd 1997, p. 157ff.). A consequence of this is that interaction design is a design discipline, and neither a subfield of engineering, computer-science, nor HCI. Stating that interaction design is not the same as HCI or a subfield, is a bit controversial, mainly due to the interchangeable use of both HCI and interaction design (see Rogers et al. 2011; Stolterman 2008). However, Löwgren (2001) explicitly argues that there is a shift in what is valued as important use-qualities, whereas HCI traditionally focuses on usability and task efficiency, interaction design increasingly broadens the focus to include aesthetic, emotional and ethical aspects and qualities (Lövgren 2001, p. 32). The movement away from HCI is also reflected in the theoretical influences within interaction design. There is an increasing convergence with and influence from architecture, graphic- and product design, arguably due to the ability to embed devices in everything and the increased need for shaping the exterior 'chassis' of many recent interactive products. This fusion is expressed in Ehn's *"Manifesto for a Digital Bauhaus"* (1998), the increased focus on the design process and the designer (Löwgren and Stolterman 2007) and design as a research strategy (Binder and Redström 2006; Zimmerman et al. 2010). At the same time interaction design has seen a turn to design theory and philosophy as a theoretical foundation. This is exemplified with the turn to Schön's (1983) notion of the reflective practitioner (Gedenryd 1998; Halskov and Dalsgård 2006; Dalsgaard et al. 2012) and the recent interest in Dewey and American pragmatism[5] (Gedenryd 1998; Dalsgaard 2009; McCarthy and Wright 2010), which again indicates a general turn towards design theory within interaction design, rather than HCI. According to Fallman (2003), interaction design is a design discipline as opposed to HCI. While HCI and interaction design are often used interchangeably, I will continue to argue

[5] This recent turn towards Dewey (often beginning with "Art as Experience" (1934)), can be seen as an inevitable step following the popularity of Schön (1983; 1987; and Wiggings 1992), who himself draws heavily on ideas and the epistemological (and ontological) emphasises practice presented by Dewey (1916; 1934). Activity theory is another theoretical influence, mainly within HCI, that emphasis practice and individual actions as an analytical departure point (Rogers 2004).

throughout the thesis that there are different variations of interaction design, prominently a Scandinavian strand (see for instance Lövgren and Stolterman 2007) and an American strand[6] (see for instance Rogers et al. 2011), which in turn can be traced back to the aforementioned change in how we research, evaluate and emphasise the role of technology.

2.3 Scandinavian themes

The notion of the Scandinavian strand of interaction design introduced above is commonplace if one has studied interaction design at Aarhus University. The Scandinavian roots are reflected throughout the curriculum, methodologies and general approach to systems. The prime focal point within the Scandinavian strand is the emphasis put on involving users throughout the process, as well as acknowledging the importance of siding with the future users of the technology, as opposed to serving narrow interests of the commissioning stakeholders. While participatory design evolved in America, England and Scandinavia around the same time, in an effort to involve the users of technology in the process of designing the systems (Asaro 2000), the Scandinavian strand took a critical position towards the introduction of technology to the workplace, and sided with the workers and their union. This was done partly to strengthen the union's ability to influence the introduction of technology at the workplace (Bansler 1989b, p. 94), and partly to question the narrow focus on rationalising the work through new technologies, leading to an increase in work-related accidents and layoffs. The long-term goal of the project was "workplace democracy" (Bansler 1989a, p.13ff.). While this entails an ideological and political outset with varying success (Kensing and Blomberg 1998), the work by Ehn and Kyng (1991) in the UTOPIA projects provided techniques for actually involving workers in the design of the tools and technologies for the workplace (Kensing and Blomberg 1998, p.171). In the project, Ehn and Kyng co-developed preliminary editions of the future systems in cardboard, so-called mock-ups, with the workers. The intention was

[6] I am well aware that interaction design are very diverse and complex field from a practitioners perspective, and only identifying two strands is a rough generalisation worthy a further examination elsewhere. But it resembles and relates to the dual origins of participatory design (Asaro 2000), and as such it is adequate within the scope of this thesis.

to create tangible and understandable versions of the future artefacts, through envisioning the future workflow between typographers and journalists (Ehn and Kyng 1991). Most notable is the underlying effort to support the co-existence of different professions, in a work situation where especially the typographers slowly lost their role in the printing process (Ehn and Kyng 1991, pp. 171 and 193ff.). The field of participatory design has since matured, but discussions regarding the role of politics and methodology continue (Beck 2002; Kensing and Bloomberg 1998; Bødker and Iversen 2002).

Recently, Iversen et al. (2010; 2012) have argued for a return to what they consider to be the core of participatory design, namely the underlying values – needs, goals, desired mode of conduct or end-state (Iversen et al. 2012). The authors argue that through the concepts of cultivating, developing and grounding values throughout the design process from all stakeholders, the designers can ensure the longevity of the developed solutions through the firm grounding of the underlying values in the existing everyday practice (Iversen et al. 2012, p. 99ff.). This emphasis on values, however vague they may be, indicates a movement away from end-users as the primary participant towards including a wide range of stakeholders throughout the process to balance different needs and desires across the complex landscape of stakeholders. Furthermore, it demonstrates another important aspect in the Scandinavian strand of interaction design, namely the continuous engagement with the surrounding society and emphasis on the role of cases in relation to research, instead of isolated prototypes conceived in a laboratory. Both Iversen et al. (2012), Brynskov et al. (2012) and many other recent research initiatives and publications, reflect this interest in working with industries, stakeholders, and users in design cases as a way of extending the understanding of the field.

The above indicates a broader and more responsible role for the interaction designer. Bødker (2006) asks for *"[. . .] a commitment from the designers to users to ensure that design truly benefits users"* (Bødker 2006, p. 6), pointing to the

responsibility for the designers to take a broader perspective on interaction design, rather than merely orienting design towards products and increased consumerism. This underlying emphasis on ideology, values and the importance of supporting everyday practice for future users, is reflected both in Bødker (2006) and Iversen et al. (2012). McCarthy and Wright (2010) regard the designer as an emphatic listener who includes the whole life of the client or user in the interpretation of their wishes. In the case of McCarthy and Wright (2010) it is often a very personal and specific design (see for instance McCarthy and Wright 2010, p. 42ff.). The interaction designer is increasingly seen as an empathic interpreter that examines the initial desires and values expressed by stakeholders, and then transforms the client's desiderata into an outcome that is an *" [. . .] expected unexpected outcome."* (Nelson and Stolterman 2012, p. 42). This is done through analysis, inquiries, refinement and experimentation (Nelson and Stolterman 2012; Iversen et al. 2012). This both entails and acknowledges the tacit dimensions of designerly ways of knowing and making judgements in design (Cross 1982; Nelson and Stolterman 2012). Furthermore, it makes the interaction designer responsible for creating more than just a consumer product and taking active part of the felt life of future users. It is not just a question regarding the immediate longevity in the context of the stakeholder's everyday practice, as emphasised by Iversen et al. (2012). It also regards the larger societal context wherein the design is placed, as interaction design potentially influences larger groups in indirect and complex ways (Löwgren and Stolterman 2007, p. 33). This is part of the theme of the next section.

2.4 Wicked problems in interaction design

The movement away from traditional HCI and computer science as theoretical and methodological foundation, towards recognising interaction design as a design discipline, signifies a movement away from seeing interaction design as a problem-solving activity, towards understanding it as a complex way of setting problems. This notion of problem setting comes from the heavy influences on interaction design by the work of Schön (1983), and his discussion of the limits of

instrumental problem solving based on scientific theory – Technical Rationality – and in parts, by his proposed alternative of putting emphasis on the reflective practitioner. According to Schön (1983), by emphasising problem solving, we ignore the act of problem setting – *"[T]he process by which we define the decision to be made, the ends to be achieved, the means which may be chosen."* (Schön 1983, p. 40).

With a similar outset in the challenges presented to policy-making and planning around societal issues, Rittel and Webber (1973) propose the term wicked problems. Wicked problems are inherently different from the more 'tame' and confined problems dealt with by natural science. Wicked problems affect large parts of society, involve multiple stakeholders, professional areas, and include nearly all public policy issues (Rittel and Webber 1973, p. 160). Rittel and Webber have identified ten distinguishing properties related to these wicked planning problems. I will shortly layout the most defining characteristics based on their description. The solution to a wicked problem depends on the problem articulation and representation – the problem setting, in Schön's terminology. This means that the way one frames or interprets the problem initially, immediately determines the consecutive steps towards solving the problem. Therefore, wicked problems cannot be defined without prescribing the solution, and in that regard, a wicked problem can only be articulated, evaluated and solved within that frame of reference. This points to the open ended nature of wicked problems. They are never solved due to their pluralistic nature and endless possible solutions. The repercussions of the proposed solution will continue to affect society well into the future. Furthermore, they can only be evaluated as adequate, good or bad solutions, not definitively solved. The direct relationship between problem-setting and envisioned solution, makes every wicked problem unique, and implicitly moves the responsibility to the planner who made the initial problem setting. The notion of wicked problems has influenced design through Schön (1983), Buchanan (1992) and several others. Following Buchanan (1992) and Stolterman (2008), Bødker's (2006) call for a broader commitment from the designer, Wicked problems are part of the subject matter of interaction design,

since it shapes the way we practice and research design. First and foremost, it means that the designer is responsible for the initial problem setting and all that it entails, especially carrying the responsibility for the design process and the outcome. Furthermore, as Buchanan (1992) points out, this means that the finished design is a manifestation of the problem setting and the consecutive steps taken in the process. In that sense, the outcome represents the designer's judgement and interpretation, as much as the outcome is an artefact. This means that the created artefact is an argument or suggestion put forth by the designer (Buchanan 1992, p. 18; Brandt and Binder 2007).

2.5 Design as an iterative process

The shift from the goal oriented and problem solving focus in HCI, towards problem setting, involving users and refining values, indicates a similar shift from focusing on the final result, towards looking at how the process can accommodate changes in the design. The design process covers the individual steps from the initial conception or contact with a client, through formulating ideas, engaging users, building prototypes, towards a final design (Löwgren and Stolterman 2007, p.15). There are two dominant approaches to the design process itself, namely the *waterfall* model and the *iterative* approach (Larman and Basili 2003; Wolf et al. 2006). The first is a sequential model where the overall problem is divided into sub-problems, which are individually solved in a series of consecutive phases. This approach is rooted in classical rational problem solving (i.e. mathematics and engineering disciplines)(Gedenryd 1998, p. 31). The waterfall model consists of four phases: problem identification, planning the solution, execution, and finally evaluation (Gedenryd 1998, p. 31). As the name indicates, the model is linear and requires a comprehensive understanding of the problem(s) from the outset. The iterative approach is closely related to wicked problems, in the sense that the iterative model seeks to facilitate problem setting and recognise the emergent character of ideas, design suggestions, and requirements. In the iterative approach the individual phases are not separated as such. As the interaction designer moves from initial problem framing, towards externalising

the first ideas towards specifications and final design, the model complements the need to return to previous phases and reconsider core design choices (Gedenryd 1998, p. 96ff.). Löwgren and Stolterman (2007) have conceptualised the design process in three abstraction levels for the individual phases, *vision*, *operational image* and *specification*[7] for the preliminary part of the design process (Löwgren and Stolterman 2007, p. 17). In their model the key notion is the ability to move between the individual phases as conflicting elements appear. The iterative approach allows the interaction designer to return to previous stages in the process, if she encounters something that questions the vision, elements in the operative image, or even if fundamental issues arise during the construction phase. Furthermore, throughout the process, the designer moves between diverging, opening the design for inspiration and exploration, and converging, subsequently closing parts of the design and making design decisions (Löwgren and Stolterman 2007, s. 29ff.). This means that not only does the interaction designer engage with designing particular outcomes, they should also consider how the process is planned and designed towards including the dialectical interplay between the phases.

2.6 Interaction design as a mode of inquiry

The epistemological turn implied by Winograd (1997), Löwgren (2001) and Harrison et al. (2007), as well as the practice based theoretical influences, such as pragmatism (Dewey 1934) and activity theory (Rogers 2004), subsequently lead to a closing of the gap between research and practice. The term *research through design* is one way of conceptualising this relationship, where design activities can provide basic insights and a methodological frame for generating theories *for* design, generating theories and methods *for* practitioners, as well as and theories *on* design (Zimmerman et al. 2010). However, Stolterman (2008) distinguish between design complexity and research complexity, arguing for a fundamental difference

[7] While the model is simplistic, it has always puzzled me why Löwgren and Stolterman (2007) do not include construction directly in their model. When drawing so heavily on Schön (1983), who emphasised a dialog with material and in essence construction as a mode of inquiry (see Schön and Wiggins 1992), it is curious why Löwgren and Stolterman chose to treat construction as something separate in their model.

between the two modes of inquiry. Within traditional research the complexity involves describing reality on a general level and forming theories that are valid in the most basic cases, while design complexity entails an opposite movement from the general towards something concrete (Stolterman 2008, 58ff.), a specific design, or what Nelson and Stolterman (2012) call the *ultimate particular* (see below). This has fundamental implications towards research within interaction design, especially if it is driven by design activities and cases. Knowledge tied to a design case is aimed at the ultimate particular, while it is somewhat expected from a research community to also provide general insight, outline new theoretical horizons and push the field forward.

Fallman (2005) has a similar point in regard to research within HCI, where he distinguishes between *research-oriented* design and *design-oriented* research. In research-oriented design, the final design is the primary outcome. Here the focus is on solving the problem at hand, and subsequently this acts as a filter for how the task is approached. This mode of inquiry is directed at the ultimate particular, where the goal is to create an artefact that can work in a specific situation for a specific purpose (Nelson and Stolterman 2012, p. 31). In design-oriented research, and most relevant in the context of this thesis, the produced artefact is 'just' a means to an end. The primary, and to some extent generalised, knowledge production are insights into the design process and the activities surrounding design (Fallman 2005); design-oriented research can produce theories for and on design. But more interestingly, design-oriented research aims at *"[. . .] trying to grasp the complex interplay between people, technologies, and society and how this 'now' changes when a new artifact is introduced."* (Fallman 2005, p. 3, pagination added). In that sense, the process and preliminary artefacts take on the role of a probe into the existing situation, and as opposed to the laboratory probe, it is probing into the real world and. Thus, as Fallman (2005) argues, it becomes more related to social sciences and ethnography than to natural science; the artefact takes on a philosophical role as middle ground between (thought) experiment and a real thing (Fallman 2005, p. 3). This notion of the artefact as a probe is

expanded by Dunne (1999) to cover a critical approach to technology, society and everyday life, with the use of design artefacts as a way to provoke and explore the role of electronic products, as well as drawing attention to legal, cultural, and social norms underlying the designed artefacts (Dunne 1999, p.147). Mogens (1992) argue for using provotypes as a way of *"[. . .] provoking discrepancies in the concrete, everyday practice to call forth what is usually taken for granted"* (Mogens 1992, p. 22).

The research framework by Binder and Redström (2006) and Brand and Binder (2007), introduced in section 1.2, also provides design researchers a frame wherein they can address larger research questions through several design projects and underlying interventions *"[. . .] outside the confines of the research setting."* (Brandt and Redström 2006, p. 5). Brandt and Redström (2006) argue that the framework enables both evolution from inside of the program, that is how the program is fulfilled and the overarching research question is informed, and from the outside, in the form of the contribution to existing theories and practice. Dalsgaard (2010) extends the framework and describes how the program offers an accessible framework for understanding the, at times, diverging agendas within a project or design experiment, as well as providing a context wherein the differing agendas can be aligned through collaboration and participation.

2.7 Related fields

The most relevant fields to include in relation to interaction design in an urban context are *urban informatics* (Foth 2009; Foth et al. 2011), *urban computing* (Shklovski and Chang 2006) and the broader field of *pervasive computing* (Satyanarayanan 2001). While both urban informatics and urban computing deal with the intersection between the technology and the city, pervasive computing takes a broader perspective and includes all application areas where the technology is embedded in the world around us, with the aim of creating environments saturated with computing and communication capability (Satyanarayanan 2001, p. 11). The three areas share *ubiquitous computing* and

Wieser's (1991) seminal vision for the computer of the 21st century, as their starting-point. Back in 1991 – based on a series of examples from the research centre Xerox PARC – Weiser (1991) described how the computer of the future is vanishing into the background computationally, and the new devices; the taps, pads and boards are interconnected with wireless radio and infrared technology. The researchers envisioned a future with seamless integration across devices, reflected in the described scenarios, where the alarm clock can activate the coffee maker and the car will help predict traffic congestion and find an available parking spot (Weiser 1991). The technologies presented by Weiser and his colleagues at PARCs laboratories, make up the core of the technological vision and the replacement of the personal computer (Weiser 1991, p. 104). Weiser (1991) hints the technologies that make up his vision: small devices with low-power consumption, smaller displays and an underlying system that can deliver the software across the network that connects everything (Weiser 1991, p. 100). The technologies presented in relation to ubiquitous computing are, albeit in varying forms, available today. The taps, pads and boards resemble the present smartphone, tablets and screens.

While ubiquitous computing has influenced research and development of technology ever since, Bell and Dourish (2007) note that the future envisioned by Weiser (1991) and his colleagues is already here, and they argue that the seamlessly interconnected world presented in the scenarios reflects a simplification of the messiness the real world entails (Bell and Dourish 2007; 2011). All in all, the common departure in ubiquitous computing for the three related areas implies a strong foundation in technology as the primary research interest. Pervasive and urban computing deal primarily with developing the technologies and the necessary computational tools, without dealing directly with the interfaces or implications in embedding technology in facades, roads or even clothing. Urban informatics however, broadens out and combines several theoretical and methodological perspectives on place, technology and people, trying to understand how the new technologies shape urban experiences (Foth et al. 2011).

As such urban informatics closely resemble recent movements in interaction design and part of my thesis work.

2.8 Interaction design reaching out

To sum up, interaction design has increasingly matured into a field of its own, the recognition of being a design discipline has contributed to an increased level of engagement with the messy real world outside the traditional research setting. Within the Scandinavian strand of interaction design, there is a strong notion of engaging and co-constructing prototypes and artefacts with the future users, and recently broadening this to include all stakeholders. This reflects an emerging discussion of the role of interaction design within society and the ability to solve societal problems (Interactions 2007) and offers new critical and ethical perspectives on the role of technology (Fallman 2011). By acknowledging the change from seeing interaction design as a problem solving activity, towards wicked problems as the subject matter, there has been a turn towards designing as a mode of inquiry. This again underlines the relevance, the interest in and methodological manoeuvrability within the interaction design research community, that in turn supports engaging with the surrounding society, as within the early Scandinavian participatory design projects. I will return to elaborate on the answer to *'why'* interaction design is a useful departure point for answering the invertible *'how'* in relation to the smart city concept, in section 4.2.

3 SMART CITY

Because the smart city term and subsequent initiatives still are in their infancy, I will start with a review of related concepts where ideas about the role and form of the city have been shaped by contemporary technological progress and visions. I will refer to these initiatives as *techno-urban*[1] hybrids. An examination of the smart city genealogy will draw out the general implications in preceding approaches to ICT and urban development. This leads to a thorough examination of the smart city term, through a critical reading of the current definitions of the term. The genealogy and examination of the smart city definitions will lead to a dual summary. In this I argue that the smart city term is a challenge in itself, due to the persistent and unaddressed challenges drawn from the genealogy and the definitions, and I propose that despite the dominating challenges, there are important differences between ICT and urban development, as well as a general movement toward a more holistic and inclusive view of both areas present in the smart city concept.

3.1 Genealogy

Technology has always played a role in the growth and shaping of cities and society. According to Dodgson and Gann (2011), cities are the epicentres for the world's creativity and innovation, and they argue that historically the development and growth of cities are linked to technological innovation[2].

[1] Gross (1971) has previously used the term in relation to technocratic fascism and Clapp (2003) uses it to describe cities as the centre of a futuristic technological utopia. I use the term to denote the recurring contraction of the city and an imagined proximate future shaped by contemporary technology. Bell and Dourish (2011) call this Yesterday's tomorrows and technovisions in relation to their exposition of ubiquitous computing.

[2] Both Tarr (2005) and Graham and Marvin (2001) are good sources for a historical overview on general infrastructure and the city. I have chosen to limit my examination to ICT related infrastructures, although many of the characteristics of ICT infrastructure are issues present for all (urban) infrastructure. See the list on infrastructural characteristics in

Technology has provided new materials, building techniques and ideals for the built environment, allowing the physical city to expand upwards, while sanitation and electrification have enabled the city to grow in population and changed the way the city is used. Moreover, the car has had a huge impact on urban form and enabled the growth outward and the rise of the suburbs (Tarr 2005). As made clear by Tarr (2005) and Graham and Marvin (2001), new technological innovations tend to bring new ideas and initiatives, represented by adding a technical prefix to the city: the *wired, telecommunication, digital, virtual, cyber, augmented-, intelligent,* and *ubiquitous* city. In the following sub-sections I will examine the preceding concepts in order to draw out some of the challenges and implications that may persist in the smart city concept.

3.1.1 Wired city

One of the first techno-urban conceptions where ICT holds a prominent role in the service- and information structure of the city is what Dutton et al. (1987) called *wired cities*. The concept was introduced in the 1960s and 1970s, as the telecommunications and cable network infrastructure expanded through North America and Europe. The main goal of these wired cities was to utilise the existing infrastructure (i.e. telephone and cable network), as a platform for delivering public services and information to residents and local businesses, ultimately increase the quality of life (Dutton et al. 1987). Initially, wired cities often focused on public service, e-democracy and education, but this changed towards a commercial orientation as the infrastructure moved from the existing networks to commercially developed fiber and satellite based networks. According to Dutton et al. (1987), the underlying premise moved from seeing ICT as a means to create social and political change in the 1960s, to seeing ICT as a vehicle for economic growth in the 1980s. The wired city initiatives emerged as *televillages* or *informations districts* in North America and *teleports, telecities, telecottages* and *wired villages* in Europe, with varying emphasis on either public service and IT related education or developing business districts or clusters where ICT could

Star and Bowker (2006).

ensure access to the global market (Graham and Marvin 1999).

According to Graham and Marvin (1999) and Dutton et al. (1987), the wired cities shared a widespread deterministic approach to ICT and reflected a normative utopian view on the actual impact following infrastructural development as an enabler of social change and economic growth. Weingarten (1987) points to the large influence from research in technology, leading to a technology-driven approach emphasising the development of infrastructure as the primary goal. The close link between infrastructure and service providers created, especially in North America, a situation where the vision of the 'information highway', slowly turned into a segmented marketplace for both access and content, resulting in an increased social and economic polarisation (Dutton et al. 1987). The challenges present in the wired cities are, according to Graham and Marvin (1999), attributed to the optimistic expectations held by local decision makers. They further argue that policy makers too often connect telecommunications initiatives *"[. . .] with utopian and deterministic ideas of technology's beneficial and linear impacts upon the social, environmental and spatial development of cities."* (Graham and Marvin 1999, p. 109).

3.1.2 Digital city

In parallel with the growth of the Internet in the 1990s, the focus shifted from the cabled networks in the wired city, to web-based platforms for public information and services in the *digital city* (Ishida 2002). Digital city encapsulates this general movement from initiatives with an emphasis on infrastructural development, towards a broad range of initiatives mimicking the functions, institutions and services of the city online – initially as information portals or a single point of entry to the city's services online, where cities could display information and public service. Under the aliases such as *information* (Sairamesh et al. 2004), *virtual* (Jackson et al. 2011), *hybrid* (Nam and Pardo 2011a), *cyber* (Aurigi 2005) and *digital city* (Ishida 2002), the initiatives increasingly focused on broad access to online services for citizens (Jackson et al. 2011, p. 12ff.). The emphasis is no

longer on infrastructure – with the Internet came a new concept, *cyberspace*, where the city could be virtually reproduced. In North America the commercialisation of previous initiatives continued to dominate, and a large part of the projects originally initiated by cities were managed and developed by large Internet corporations like America Online (AOL) or Yahoo (Sairamesh et al. 2004). In Europe and Asia similar initiatives were established experimenting with various visual and metaphorical representations of the city and its functions, such as 3D elements and notions of a virtual town square or town hall (Oudshoorn et al. 2004, p. 34). Digital Amsterdam is an early example where the virtual version of Amsterdam aimed at creating an open platform engaging citizens in public debates and a broad investigation of the potential in new technologies (Oudshoorn et al. 2004). In Kyoto they introduced conceptual layers in the city, representing different views of the city, as well as providing tools for content generation and integration of real-time information from 'physical' Kyoto (Ishida 2002).

In Europe and Asia the initiatives focused on broad access and public services, while the initiatives in North America primarily aimed at integrating commercial services, such as marketplaces and entertainment portals. According to Jackson et al. (2011, p. 12ff.), the different approaches could be attributed to high levels of public and citizen participation throughout the development of the European and Asian digital cities, while the North American initiatives were developed by commercial partners (Sairamesh et al. 2004). Both Oudshoorn et al. (2004) and Jackson et al. (2011) point to a lacking social equality as a dominant issue in the different digital city initiatives. Large parts of the population, such as the elderly or social marginalised groups, were not taken into account when the digital cities were developed and implemented (Jackson et al. 2011, p. 13). There continues to exist an assumption about the generic user being all citizens, which in turn result in considerable social and economic polarisation.

3.1.3 Technopolis

During the 1980s and 1990s several *technopolis* initiatives started to emerge in North America, Europe and Asia. They differ from the previous initiatives in the way they focused on ICT as a driver in the transition from traditional industry based economies towards knowledge and innovation economies, as opposed to the previous emphasis on local residents, virtual elements and service delivery. Just as previously, the initiatives were strongly inspired by ICT research and focused on attracting the multinational technology and companies and establishing local ICT industries (Smilor et al. 1989; Oh 1995). The technopolis initiatives were large regional and national initiated development programmes with both a technical and a strategic level and a strong involvement from both universities and the private sector. The scope and large set of stakeholders is reflected in figure 3.1, drawn from Smilor et al. (1989) and their studies of a technopolis initiative in Texas, U.S.

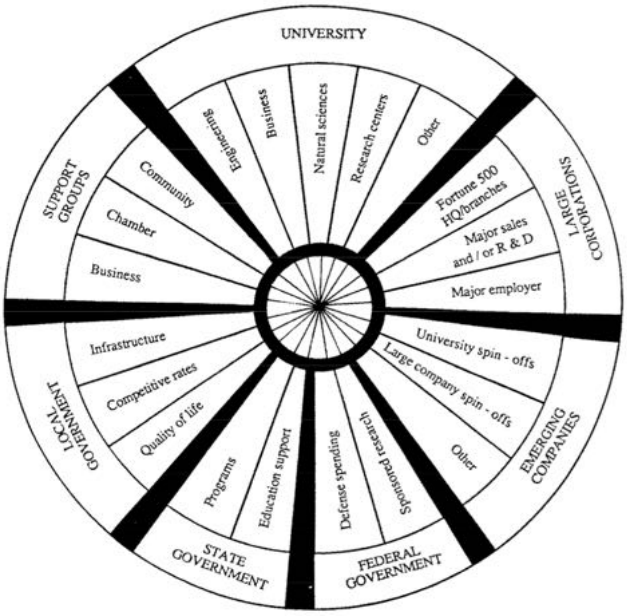


Figure 3.1: Technopolis wheel

According to Smilor et al. (1989), each stakeholder had a supporting role in the overall program. The universities both initiated concrete research programmes, attracted and contributed with funding, provided education, as well as ensured

knowledge transfer, in the form of spin-off companies or matching the educational profile with the needs of the industry (Smilor et al 1989; Oh 1995). Similarly, the local and national administration played a supporting role through initiation of the overall program and providing appropriate funding for research, education, infrastructural development, as well as ensuring an adequate living standard and quality of life, such as affordable housing, schools, recreational opportunities (Smilor et al. 1989, p 55). According to Oh (1995), the South Korean technopolis programme, can be traced back to the establishment of a science city in the seventies. With the strong governmental strategy and control, the South Koran technopolis programme created the foundation for the later U-city initiatives.

3.1.4 Intelligent city

During the 1990s, the concept of an *intelligent city* emerged in parallel with the digital city and technopolis. In the intelligent city the virtual platforms and marketplaces, which characterised the digital cities, converged with a focus on innovation and economic growth. This shift towards a broader innovation agenda marked a shift from looking at more basic ICT infrastructure towards including education and citizens as resource. Komninos (2006) presents the following definition:

> *"For us, intelligent cities and regions are territories with high capacity for learning and innovation, which is built-in the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management." (Komninos 2006, p. 13.)*

The architecture of the intelligent city is anchored in the local ICT or innovation cluster, supported by an institutional level facilitating knowledge transfer and innovation. The final layer is ICT and digital tools, creating *"a virtual innovation environment"* (Komninos 2006, p. 18) supporting knowledge transfer among participants across the cluster. In that sense, many of the elements of the technopolis (see figure 3.1), are transferred to the virtual platforms of the digital city, as tools and interactive technologies facilitating distributed problem-solving,

knowledge- and technology transfer and new innovations (Komninos et al. 2007).

Along with related concepts, such as the *learning*, *knowledge*, and *creative city*, the intelligent city represents a shift towards seeing human capital, education, talent and creativity, technology and knowledge transfer as pivotal elements in innovation and economic growth. It is no longer sufficient to have a strong ICT-infrastructure or a digital representation of the city, it is necessary to focus on education and the creative class (see Florida 2003), as components of the intelligent city.

3.1.5 U-city

As the ICT- and sensor technology becomes broadly available, there is a general progression away from the digital and virtual representations of the city, towards integrating technology *in* the city itself. Based on Weiser's (1991) vision for ubiquitous computing (see section 2.7), the concept of a ubiquitous city emerges mainly in South Korea as a result of their early fascination and adaption of ICT, mobile technology and spread of broadband (Hwang 2009, p. 373; Jackson et al. 2011, p. 16). Under the shorter term *U-city*, the concept represents a movement back to the infrastructural layer as the primary area of interest. While cables formed the backbone of the wired city, the infrastructure of the U-city relies on the recent technical progress and consists of a sophisticated layer of sensors, wireless technologies and IT-systems. The aim is transforming the city to a coherent automated system, which enables seamless integration and access to location-aware services and information, based on real-time information (Hwang 2009).

Despite the conclusion drawn by Oh (1995) on the challenges in and lacking success of the technopolis initiatives (Oh 1995, p. 265ff.), the U-city has a chronological, thematic and strategic connection with the preceding initiatives. While the technopolis programmes ran in the years from 1985 to 1995 (Oh 1995, p. 259), the next initiatives, leading to the formulation of a national strategy for U-

cities in South Korea, began in 1994 (Jackson et al. 2011, p. 16). In 2003 the central government formulated a strategy for establishing numerous U-cities in South Korea, with the specific aim of building new (U-) cities, supporting domestic ICT industry, increasing the quality of life and making the core technologies a national export (Hwang 2009; Jackson et al. 2011). In this way, the U-city strategy reflects a high degree of national involvement and control, just as in the previous technopolis programme. As part of the U-city the South Korean central administration played an active role, partly by improving the basic ICT infrastructure in large parts of Korea in order to pave the way for the new cities and attract private stakeholders, and partly by revising the legal and institutional framework towards removing barriers (Hwang 2009, p. 375ff.). According to Shin (2009), the development of U-city is extremely driven by technology, both in terms of a general development in the South Korean society, and innovation in technology is regarded as the central driver for economic growth (Shin 2009). He continues to note an absence of dealing with the social and cultural implications, which is explicated in the following quote made by a member of the governmental U-city forum: *"Our plan was to first arrange technologies, then think about other issues"* (Quoted in Shin 2009, p. 521). The predominant positive attitude towards ICT and technology in general, expressed in the U-city concept, is contested by Shin (2009). He points to a biased approach from the outset, driven by ICT research and involving mainly technical stakeholders in the formulation of the national U-city strategy. Shin argues that the citizens of the South Korean U-cities are participating unwillingly in a technological experiment, and questions the ethics of such an experiment (Shin 2009, s. 523).

3.1.6 Ambient city

While the 'purest' form of the ubiquitous city is the U-city initiatives in South Korea, similar initiatives exist in North America and Europe, under the common term *ambient city*. On the technical side these initiatives resemble the U-city, with the exception that they are often smaller and defined around a specific service, technology or area (Jackson et al. 2011). The narrow focus and monolithic nature

can be attributable to the competitive space and the commercial driven approach, which in turn result in a segmented implementation pattern. Commercial systems are increasingly being implemented on market terms, meaning that only service-specific systems are being developed, and only in urban areas with a commercial business model. This leads to both technical barriers in terms of a lack of standardisation across different stakeholders and application areas, as well as a growing social and economic polarisation. Furthermore, Jackson et al. (2011) point to privacy concerns as a dominating issue, especially in North America and Europe where there are concerns regarding the so-called 'surveillance city', as opposed to the more positive orientation towards technology represented in Asia (Jackson et al. 2011, p.34ff.). Unlike the U-city, the technologies and services of the ambient city are not interlinked or covering the entire city (Jackson et al. 2011, p. 15ff.). In that sense each system, albeit utilising 'ubiquitous' technologies, are monolithic in design.

3.1.7 Challenges for the smart city

Before progressing to the smart city term, I will briefly sum up the most pressing challenges left unaddressed by previous techno-urban initiatives. My point is that if the smart city should show success where the previous initiatives have failed, it is important to understand the persistent challenges and push these in the foreground of the smart city.

In general, there are predominantly optimistic and naive expectations to the potential and transformative powers of technology. This technological determinism is partly expressed in the initial vision for the future and the specific rationale behind the initiatives. In the wired and digital city, there was an initial conception that ICT-infrastructure and virtual platforms could be a new medium for public involvement, democracy, and social and economic growth. The underlying vision for the initiatives is often conceived within research and development of ICT, which is in turn adapted by decision-makers – both rhetorically and in their expectations. This one-sided dominance by technologists,

pointed out by Weingarten (1987) and Shin (2009), and the deterministic position towards the potential in ICT reflected by authorities and decision-makers (Graham and Marvin 1999), result in initiatives with a focus on what is technically possible, rather than what is desirable and realistic in a large urban context. This is expressed in the, often exaggerated, expectations of how technology will transform the society in the imminent future. The previously so widely presented idea that ICT would make cities less important as a geographical location, has been replaced by a renewed recognition of the importance of meeting face to face and the role of the city (Graham and Marvin 1999). The utopian expectations towards the technological advancement are time after time replaced by a realistic acceptance of the limitations, complications and implications regarding technology and the subsequent implementation (Oudshoorn et al. 2004; Jackson et al. 2011; Oh 1995; Shin 2009).

Moreover, each initiative shows that there are considerable commercial interests at play when technology is moving into an urban context. In some of the cases - not least the technopolis programmes and the U-cities - this is present in the initial visions for the future city, due to the close collaboration between authorities, decision-makers and the private sector. Here the central government makes large investments in infrastructure and technology research, as well as plays an active role in creating a market for the technology. While several of the initiatives started with a focus on public service and societal change, they are frequently 'overtaken' by commercial interests. This partly leads to a segmentation of the services and heterogeneous development of the infrastructure, and partly to a market driven by commercial interests instead of need; a technology-push opposed to technology-pull (Shin 2009).

Finally, there is a fundamental issue relating equal access and the democratic role of both these initiatives and technology in general. This is closely related to the previous challenges. In relation to equal access, Aurigi (2005) describes how authorities and a closed group of partners dominate the decision process

involved in the planning and policy related to urban ICT initiatives. This is most distinct in the technopolis programmes and U-city initiatives, but it is a general issue due to the narrow expertise involved both in governmental policy and ICT development (Oh 1995; Shin 2009). The citizen is often a 'user', in some cases part of an experiment without explicitly knowing, and with the increased commercialisation a 'consumer' of services and products (Aurigi 2005). The ability to participate in and affect the visions in the process is but only one side of the democratic challenge. The commercial approach creates both uneven physical distribution of the infrastructure and the subsequent service layer, as well as an unequal level of access. This is due to the excluding nature of infrastructure and technology, described by Star and Bowker (2006) as a division of the citizens into *"the 'information rich' and the 'information poor'"* (Star and Bowker 2006, p. 239), based on access to training, hardware and general IT-literacy. This social and economic polarisation is a consistent theme from the wired city to the intelligent city (Dutton et al. 1987; Jackson et al 2011), and it is only growing with the emphasis on the talented and creative citizens in later initiatives (Hollands 2008).

3.2 Conceptualising the Smart City

The smart city term has been used prior to the recent uptake, both in connection with previous concepts, such as the intelligent and the U-city (Jackson et al. 2011; Shin and Kim 2012), and in the visions for the future of ICT, digitisation, and urban development. Smart city is increasingly gaining attention from decision and policy-makers, ICT industry, consultancies, research programmes and academia in general, and it is used in a wide range of publications, sales material and reports, with diversity in interpretation and as part of different agendas. Equally diverse are the various smart city initiatives that are starting to show around the world. Reviews of the literature on the subject and the many accompanying examples, reveal that the concept of a smart city and the term are still heterogeneous, contested and elude a precise definition. Part of the discussion concerns how 'smart' is to be understood in relation to the city (Hollands 2008; Deakin and Waer 2011): Does it imply that the infrastructure is intelligent, efficient and automated?

Is it the intelligence, educational level or mindset of the citizens? Is it the number of technical innovations and patents produced by the local ICT cluster? Other descriptions concern the embedded visions and utopias (Andersen and Pold 2012; Roche et al. 2012) or its underlying constituents and genealogy (Nam and Pardo 2011a; Hollands 2008; Chourabi et al. 2012). Similarly the concept of a smart city is used in benchmarks to describe the characteristics and competitive position of the city (Giffinger et al. 2007; Caragliu et al. 2011), as part of innovation studies (Leydesdorff and Deakin 2011; Paskaleva 2011; Shaffers et al. 2011; Steinert et al. 2011), management, policy and strategic models (Cosgrave and Tryfonas 2012; Nam and Pardo 2011b), e-governance (Kuk and Jannsen 2011), social inclusion and the digital divide (Partridge 2004), green and sustainable growth (Steinert et al. 2011), automation and 'decision-making' algorithms (Hall 2000), specific technologies (Haubensak 2011), case studies (Mahizhnan 1999; Shin and Kim 2012) and not least, sales and communications material from technology vendors, consultancies and service providers (Washburn and Sindhu 2010; Arup 2011; Kehoe et al. 2011; CISCO 2012). The use of the term is versatile and the selected publications above reflect a similar academic and professional breadth. In the latest iteration, the term has seen a transformation from being used synonymously with other terms (see Mahizman 1999), to being a specific term, covering new concepts and approaches to the technology and the city, and previous initiatives are increasingly adapting the term (Deakin and Waer 2011; Shin and Kim 2012). The pluralistic nature of the term reveals a movement towards focusing more broadly on the issues at stake and including perspectives that are often dealt with in isolation by the preceding techno-urban concepts. The broad perspective is reflected in a tentative working definition put forth by Caragliu et al. (2011):

> *"We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance." (Caragliu et al. 2011, p.70).*

The definition put forth by Caragliu et al. (2011), is but one of many. Nam and Pardo (2011a) and Chourabi et al. (2012) have compiled an overview of the many conceptualisations presented throughout the various sources that deal with the smart city term. A brief review of the list, see figure 3.2, reveals that despite the diversity, there are some common focal areas. In the following, I will pursue four conceptual strands in an effort to critically examine the many definitions and underlying notions of a smart city.

3.2.1 Smart city as the solution

The smart city term is commonly introduced in conjunction with contemporary urban and societal challenges. As indicated by the definitions in figure 3.2, the notion of a smart city is often presented as challenge-driven and as the solution to larger economic, environmental or urban challenges. The juxtaposition of the smart city and global challenges are most prevalent in presentations from commercial stakeholders (Arup 2010, 2011; Washburn and Sindhu 2010), but are also included in the introduction to the term in the academic literature (Caragliu et al. 2011; Nam and Pardo 2011a,; Harrison and Donnelly 2011; Haubensak 2012; Schaffers et al. 2011).

The primary challenge for the smart city is typically presented as the rapid urbanisation – over half of the world's population lives in urbanised areas (UN-DESA 2012) – which in turn challenges the urban infrastructure, services, access to resources and living conditions (Cohen 2006; Washburn and Sindhu 2010), as well as city management. Especially Arup (2011) and Washburn and Sindhu (2010) emphasise the ability to utilise ICT infrastructure and integration of the administrative IT-systems, and make infrastructure and urban systems more efficient, through automation, coordination and data analysis. According to Arup (2011), the smart city will enable the creation of new digital services to citizens, and Steinert et al. (2011) foresee that 'smart living' can provide high healthcare and social service as an answer to the increase in population and demographic imbalance challenging the western societies. Closely interrelated

Source	Definition
Giffinger et al. 2007	A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens.
Hall 2000	A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens.
IBM research (Kehoe et al. 2011; CISCO 2012)	A city "connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city"
NRDC	A city striving to make itself "smarter" (more efficient, sustainable, equitable, and livable).
Toppeta 2010	A city "combining ICT and Web 2.0 technology with other organizational, design and planning efforts to dematerialize and speed up bureaucratic processes and help to identify new, innovative solutions to city management complexity, in order to improve sustainability and livability."
Forrester (Washburn and Sindhu 2010)	The use of Smart Computing technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation, and utilities – more intelligent, interconnected, and efficient.
Rios 2008	A city that gives inspiration, shares, culture, knowledge. and life, a city that motivates its inhabitants to create and flourish in their own lives.
Patridge 2004	A city where the ICT strengthen the fredom of speech and the accessibility to public information and services.
Arup 2011	An 'intelligent' or 'smart' city is one that meets its challenges through the strategic application of ICTs to provide new services to citizens or to manage its existing infrastructure.
Steinert et al. 2011	The concept of the smart city is a framework for a particular vision of modern urban development that recognizes the growing importance of information and communication technologies (ICT) — broadly characterized here as 'networks' — in driving the economic competi- tiveness, environmental sustainability, and general liveability of cities.
Batty et al. 2012	"[...] what constitutes a smart city, which we define as a city in which ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies."
Cohen 2013	Smart cities use information and communication technologies (ICT) to be more intelligent and efficient in the use of resources, resulting in cost and energy savings, improved service delivery and quality of life, and reduced environmental footprint - all supporting innovation and the low-carbon economy.

Figure 3.2: Smart city definitions (Nam og Pardo 2011a; Chourabi et al. 2012).

with the challenge posed by urbanisation, is what IBM identifies as a "new economic environment" (Dirks et al. 2010, p.1ff.). Partly due to the rising cost of urban management and need for infrastructural investments, and partly due to the conditions presented by recent economic crises, cities are under financial pressure, and at the same time they increasingly compete for investments, resources and talent in the knowledge economy, on a global scale (Griffinger et al 2007; Arup 2011). The envisioned solution embedded in the smart city is to optimise the management of infrastructure and resources, in order to lower the cost, through the utilisation of ICT (Arup 2011, Washburn and Sindhu 2010; Steinert et al. 2011), while at the same time trying to improve the overall 'smartness' of the city in order to attract investments, talent, and business (Giffinger et al. 2007). The final, and most dominant challenge to the smart city is the need for environmental sustainability. This cannot be separated from the increased urbanisation – cities consume 75 percent of the world's energy resources and stand for 80 percent of the global greenhouse gas emission (Keivani 2010) – but the environmental perspective is currently dominating the smart city literature (Arup 2011; Steinert et al. 2011; Mortensen et al. 2012). This is due to the larger societal goals on lowering carbon emissions and providing a sustainable source of energy, as well as to the concept of smart grid (see Amin and Wollenberg 2005, for a brief overview), which precedes the smart city and still defines large parts of the technical potential within this concept (Arup 2011).

The challenges are primarily used to contextualise the smart city and warrant specific initiatives, approaches, or technologies. Nevertheless, the challenge driven perspective is a defining characteristic across the definitions and presentations of the smart city conceptualisations and examples.

3.2.2 Smart city as an infrastructure

While many smart city descriptions depart from the urban and societal challenges, ICT, digital technologies and infrastructure are core elements in definitions of the smart city term, see figure 3.2. This entails establishing new technologies and

infrastructure in order to monitor and optimise the existing infrastructure. For the majority of approaches infrastructure is presented as a means to achieve an end. For Schaffers et al. (2011) and Washburn and Sindhu (2010), the work with the smart city begins with the development of a state-of-the art ICT infrastructure – broadband, wireless and optical networks, embedded sensors and 'smart devices' – as a foundation for the future service layer (Schaffers et al. 2011, p. 435). The infrastructure is not put forth as the end in itself, but a means to creating an innovation environment (Nam and Pardo 2011b), providing an administrative overview of the city (Kehoe et al. 2011; Arup 2011), and transforming the city to a business platform, where information and data is the new raw material in the city's value-chain (Arup 2011, p. 32). In the smart city, the ICT-infrastructure and the existing administrative IT-system should be integrated to a system of systems across organisations and sectors (Arup 2011), in order to providing a total administrative real-time overview of the city, such as the 'smart city' control centre in Rio de Janeiro. This centre provides an overview of the city through monitoring the traffic, energy distribution, and telecommunication, supplemented by computer simulations of weather and flood warnings (IBM 2013a), and is in many ways a manifestation of the vision for the real-time smart city presented by Arup (2011 p. 24).

The control centre in Rio de Janeiro is an example of how the IBM seeks to implement this system of systems in their measurable, seamless and intelligent city, where the raw data from the infrastructure enables automated regulation (Kehoe 2011, p.9ff.), which Hall (2000) describes as decision-making algorithms. In the discussions presented by Arup and IBM, the ICT infrastructure and the integration of the various IT-systems of the city, are expected to optimise the overall infrastructure (e.g. utilities and road systems), and subsequently to cut administrative cost and better the resource management. The promise of a more efficient and optimal city departs from a quantitative view of the city, exemplified by Arup's (2010) maxim: "if you can't measure it, you can't manage it" (Arup 2010, p 4). ICT-infrastructure is emphasised and positioned as the

primary answer to the challenges in many of the central presentations of the smart city (Hall 2000; Arup 2011; Kehoe 2011; Washburn and Sindhu 2010; Haubensak 2012; Schaffers et al. 2011). Furthermore, the turn to infrastructure and administrative IT-systems as a primary focus area tends to see ICT as something in the background, an underlying system of systems and something that runs underneath everything. The systems listed (Kehoe 2011, p. 9; Arup 2011, p. 16) are traditional infrastructure which can be made more efficient in a smart city, and not systems that can be accessed by citizens – apart from a few exceptions dealing with crowd-sourcing, online learning facilities (Deakin and Waer 2011), and e-governance (Deakin et al. 2011). But the predominant definitions of the smart city emphasise the integration of existing infrastructure with an intelligent (i.e. automated) administrative system geared towards better management.

3.2.3 Smart city as an innovation platform

The consultancy and research groups Alcatel-Lucent (2012), Arup (2011) and Washburn and Sindhu (2010) identify the societal challenges and technical innovations as a new opportunity for market creation and further business, service and technology innovation.

The idea of increased global competition and the need for innovation to sustain the wealth and growth of cities (Hollands 2008), have made innovation and business development an integrated part of the smart city definitions (Arup 2011; Kehoe 2011; Schaffers et al. 2011; Nam and Pardo 2011b; Steiner et al. 2011). In order to address the challenges, create new markets and economic growth, and attract investment and talent the city needs to focus both on turning itself into a platform for innovation and ensuring the right conditions for local innovation (Nam and Pardo 2011b) and global competitiveness (Kehoe 2011). According to Giffinger et al. (2007) and Caragliu et al. (2011) the city needs to focus more broadly in order to attract investments, talent and enable local innovation. Giffinger et al. (2007) points to parameters, such as educational level and flexibility of the population, and Caragliu et al. (2011) have exanimated smart cities in Europe

and shown that an existing creative sector and public transit systems are positives towards economic growth and wealth (Caragliu et al. 2011, p. 76ff.). Nam and Pardo (2011b) identify the orientation towards the smart city concept as a *"[. . .] comprehensive commitment to innovation in technology, management and policy"* (Nam and Pardo 2011b, p. 185). Hence, ICT and digital technologies are seen as enablers, while the cities are increasingly the Epicentre and driver for innovation (Schaffers et al. 2011) or 'living laboratories' for experimenting and developing new services (Vicini et al. 2012). Arup (2010; 2011) argue that the innovation and business potential lies both in the integration of systems, as well as the potential for innovation in the smart city. They envision the collected data from the various IT-systems, sensors, and the devices of the citizens, as the new raw material in the development and deliverance of new services (Arup 2011, p. 32). Not only does this real-time data provide insights that are useful when it comes to optimising infrastructure and management, they also provide information and data to the digital value-chain, as Arup puts it. Therefore, the infrastructure and the data it produces, and even data on citizen interactions such as smartphone data and purchases, are seen as an asset in the creation of markets (Arup 2011, p. 36).

Smart city is increasingly presented as a business opportunity or market useful for solving the connected societal challenges. This is either reflected through a focus on increasing the smartness of the city in a global competitive climate (Giffinger et al. 2007) or on the ICT infrastructure as an enabler of innovation (Nam and Pardo 2011b; Schaffers et al. 2011). Arup (2011) explicitly turns to the vast amounts of data provided by the 'system of systems', as a material for market creation and service innovation, and they see this in a larger smart city value chain. Despite the optimistic stance, both Arup (2011) and Alca-lucent (2012) argue that from a business perspective the business case and revenue models still are unclear and tentative (Arup 2011, p. 18; Alca-lucent 2012, p. 10ff.) Furthermore, Arup (2011) argue that smart city initiatives are still in their infancy and *"solving the social, economic and environmental challenges is not straightforward in practice, and will happen once those technologies make 'common sense'"* (Arup 2011, p. 18). Thus, the

innovation in the smart city is closely linked to the quality of the ICT-infrastructure and IT-systems available.

3.2.4 Smart citizens

When revisiting the list of definitions on 52, the role of the citizens in the smart city appears as part of the *"social infrastructure"* or to a large extent, as consumers or recipients of the services provided by the smart city. While citizens or people are acknowledged as a defining element as to whether or not a city is smart, the citizens are often included as a truism when focusing on new services and quality of life. From the more general perspectives of Giffinger et al. (2007) and Caragliu et al. (2011), the simplistic notion of the citizen can be attributed to the statistical examination of what smartness entails for the citizens on city competitiveness and creativity. Similarly, Nam and Pardo (2011) point to education and restate the argument made by Florida (2003), on the importance of technology, talent and tolerance. According to Nam and Pardo (2011) *"The label smart city therefore points to clever solutions by creative people."* (Nam and Pardo 2011, p. 287). They continue to point to communities and learning as a way of overcoming the digital divide. In their view, the human factor is both important in terms of citizens as a well-educated and creative knowledge workers, as well as participants in institutional dimensions of the smart city (Nam and Pardo 2011).

Washburn and Sindhu (2010), and to some extent Steinert et al. (2011), present a similar distant or abstract image of the citizen. They emphasise the citizen as a consumer of the new services. In their perspective, the smart city should enable the administration to provide efficient services, as well as optimise the existing sectors with ICT in order to provide better and more cost-efficient service. Washburn and Sindhu (2010) further argues, that the smart city uses information from citizens, such as traffic data, to provide efficient services in relation to existing infrastructure. The citizens themselves play a vital role in providing the city with this information, not least in Arup's vision (2010, p.7), and for both Arup and others, citizens appear to participate in the smart city entirely via sensor data and

information from social networks. But Arup primarily present this in relation to service innovation, and thus citizens are consumers or a part of the city value-chain (Arup 2011, p. 33). While Nam and Pardo (2011a) and Patridge (2004) stress the importance of addressing learning capabilities, social inclusion and the digital divide as important factors regarding citizens in the smart city, the smart city citizens are portrayed as technologically apt consumers of new services. Furthermore, efficient and optimal service and urban user experience is idealised, often related to an economic and cost-efficient perspective (Arup 2010; Washburn and Sindhu 2010; Steinert et al. 2011), lacking a nuanced image of everyday life in the city.

3.3 The problematic smart city

The critical examination of the smart city definitions reveal a set of challenges that resembles those left unaddressed in preceding techno-urban initiatives. The technological determinism and the optimistic expectations toward the use and integration of technology dominating previous initiatives, appear to be restated as part of the smart city definitions. This is expressed both in the visions for a more (cost) efficient and optimal smart city, where infrastructure and services are maximized, and in the emphasis on apparently untapped business potential in the data produced by the smart city and its citizens. Hollands (2008) criticises the smart city concept for being predominantly deterministic and Roche et al. (2012) point to the underlying expectations of technology as a *"wundermaschine"*, a salvation in spe (Roche et al. 2012, p. 218). Hollands (2008) further notes that the perceived linear relationship between urban regeneration and technology has become a mantra to cities and that it is implied that *"[. . .] somehow information technology itself will deliver the smart city a priori."* (Hollands 2008, p. 310). This deterministic position is directly reflected in the U-city concept and continues to dominate in the smart city, where several argue that the progress to become a smart city starts with the development of a sophisticated ICT infrastructure (Hall 2000; Arup 2011; Washburn and Sindhu 2010; Shaffers et al. 2011).

And just as in the preceding techno-urban initiatives, economic growth is an important driver in the smart city definitions. Hollands (2008) argues that the smart city concept demonstrates a neo-liberal turn. This is expressed in the fact that cities are increasingly 'wed' to the idea that they need to compete on a global scale for resources, talent and the favour of the mobile global IT-industry (Hollands 2008), which in turn leads to a situation where cities increasingly, and self-congratulatory, use the label 'smart' in marketing strategies and city promotion. Furthermore, cities increasingly offer themselves and their inhabitants as a resource for the mobile IT-industry, hoping for some economical effect until the industry finds a better 'deal' elsewhere (Hollands 2008, p. 314). According to Hollands' (2008) critique, this increases social and economic polarisation, and more importantly, cities start catering to the IT-industry, rather than serving the needs of local citizens (Hollands 2008, p. 311). Therefore, by emphasising technology as a driver for economic growth and commercialisation, the smart city risks repeating the tendency reflected in the genealogy. Following Hollands (2008) argument, the smart city risks increased social and economic polarisation.

Finally the visions of the smart city are primarily presented in optimistic and positive terms from consultancies, ICT-industry and in innovation studies, with the city administration and decision-makers as the primary recipient (see Arup 2011; Washburn and Sindhu 2010; Kehoe 2011This resembles the research driven approach shaping the preceding techno-urban initiatives, with Shin (2009) explicitly criticising the narrow interest groups participating in formulating the strategy for the U-city, with both social and ethical implications. Across the previous techno-urban approaches there is little to no regard for issues around access and IT-literacy, which in turn creates social and economic exclusion and polarisation. The democratic implications of infrastructure and technology are often raised within research (Graham and Marvin 2001; Star and Bowker 2006; Tarr 2005), but the smart city definitions reflect a naive commonplace notion of the citizens, subsequently questioning whether the smart city covers the less creative and smart citizens (Hollands 2008, p. 312). Therefore, there is an inherent

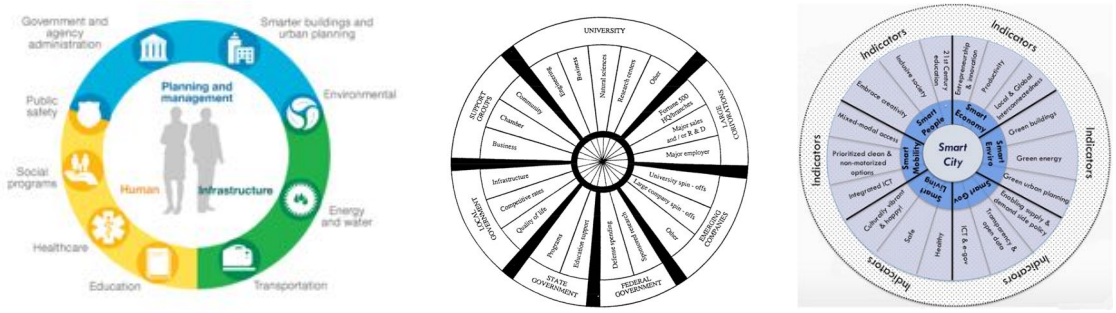
danger that initiatives will fail to include the diversity of citizens in the process of formulating what smart entails for their city, as well as in using the new smart services once they are implemented.

I am not the first to highlight these fundamental challenges in relation to the smart city or the increased focus on technology in urban development (Graham and Marvin 2001; Tarr 2005; Aurigi 2006; Hollands 2008; Greenfield 2006; Bell and Dourish 2011; Pold and Andersen 2012). This points to a fundamental implication within the smart city term, namely that it is a challenge in itself to begin operationalising the underlying ideas in the context of a specific city, without neglecting the challenges that emerge through examining previous initiatives and the common smart city definitions. I will argue, that the merit of the smart city is to specifically address the challenges put forth, instead of blindly introducing technology into the city.

3.4 Towards a smarter city

Though the smart city definitions are generally problematic in the same areas as their techno-urban predecessors, at the same time they represent a subtle movement away from these. While both the technopolis programme and intelligent cities represent a broader scope, they focus narrowly on the role of ICT in innovation and knowledge transfer anchored in a local technology cluster. As figure 3.3 indicates, there are some similarities between technopolis and the smart city, but a closer inspection shows that while technopolis focuses on aligning the stakeholders and institutions of the region towards knowledge transfer and innovation within the local ICT cluster, the smart city emphasises a cross-sectorial perspective (Kehoe 2011) and multiple indicators of how smart the city is (Cohen 2013, inspired by Giffinger et al. 2007). In relation to this, Arup (2011) advocates for establishing strategies, collaboration and a shared smart city vision, across the 'hard' infrastructure, the technical and digital infrastructure, and 'soft' infrastructure, such as ICT-strategy, management and citizen engagement. In order to broaden the smart city concept up to include the entire city, and not only

city administration or the local ICT industries, I would argue for combining Arup's call for a shared vision with Nam and Pardo's (2011a) call for broad collaboration across functional sectors and an equally broad spectre of city stakeholders (Nam and Pardo 2011a, p. 288).



(a) IBM 2013b (b) Technopolis (c) Cohen 2013

Figure 3.3: The holistic smart city (wheel)

Arup (2011), Nam and Pardo (2011a) and Cosgrave and Tryfonas (2012) all point toward strong leadership and a new role for policy and strategy, as keys to success in smart city initiatives. Cosgrave and Tryfonas (2012) note that city leaders should take care to ensure that *"[. . .] investment in ICT is derived from a sound articulation of political, social and cultural values."* (Cosgrave and Tryfonas 2012, p. 80). Arup (2011) states that city leaders should understand both the long-term goals and the short-term implications, and the organisation should be aligned to the shared vision. The challenge herein is the balance between understanding the current needs and opportunities, while at the same time adhering to the shared vision. According to Nam and Pardo (2011a) this *"[. . .] requires a comprehensive understanding of the complexities and interconnections among social and technical factors of services and physical environments in a city."* (Nam and Pardo 2011a, p. 288). This is what Arup (2011) envisions as the role of the city's Chief Information Officer (CIO). It is critical that the CIO is placed closer to the strategic level, with Arup arguing, "that perhaps IT is too important for the IT department?" (Arup 2010, p. 10). All in all, most smart city definitions acknowledge the importance of a close relation between a shared vision and city policy, as well as

seeing ICT in relation to the current challenges and public value. In the previous initiative, complexity entailed a technical complexity, while smart city complexity increasingly is being described as an organisational issue, as well as in combining the multiple perspectives across sectors. This is where, I argue, the smart city differs from previous techno-urban approaches.

While previous initiatives have been dominated by a technology push, the smart city departs from societal challenges (see Washburn and Sindhu 2010 or Arup 2011). Albeit the normative interpretation of how these challenges should be addressed is still unresolved – will ICT provide a magical fix (Roche et al. 2012, p. 218) or will it require a better understanding of the underlying mechanisms (Nam and Pardo 2011a) – the turn towards challenges implies a broader perspective than just supporting local ICT innovation or expanding the (ICT) infrastructure. But as Hollands (2008) points out, some of the challenges (e.g. sustainability and economic growth) are interrelated and even contradictory. While the challenges are often seen as questions of maximising or optimising resources, or making the city more efficient, I agree with Hollands' (2008, p. 314) call for a smart city that starts with the peoples' side of the equation, both in terms of defining the vision, identifying the core challenges and the desired approach to addressing these challenges.

3.5 Defining smart city

In my concluding effort to define what a smart city can be, I will return to the initial working definition put forth by Caragliu et al. (2011):

> *"We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance." (Caragliu et al. 2011, p. 70).*

While the definition above is both open, optimistic and normative, it is worth noting the following in correlation with the preceding exposition: a smart city

involves all the elements depicted in the smart city wheel (see figure 3.3c), i.e. every part of the city and aspect of everyday life. It concerns the way we organise around technology across sectors, and how we include all citizens in an effort to support the diversity of urban life in the most sustainable manner. It might depart from ICT, but just as the digital layer is everywhere, the smart city involves every aspect of the city and its physical, social, and digital fabric.

Furthermore, everything is digitally interconnected and interdependent following the spread of ICT. This adds an unprecedented layer of complexity to the city. Following the notion of wicked problems, nothing can be addressed in isolation or without regarding the implications - unlike previously, when the installation of infrastructure or changes in the configuration could be made somewhat in isolation. Changes in the sewage system involved digging up smaller parts of the city, blocking traffic in isolated areas and periods where the utility was unavailable. Today, even small changes, breakdowns and reconfigurations of the ICT infrastructure can paralyse sectors (i.e. banking, public administration and commerce) and services (i.e. financial transactions) (Graham and Marvin 2001, p. 22). This also affects existing infrastructure depending on ICT (i.e. energy distribution), resulting in a standstill for some areas. The same interrelated complexity is inherent in the urban challenges. The economic growth of a city can result in increased energy consumption and resource scarcity, potentially undermining sustainability goals and living conditions (growth often induces demand, subsequently leading to rising cost of living). This dual complexity – the complex network and interdependency of challenges and solutions – is the new condition for urban development and the merits of the smart city concept. It has resulted in the movement from focusing on a sector, cluster, technology, or interest group, towards acknowledging the need for a more inclusive and holistic approach. This entails a continuous process of looking at technology, how we organise around technology, and who takes part in deciding what is desired in the smart city. This brings me to my next point: if something is to be learned from previous iterations of the techno-urban hybrids, and even further back, it is that

each era has it's set of urban challenges, visions and ways of addressing these challenges through technology (see section 3.1). Citizens will never experience the city as smarter, per se. They will experience new services, devices, interfaces, possibilities and challenges; once the initial fascination of discovering something new fades away and is integrated into everyday practice, what once stood in the foreground becomes invisible. Once the fascination of 'surfing the information highway' or using the first mobile phone is transformed into the habits of everyday life, the smart city will just be the city.

But first and foremost, I will argue that the combination of unique societal challenges and the movement towards acknowledging the complex interplay between the urban layers, citizens and policy, means that the smart city term is both an opportunity and a challenge that calls for an integrated view on the city. The smart city vision is still open and in its infancy, and the opportunity to address the challenges in a wise and smart manner is still a possibility. While I have provided an adequate answer to the question: *"What is a smart city?"* I will know turn to the pressing question of *"how?"*

4 DIGITAL URBAN DEVELOPMENT

Up until now I have done my best to examine the notion of a smart city and interaction design separately. Now I will return to the smart city challenges and core concepts from part 3, and to the strands from interaction design introduced in section 2 , in order to combine these towards an integrated perspective. I will first and foremost bring theoretical and methodological perspectives from interaction design to bear with the challenges and core concepts of the smart city, in order to propose a reconceptualisation in the form of *digital urban development*. This reconceptualisation should not be seen as a rejection of the smart city notion, as it holds merit, discussed previously (see section 3.4), and the smart city term offers a useful departure point for drawing up an answer to the question, *"How can we begin operationalising the smart city term?"*

As previously discussed, designing a smart city poses a challenge in itself. Cities have existed for centuries with their complex infrastructures, built environments, citizens, business, institutions and rich cultural heritage.

For large parts of the world, it is not an option to build new cities, such as the South Korean city New Songdo or Masdar city in United Arab Emirates, and thus any move towards making a city smarter should work within the existing city. Furthermore, a city is a complex evolving socio-technical system, where the urban layers make the city more than the sum of its part; the city is more than its fabric, it is constantly evolving. Few cities have a governmental structure and finances to deploy a smart city, even if the smart city came as a well-defined solution. Following the lessons from the U-city and Shin's (2009) criticism, a

centralistic top-down approach would be a catastrophe. In the following I propose reconceptualising the smart city as digital urban development. I propose this as a tentative framework for operationalising the smart city term in the context of a specific city, with an emphasis on concepts drawn from interaction design. The framework represents a change in scope from the generic and open smart city term, towards focusing on what we can operationalise, affect and change within the scale of the city. While digital technologies in many ways dissolve distance and time, digital urban development concerns the physical city, its citizens, institutions, organisations and cultural heritage. It concerns the complex interplay between the city, its digital layer and existing urban life. It emphasises urban development as an open-ended process of developing, adapting, reconfiguring, changing and supplementing the existing city towards becoming smarter.

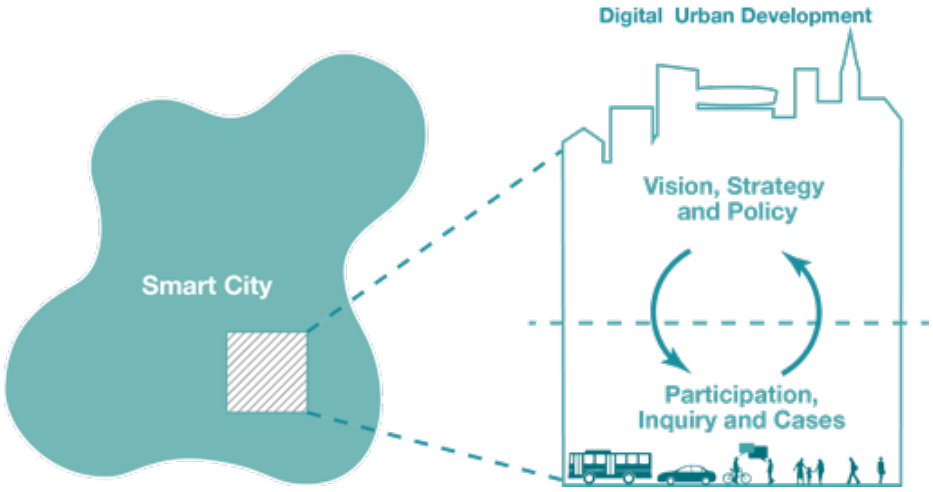


Figure 4.1: Digital urban development and the smart city

As illustrated above, digital urban development does not dismiss or replace the smart city concept. It is a part of the smart city in the sense that it regards what citizen, city leaders, and stakeholders are able to operationalise, affect and change, opposed to the broad and intangible concepts presented as part of the generic smart city. As such, digital urban development seeks to consistently examine and prototype what we are able to operationalise, through a dialectic interplay between the vision, strategy and policy, and the existing city and its specific

challenges and opportunities, in line with the iterative approach within interaction design. This must happen through engaging with multiple stakeholders across sectors, interest areas, organisations and social groups in an effort to consciously develop the local smart city vision(s) and concrete examples in parallel. The departing premise is that the smart city is beyond planning and design, due to the complexity involved and often competing visions of the future city. Therefore digital urban development entails turning towards design cases as a mode of inquiry in order to understand the existing city as a foundation for exploring the evolving smart city vision.

Before commencing, I will briefly touch on the relationship between digital urban development and traditional urban planning. This is followed by a short re-iteration of the reason for departing from interaction design and presentation of digital urban development as the central contribution. Following this, I will concentrate on the *"how"* from an interaction design perspective and slowly give form to my notion of digital urban development. In the subsequent section I will present and analyse two concrete design cases within a smart city frame through the lens of my proposed operationalization.

4.1 Urban planning and ICT

Introducing interaction design as a theoretical departure point for digital urban development is motivated by the increased convergence between urban space, technology and societal challenges. Architects and urban planners have taken care of shaping urban space, while computer science and engineering shape technology. As urban space and buildings become augmented and embedded with technology, and the city increasingly is 'read' through devices and interfaces, and even buildings become interfaces themselves, there is a need for expanding the existing understanding of this convergence.

Traditionally, the urban planners work in the large scale – bird's eye view – and plan and design the city from the outside and above (Gehl 2010, p. 206ff.),

while architects work and design on the scale of a building or the urban space that surrounds it. For an urban planner the aforementioned urban layers (see section 2.1), are seen as layers that can be pealed off from the outside in, while the architects (and inhabitants) see the layers as vertical – the layers of monuments, buildings and the skyline – when gazing across the city (Gehl 2007, p. 43ff.). This has implications for introducing ICT into urban planning and adopting the urban digital layer as a subject matter for both disciplines. Both Graham and Marvin (2001) and Aurigi (2006) have noted the surprising absence in dealing with networked infrastructure, digital technology and electronic layers. Graham and Marvin (2001) extend this to note that the existing disciplines fail in addressing the digital urban layer because it is not regarded as part of their remit, it is "engineering stuff". The authors argue that architects and urban planners tend to focus on the space around the building or within, neglecting the infrastructures that connect the buildings (Graham and Marvin 2001, p. 16ff.). Aurigi (2006) offers part of the explanation, when he argues that this is related to the intangible and invisible nature of the digital layer which challenges disciplines that traditionally deal with the tangible and visible (Aurigi 2006, p. 11ff.).

This is of course a generalisation, as architects and urban planners increasingly adopt digital tools in 'production' (i.e. digital visualisations, maps and sketches) and in methodology (see Delman et al. 2008). Similarly, there is a kinship between architecture and urban interaction design in the adoption of the notion of patterns from Alexander et al. (1977) into software development (see Vlisside et al. 1995), and interaction design (Dalsgaard et al. 2008). Lately Robinson (2013) has suggested producing similar patterns for the smart city. While ICT and the digital layer have been ignored by the urban planners and architects, Gehl (2010) offers a way in, when arguing that the existing practice of planning has failed, and urban planners, policy-makers and architects should start from the scale of the people and the social life that unfolds in the space between the buildings (Gehl 2007; 2010). This includes the digital urban layer that increasingly emerges as a social space between the buildings. The citizen-centred focus expressed by Gehl

(2010) is closely reflected in the emphasis on participation posed in relation to digital urban development.

4.2 A role for interaction design

Practitioners and researches alike within interaction design seek to understand what they are designing and why in parallel with actually doing so. This closely resembles the how the challenges in operationalising the smart city are manifested and addressed. Therefore, Interaction design has a key role in digital urban development, partly by providing theoretical and methodological perspectives, and partly by offering a crude map and a common language to describe, explore and understand what a smart city could be, the role of technology and the specificities of the local context. The current conceptions of a smart city emphasise an optimal, quantitative and efficient understanding of the city, just as early HCI and interaction design emphasised usability and efficiency. Following the movement away from HCI, interaction design has expanded this narrow focus on efficiency, usability and problem solving, towards including users in the defining parts of the process, focus on broader aspects and acknowledging the wickedness and complexity of innovation and creating the not-yet-existing. Therefore, interaction design can provide the initial theoretical perspectives on how to divert from those simplistic notions toward a more coherent image of the city.

Furthermore, focusing on engaging in design activities as an integrated part of design and research offers a methodological departure point for understanding what a smart city is and how to operationalise it. In interaction design knowledge is both aimed at producing a particular result based on an integrated understanding of the existing, as well as utilising design activities as a vehicle for understanding the relationship between technology, people and society.

Lastly, interaction design and participatory design depart from an ideological foundation, where the future users are put in the centre of the development

process with the aim of supporting their needs and enabling them to reflect critically on the role of technology. This focus on democratising technology is a far more compelling departure point for digital urban development than the narrow deterministic and excluding view reflected in the smart city definitions. Interaction designers and researchers can contribute through engaging all citizens and stakeholders in understanding what a smart city is and what questions are to be asked and how the answers are put to use, as Bødker (2006) envisions the role of designers and researchers:

> *"I imagine that researchers provide re-configurable alternatives, through design-prototyping, where the questions asked have been carefully examined and the answers digested in cooperation with users." Bødker (2006)*

4.3 What are we designing?

As previously noted by Winograd (1997), interaction designers have slowly moved from designing interfaces to designing the 'interspace'. We have already moved beyond designing products, software or IT-systems that were designated to fulfil a single purpose or usage in isolation. Contemporary examples such as Apple's iPhone and Microsoft's Xbox are products, platforms for communication and media consumptions, as well as a marketplace for application and game developers. At the same time applications and services increasingly interface and rely on each other. Google's map application is a good example of a hybrid between a standalone service delivered by Google, that is also a part of many other applications and services. Products, services, applications, specific technologies and the underlying service and information layer, all enter into the existing digital urban layer and become part of the smart city. This requires both a careful understanding of the existing and the how the new can be integrated. For the lack of a better word, digital urban development can be understood as *infrastructuring* (Star and Bowker 2006), in the sense that we design the underlying social and technical infrastructure, which enables the future development of services, artefacts, events and urban experience. Star and Bowker (2006) argue, that infrastructure is an on-going process, where political, ethical and social choices

inevitably shape the future standards and classifications. They continue to note that good infrastructure should be stable enough to allow something to exist on top of it, while at the same time being tailorable and flexible enough to respond to social needs. This includes the social infrastructures and the organisational setup around the technology (Star and Bowker 2006,p. 241). But while the influence of political, ethical and social choices often happens unnoticed in infrastructuring, as Star and Bowker (2006, p. 233) point out, digital urban planning entails making that element of infrastructuring explicit, open, and inclusive.

Departing from that notion, the subject matter of digital urban development is designing for reconfiguration and appropriation (Redström 2008), through designing soft and hard infrastructures that support new services and practices, resulting in interspaces that allow future reconfiguring, ecologies of artefacts and systems, possibilities and future design. While interaction design usually deals with something closer to a product, a service or digital artefact, digital urban development concerns the smart city and the digital urban layer. Moving into seeing digital urban development as the design of the platform for future development, includes – albeit not always actively designed or directly reconfiguring – the design of the 'interspace' between organisations, stakeholders, and sectors in the city. As such, digital urban development regards the design of the smart city and how it supports cross sectorial and city collaboration and active participation in articulating the vision for the future city. But as I will continue to argue in the next section, the design of the whole is, per complexity, out of range. Therefore, we are left with designing parts or selections of the whole, as a strategy for understanding and developing the emergent whole indirectly.

4.4 The smart city as an emergent whole

To get a better understanding of the design of the smart city as a whole, I will draw on Nelson and Stolterman's (2012) theories on design and the relationship between the whole and the constituting parts. According to the authors, the whole is *"[. . .] a complex ensemble of relations, connections, an underlying unifying force or*

principle" (Nelson and Stolterman 2012, p. 93). It is made up of compositions and assemblies of specific parts, resulting in the whole as something that emerges, with varying degrees of intentionality, as the sum of its parts. As such, *"A whole can never be described before fully formed, even with the parts at hand."* (Nelson and Stolterman 2012, p. 95), and it is impossible to *"[. . .] impose that emergent quality onto parts that cannot belong in the whole a priori."* (Nelson and Stolterman 2012, p. 95). Transferred to the scale and image of the (smart) city, this means that the city emerges out of the infinite complexity of the unfolding urban life and interplay. It also means that the smart city as a whole is beyond the reach of design or controlled composition based on a vision, because this would entail knowing both what is supposed to emerge, as well as imposing a vision onto the unfolding complexity of its infinite parts. In that sense it resembles what Nelson and Stolterman refer to as a natural whole in opposition to the designed whole, and as such *"[. . .] its comprehensiveness can never be fully disclosed, because of its complexity"* (Nelson and Stolterman 2012, p. 97). In the following I will denote the smart city as an emergent smart city to underline that it is beyond the scope of present vision, direct design and comprehension. Instead, we should go into the constituting parts of the smart city until we reach a sufficient level of complexity where the parts can be sufficiently conceptualised as a design case or prototype. These design cases and the underlying design process, are what we can engage with to design, operationalise and examine in collaboration during the development and afterwards.

4.4.1 Multiplicity of wholes and parts

There is still a layer of complexity to be added to the above notion of wholes and parts. According to Nelson and Stolterman (2012), a complex system, such as a city, can never be comprehended in its fullest or be 'seen' in its entirety. Individuals always see the whole and the parts from a specific *station point* or *standpoint*. The first regards the position one has in relation to the object, while the latter is the ones attitude, beliefs and norms that shape ones perception (Nelson and Stolterman 2012, p. 68). Both the station point and the standpoint affect

how the individual perceives an object, situation or design artefact. Changing stationary or observatory point means that new qualities, characteristics and aspects of the form are revealed. But changing stationary point also means that the previously observed no longer can be observed directly; pivoting an object changes ones perception of its form, function and purpose. While sharing station point in an ideal situation would provide roughly the same image of an object, it is difficult to share the same standpoint entirely. This in turn creates competing accounts of and disagreement on the significance of elements in a situation and on what is to be done. The idea of a (individual) standpoint is both a well-developed epistemological notion[1] and a key concept towards understanding why we interpret situations and objects differently (Nelson and Stolterman 2012, p. 64ff.). Nelson and Stolterman (2012) present typical examples of the multiple perspectives shaping how we interpret situations, whole and parts, such as *technical, organisational, ethical, political, economic, personal* or *spiritual* (Nelson and Stolterman 2012, p. 68). The consequences of acknowledging the role of the standpoint as well as the station point, leads to many of the core characteristics of the wicked problem (Rittel and Webber 1971), as well as the emphasising problem setting in Schön's (1983) settlement with technical rationality.

The implications toward comprehending the complex whole and even the individual parts in totality presented above, necessitate a different approach to developing a smart city. For each citizen and stakeholder the city is something different, depending on stationary point and standpoint. The same goes for the interpretation of how a smart city is defined and what makes it smart (see section 3.2). So the challenge for digital urban development is partly to include and align different, at times competing, perspectives on both the city and its parts (see figure 4.2[2], and partly to understand the relationship between the parts – design cases – and the city as emergent whole. This leads me to presenting the methodology of digital urban development, where I argue that in order to affect, shape and comprehend the whole – the digital urban layer or smart city – practitioners

[1] see Dewey (1916;1934) and Schön(1983)

[2] Appropriated from Nelson and Stolterman 2012, figure 3.8

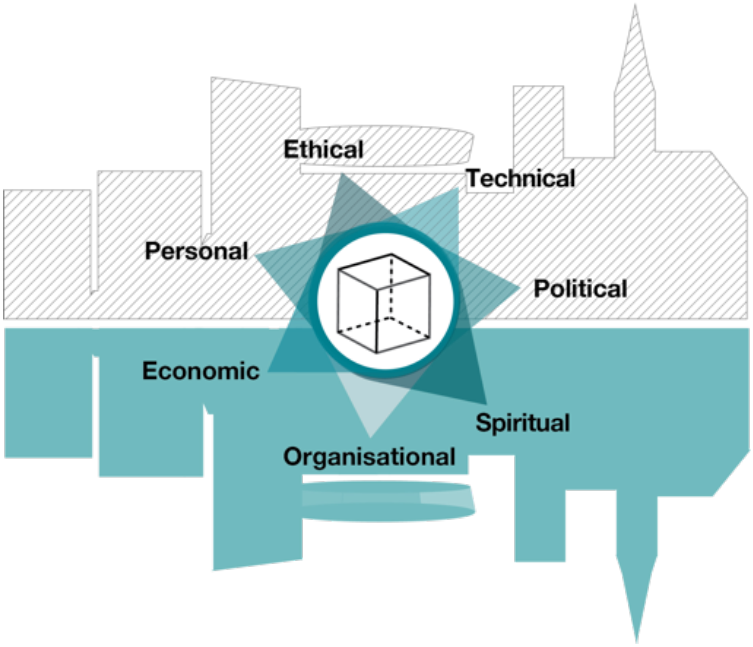


Figure 4.2: Multiple ways of seeing the parts and whole

within smart cities and digital urban development should use the design cases as a way of producing concrete examples of smart city innovations, probing into the existing and actively prototype the proximate future, through broad and mutual participation.

4.5 Digital urban development as a dual process

The process of developing and operationalising smart city concepts consists of two parallel processes. There is an overarching process regarding the continued efforts to develop the city as a smarter city. This process is open-ended and continues to expand the vision for the city as well as initiating projects and design cases within the larger smart city frame. Each of the initiated design cases requires a design process wherein the participants can explore possible solutions, stage design interventions, build prototypes and produce a final outcome. Analogous to how the physical city evolves, the design cases can be understood as individual buildings within the city. Each of these is the result of an architect's work, constructed to fulfil a purpose (i.e. a housing complex, business headquarter, government building, shopping area). When the building is finished, it takes part in shaping the city's skyline and how the urban life unfolds around it (Gehl 2007).

The above analogy illustrates the relationship between the design cases and the emergent smart city, but offers no clear demarcation between the two. While buildings are confined in their physical structures, the digital services and infrastructure of the digital layer are potentially spread all over the city (see section [Urban layers]). As a conceptual demarcation, the design cases are characterised by something we can design within the confinements of a single process leading to a final outcome. As such it is not limited to interaction design or development of technologies. All forms of intervention, investigation or intentional change, such as public hearings, events, or presentations, can all shape the intangible smart city. In the context of interaction design, I will focus on design cases and prototypes as a specific type of intervention from an interaction design perspective.

4.5.1 Design cases as strategic inquiry

The overall smart city vision resides at a *strategic level*, where city leaders, policy-makers, urban planners and a broad group of stakeholders seek to understand what a smart city is in the local context, as well as balancing short-term goals and implications. As aforementioned (see section 3.4), this requires that city leaders or others can take part in defining policy and balance public value and city needs. This could be the city CIO proposed by Arup (2011)(see section 3.4). In order to develop and expand the vision, the strategic level uses design cases as a means to explore and develop the smart city vision in a broader context and most importantly involve the multiple stakeholders and citizens in the process. Furthermore, the strategic level imposes considerations on the design case, in order to develop prototypes and cases that adhere to the overall smart city vision, as well as to challenge and inform the vision. But design cases also depart from existing challenges at the *operational level*. The operational level is the organisational context or the problem area wherein the design case is a suggestion for a solution. This is often a specific area, organisation or sector within the city. For most design cases, they will be initiated from a strategic level, as a way of changing the existing situation or inform a long-term challenge or from the

operational level as a response to an immediate challenge or need, see figure 4.3.

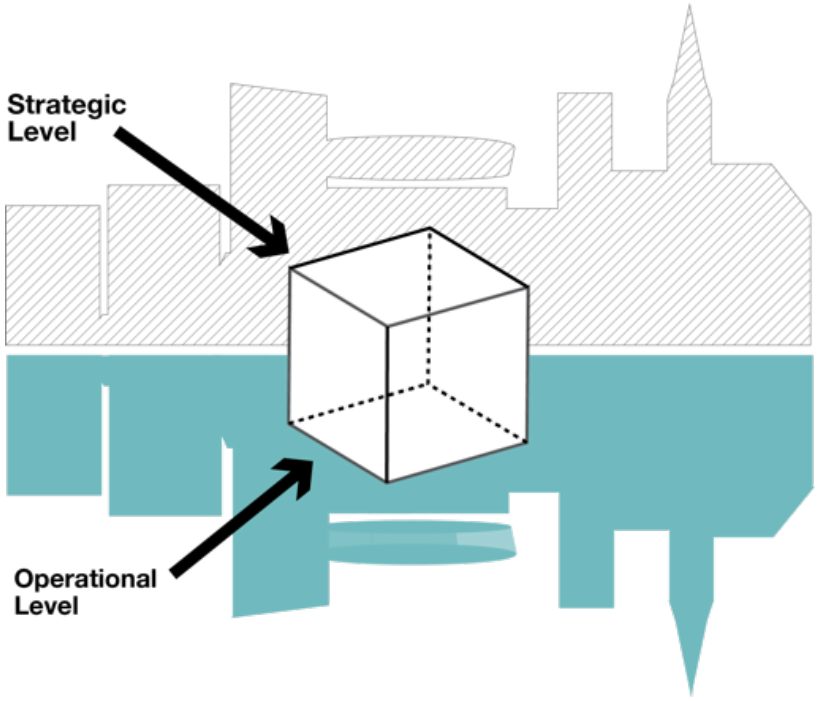


Figure 4.3: Strategic and/or operational initiation of design cases

The strategic level within a smart city could initiate a design case in order to explore typical smart city concepts, such as the financial models of new services, investigate how to coordinate information and data flows across sectorial silos or examine how to facilitate online citizen services to the elderly. However, the operational level often departs from a concrete challenge, such as integrating specific systems, handling traffic congestion or digitising specific services in the best way. Therefore it is necessary to either challenge the existing understanding of the situation – the sectorial way of problem setting – or impose specific strategic concerns that would provide input for the smart city vision.

This dialectic relationship between the strategic level and the operational level resembles the ways in which design-oriented and research-oriented designer engage in activities to understand both the outcome and context wherein the final artefacts enter. Within digital urban development, the strategic level represents

the design-oriented researcher and the operational level shares similarities with the research-oriented designer. The strategic level participates in or initiates design cases as vehicles for probing into the existing urban layers, while the concrete level shares the challenge centred focus with the research-oriented designer.

4.5.2 Design cases at the junction

For digital urban development and the notion of the smart city, the design cases are an important intersection between the multiple stakeholders, their different standpoints, interpretation of the challenges at hand and subsequently their vision for the smart city. It is not only the convergence point between the strategic level and the operational level, it is also the frame for engaging with the broader range of stakeholders within the city. While the operational level often imposes an existing understanding of the challenge and subsequently the solution, the strategic layer imposes the opposite. The strategic need for exploring larger societal challenges, multiple standpoints and new ways of coordinating across the broad city, challenges the existing assumptions. By engaging in interaction design and approaching the design case as an iterative process, emphasising a citizen centred approach, questioning existing rationales and actively exploring alternative approaches to a given challenge, the design case becomes means for both probing into the existing, as well as prototyping the future.

Within the confines of the design process, the steps taken act as a way of understanding the complex interplay between people, technology and design, in relation to the smart city context. As such, it can act as a probe, exploring technical configurations, identifying weakness in the existing infrastructure (see Edwards et al. 2010), by providing valuable insight into existing practice, procedures and the organisational context or even challenging or critically probing the existing understandings of the city. Moreover, throughout the process the participants produce preliminary prototypes as incomplete design ideas, with a filtering ability to explore new solutions or discover problems. Just as mock-ups and scenarios capture elements of the existing, they immediately prompt ideas and resemble

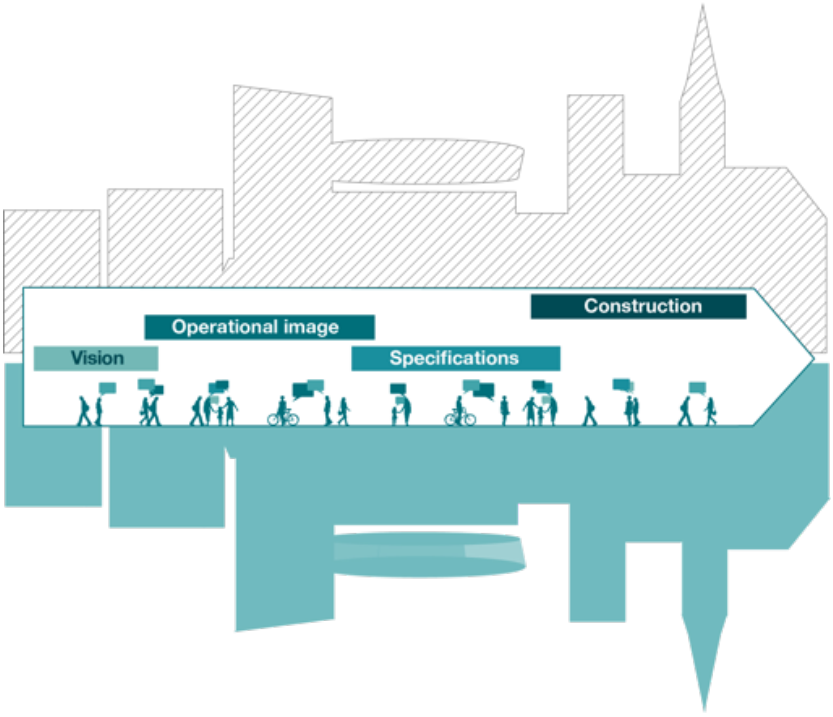


Figure 4.4: Embedded design process in a design case

intermediate problem setting. Prototypes both inform the individual design process, as well as invoke images of possible futures influencing broader visions. Importantly, design cases are a setting in witch future users and stakeholders can participate in developing, refining and exploring their desires, values and visions (Iversen et al. 2012). The different standpoints are shaped by participating in activities with others and through reflection on the produced prototypes. As such the design situation and how we interact in it, shapes our interpretation of *"what is"* and *"what could be"*, not only at an individual level, but also jointly in collaborative doings. The design case becomes an arena for critically examining preconceptions and underlying rationales in how we prescribe solutions in our initial problem setting (see section 2.4).

4.5.3 Design cases as prototype

Throughout the design process and afterward, a design case informs the strategic layer, and provides provisional suggestions towards addressing the challenge at the operational layer. As illustrated in figure 4.5, the design case informs and

shapes the vision in two ways at the strategic layer. The knowledge that is built up throughout the underlying design process is not confined to the specific case. The emerging understanding of *"what could be"*, represented by the design case, further shapes the overall smart city vision. Moreover, the probing throughout the underlying design process provides insights into previously unknown challenges, opportunities and barriers. If a specific approach has been chosen, due to a technical challenge, a divergence in standpoints or resistance from a specific stakeholder, this knowledge will be available through further inquiry into the circumstances.

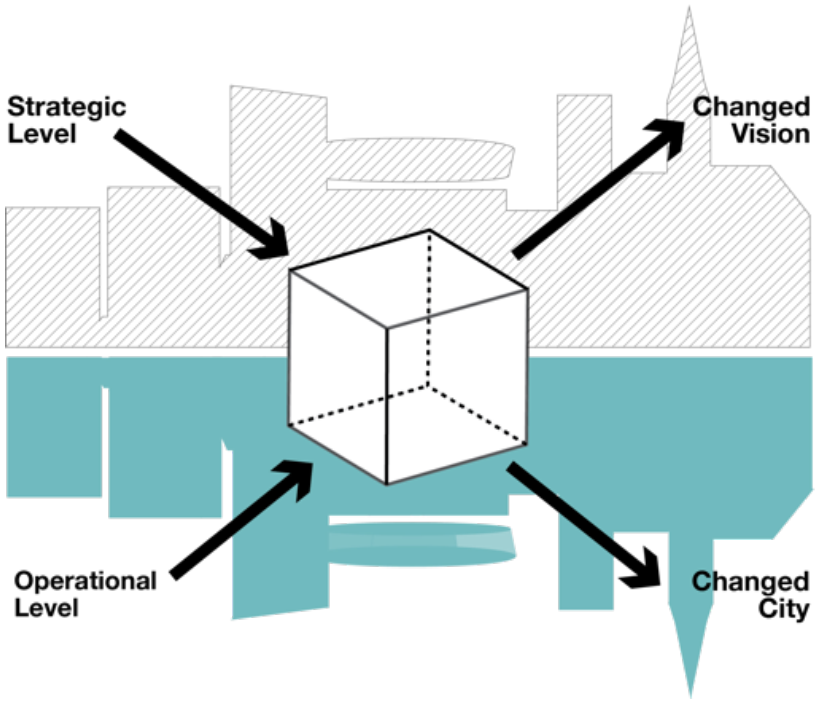


Figure 4.5: Design case as prototype

At the operational level, the design case provides a concrete suggestion to the specific challenge. Even though it could be a tiny change, the design case still affects existing practice and changes the existing city by providing a solution or addressing a need. Additionally, the proposed solution is available for evaluation among a larger set of stakeholders and acts as an example of collaboration across interest areas and sectors.

4.6 Prototyping the smart city

In the preceding sections I have argued that something as intangible and complex as the smart city is beyond immediate design and planning. And because the smart city emerges from a complex interplay between its constituting parts, I argue that we should not attempt to comprehend and design the complex whole. Instead we should focus on design cases as a strategic vehicle for investigating what a smart city is in a local context and how to approach it. Within the notion of digital urban development, I have proposed a dual design process wherein a strategic level around city leadership and policy-makers initiates specific design cases as a way of simultaneously addressing current smart city challenges and using the design cases as a means to investigate the emergent smart city. By deploying multiple design cases within the frame of a smart city initiative, they will both provide very concrete prototypes and solutions to the specific challenges, as well as informing the smart city vision and shaping the contours of the emerging smart city.

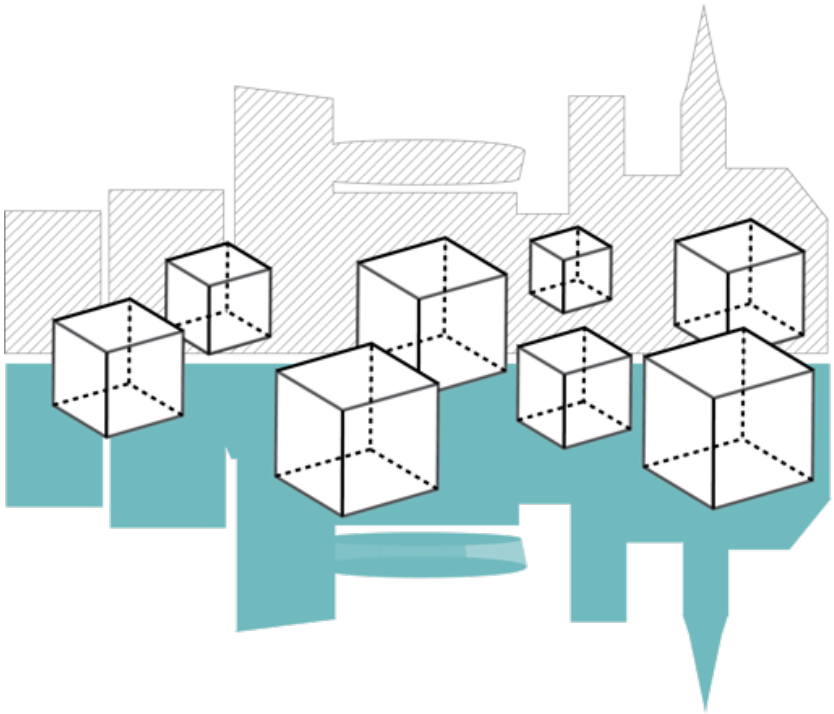


Figure 4.6: The emergent smart city

As a design strategy, it is important that each design case has a high degree of participation across the smart city stakeholders. This is difficult to achieve through a few design cases, but by engaging in multiple design cases, such as illustrated in figure 4.6 and targeting a broad range of participants, it is possible to facilitate multiple viewpoints and interpretation of the existing and *"what ought to be"* within the frame of a smart city.

5 DESIGN CASES

I will now exemplify digital urban development through two design cases. I begin with a brief introduction to Smart Aarhus, before going into detail with the two design cases. Then I will present my findings in relation to design cases and how they contributed to Smart Aarhus. Finally, I will revisit digital urban development and discuss the contribution in relation to my findings.

5.1 Smart Aarhus

Smart Aarhus[1] is a local smart city initiative launched the 24th of January 2012. The initiative is a partnership between Aarhus University, the municipality of Aarhus, the Alexandra Institute and the central region of Denmark. Its origins can be traced back to the IT-city of Katrinebjerg and the strategic research centre Digital Urban Living (2010-2012), in which the same partners participated. The initiative took shape at a preliminary meeting in February 2011, where Aarhus University and The Alexandra institute invited key participants to a smart city presentation. During 2011 a secretariat was formed and in August 2011 the city mayor invited a broad spectre of city, institutional, regional and industry leaders to participate in the steering committee.

The purpose of the initiative is to rethink the city in the wake of increased digitisation and societal challenges through increased collaboration across sectors, institutions, government, industry, and citizens. This is expressed in the efforts to present the initiative as a platform or ecosystem for the future digital city of

[1] The following is based on my knowledge from participating in the initiative. See www.smartaarhus. (dk/eu) or Mogensen (2013, pp. 23 -25) for other presentations. Finally, the report from the initiative should be published ultimo June 2013

Aarhus, which supports entrepreneurship, open government, sustainable living and more efficient public service.

Smart Aarhus is organised around a secretariat, which acts as an intermediate layer between the many participants and the committee. The secretariat plays a defining role in planning events, presenting and communicating the initiative, coordinating across the partnership and facilitating the contribution from the working groups.

5.1.1 The process

Within Smart Aarhus, 2012 was seen as an exploratory year where the initiative was framed as a think tank. During this year, multiple working groups where invited to participate by identifying visions and barriers within thematic areas, such as open data, culture, smart learning, and digital entrepreneurship. All in all, 13 groups contributed with input ranging from recommendations to visions and lists of specific challenges. The result of the exploratory year is a short report highlighting the contribution from the working groups, key events and presenting the core principles for the coming years. The initiative is still in a defining phases.

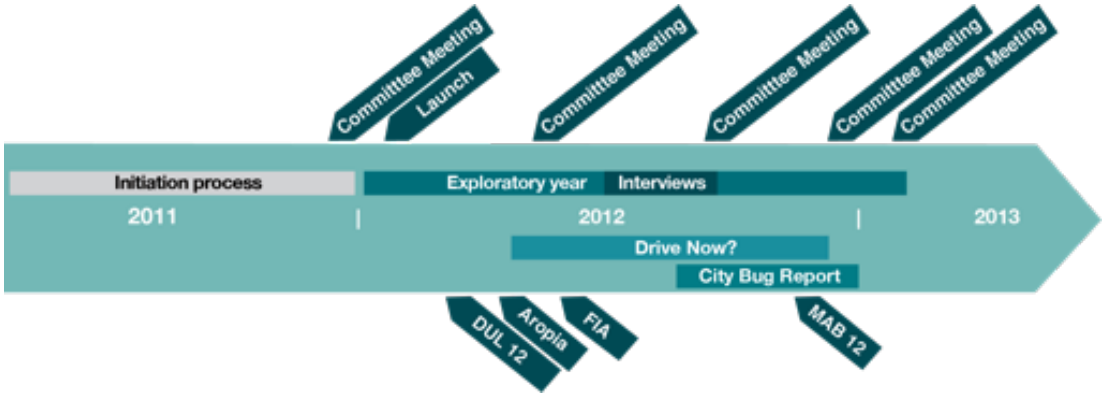


Figure 5.1: Smart Aarhus process and events 2011 - 2013

By engaging multiple working groups, the initiative seeks to include as many different stakeholders and viewpoints as possible. Throughout 2012, this was presented as an open invitation to participate and it emphasise that part of the

vision, ideas and core principles should emerge through this bottom-up approach with the working groups. Several chairs from key working groups have presented their findings to the committee as part of the regular meetings in the think tank. In figure 5.1, I have noted the most important events.
The result of the exploratory year is a short report highlighting the contribution from the working groups, key events and presenting the core principles for the coming years. The initiative is still in a defining phase.

5.2 Drive now?

The application, "Drive now?"[2], was developed as a prototype in the context of the Smart Aarhus workgroup Intelligent Traffic Systems (ITS). While the primary objective was to create a tangible showcase for Smart Aarhus and a local developed exemplar of a novel smart city concept, the project was initiated with several interests in mind. Initially, the municipal traffic department was interested in exploring novel and unconventional approaches to ITS, partly as an input to a funding application to the National Ministry of Traffic, and partly as an alternate way of addressing the projected increase in traffic in the coming years. Moreover, inline with the notion of data as the new raw material for innovation within the smart city (see section 3.2.2x), the project aimed at exploring what kind of data could be released and especially how this could be done from within a sector.

From a research perspective, I participated with the general interest in bringing perspectives form interaction design to bear with the traditional sectorial challenges, exploring novel application areas on top of municipal data and exposing sectorial and administrative data to the citizens.

Congestion and traffic infrastructure is an integrated part of the smart city concept, and Washburn and Sindhu (2010, p. 7) identify congestion as a specific challenge. However, expanding the existing infrastructure will induce

[2] The application is called "Skal jeg køre nu?" in Danish, which translates into the question "Should I Drive Now?" in English. I have further shortened it to the more direct and informal "Drive now?"

demand due to the rebound effect (i.e. increasing capacity will generated increased use). For most cities, expanding the infrastructure is not a sustainable economic and environmental approach. While optimisation and planning based on current commuter and traffic patterns will help improve the overall situation, the developed application seeks to address the current issues from a different approach, arguing that that re-using real-time data and serving the information to the commuters and citizens on mobile devices prior to departure can better the situation by creating awareness of the nature of congestion and peak-hour traffic. The hypothesis behind the application is that information traditionally utilised by government and policy-makers can support citizens to make well-informed decisions, if the information is made available in the right format at the right time.

5.2.1 The application prototype

The application prototype[3] is comprised of two views on the interface level. The first view is displayed when the application is launched (figure 5.2a). It is simplistic, displaying only the essential information and one primary button. The current user location is displayed at the top, with a button in the middle saying "Should I drive now?" in Danish, and finally a list of often used destinations at the bottom. The second view (figure 5.2b), displays a response to the query initiated when the user presses the button in the first view. The text shows a minimum amount of information regarding the current traffic situation on the selected route, in order to balance between providing enough information to inform and not confuse or even make the information too complex.

When the user presses the button, the application sends the current address and desired destination to the back-end service. This service then calculates a route based on an open street map service, and compares the given route with real-time information obtained from the sensor network within the city via an integrated web service. Then the back-end service compiles a response string 'answering' the question from the user. The response states a clear 'yes', 'no' or 'maybe'

[3] The prototype application is still accessible via a smartphone, which provides the main application while accessing the site from a browser will display information on the project. The platform is available at http://henrikkorsgaard.appspot.com/

(a) User question (b) System response

Figure 5.2: Drive Now? application screenshots

indicating whether it is a good idea to drive or if the user should wait until the congestion is settled. Just below the short answer are the details on the current travel time, possible delays and average speed on the route. The system thus provides a short recommendation and explanation.

5.2.2 Design process

The underlying design process stretched over a long period with only few meetings between the core stakeholders (see figure 5.3). Beside representatives from the traffic department, the working group that initiated the project included two researchers from the research centre CAVI at Aarhus University. The Mayor's department within the city facilitated and followed the project on the side.

After the initial meeting, where the stakeholders agreed upon the project, the key participants met at a design workshop at CAVI. Following a short introduction, the participants developed three concepts through a design game (Halskov and

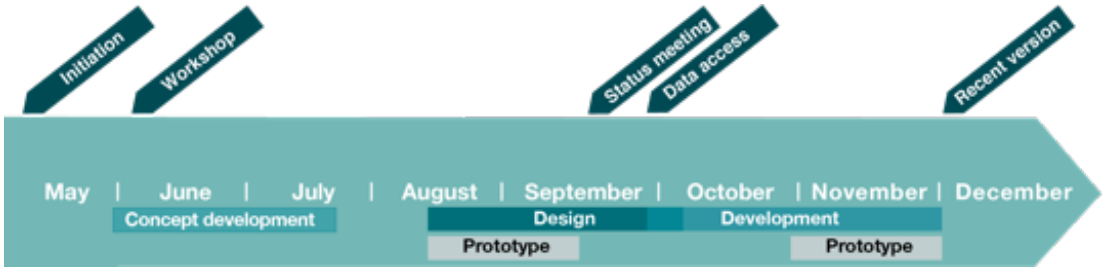


Figure 5.3: Drive Now? design process

Dalsgaard 2006) in which inspirational material, domain specific images and technical components were used as 'building blocks' in the concept development. The three concepts were captured on small posters and subsequently refined into scenarios.

After the workshop, the participants met on several occasions regarding specificities, such as access to the real-time data and defining the scope of the application. At the meeting in September 2012, I presented a rough prototype, which resembles the final prototype without the underlying real-time data implemented. Subsequently we obtained access to the real-time data.

The project is not finished and the prototype will be the basis for the development of a finished application to be released September 2013.

5.3 City Bug Report

In connection with the Media Architecture Biennale 2012 (MAB12), the city hall tower was transformed into a media facade illuminated with visualisations of municipal data. The media facade and the underlying systems were developed in conjunction with Smart Aarhus, Media Architecture Institute and the research centre CAVI. It is comprised of a large media facade on the tower of the city hall in Aarhus (see image 5.4), a supporting backend and a service where citizens are able to report 'bugs' within the city. The purpose of the design case was partly to produce a concept for the media facade and partly to visualise citizen data in the urban space. This entailed an investigation into the types of available data,

Figure 5.4: City Bug Report: Mediafacade at city hall (Photo: Rasmus Steengaard)

how they could be released and visualised. Moreover, throughout the project we knew that getting access to citizen related data would be sensitive and posed an organisational challenge.

Within the smart city concept, the use and collection of data and information from the citizens often emphasises that the administration or policy-level uses the data internally for benchmarking, optimisation and business intelligence (Arup 2011). The data is seldom fed back to the citizens or exposed to outsiders.

By borrowing the notion of 'bugs' from the world of software, the project wanted

to examine new forms of digital relationships between city administration and citizens. Currently, the municipality provides web-forms for reporting issues within the city, divided into subject areas and scattered across the municipality website. We wanted to take a citizen centred perspective and offer a single point of entry to report various bugs, as they were encountered in the urban space. Furthermore, the design case aimed at exploring the digital agenda within the municipality, critically probing their stance towards openness, transparency and civic communication within the urban space, both on a large scale with the tower, as well as the dialogue initiated by the report tool.

5.3.1 The concept

The design case is comprised of two separate systems: The installation on the city hall tower that visualised existing data on online communication between the municipality and citizens, and a bug report service that enabled citizens to report various issues from around the city.

The city bug reporting service was comprised of a mobile version (see image 5.5a) and a browser version (see image 5.5b)[4]. While both interfaces support reporting bugs in key areas, the primary intention was that citizens use the mobile interface to report issues as they encountered these around the city, and then used the browser interface to explore, share and comment on the individual bugs via online social media and networks. When a citizen encountered a bug in the city, they could immediately report the issue with their smartphone under predefined categories resembling the department areas within the municipality, such as waste, parking, school and health. As soon as the bug is reported, it is pushed into the system and displayed on the website, ready for comments and municipal attention. The interface is in principle the same for the citizens reporting the issue and the public case worker or service employee who wants to fix current issues.

[4] The bug report tool is still accessible via a smartphone, which provides the mobile interface or a browser that displays the standard edition. The platform is available at www.citybugreport.projects.cavi.dk

(a) Browser - Buglist (b) Mobile interface

Figure 5.5: City Bug Report application screenshots

The installation at the tower is comprised of 5500 LEDs attached to a mesh and deployed along the existing railing sections. The visual effects on the facade where created programmatically from a year's extracted data on civic communication, compressed into a 24 hour time-lapse. Each citizen request or case where identified by id, and each correspondence were given a colour depending on whether it came from the citizen (question) or from the administration (answer). When a question was posted a red spot spawned on the facade at the lower ribbon (see image 5.4), when the question was answered it turned blue. When a transaction occurred, the specific dot would jump up a ribbon and grow in size. If the case was closed, the dot disappeared. The core idea was to avoid too many unanswered questions, represented by red dots, and more importantly to avoid any drifting red dots at the uppermost ribbon, indicating a question that remained unanswered. The installation and visualisation should indicate that citizens already posed questions – reported bugs – to the municipality, and subsequently make the reaction time and ability address the issues of the citizens more visible to the public, emphasising transparency.

As part of the event around the MAB12, we used the existing information board in front of the city hall to promote and explain the installation and the bug report system to the public.

5.3.2 Design process

The underlying design process was rather short. The opportunity to set up the installation at the tower came by through a sponsorship for MAB12 from a LED manufacturer. The process itself was initiated with a two-day design workshop co-facilitated by Smart Aarhus and the open data initiative, during which invited stakeholders from local IT-industry, the region, academia, municipal data-owners and students explored the notion of open data. The workshop participants produced 6 concrete design concepts for the MAB12, through an exercise where each participant wrote down important aspects to open data, which subsequently got analysed and combined into concepts.

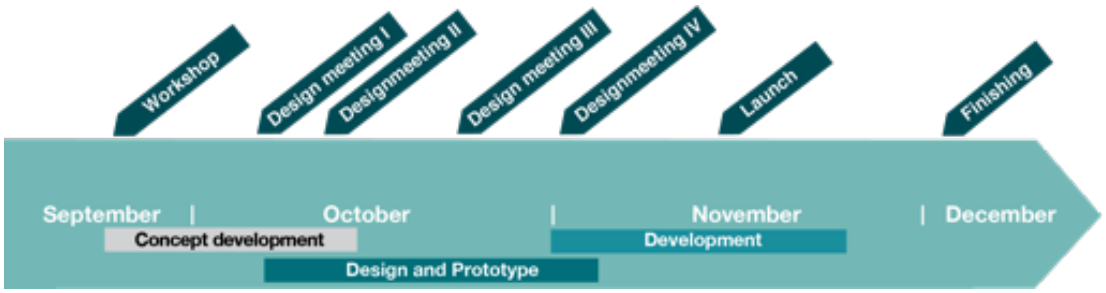


Figure 5.6: City Bug Report design process

Following the workshop, the concepts were further refined into City Bug Report through a series of meetings between the participants from Media Architecture Institute, a local business intelligence company called D60, representatives from the open data initiative and the citizen service group within the municipality.

During the development, citizen services provided data and input for the platform, D60 analysed the provided data, while students and CAVI built the media facade at city hall. I developed and maintained the platform throughout the life of the installation, from the 15th of November to the 3rd of December.

5.4 Digital urban development in Smart Aarhus

Now I turn to the role and contribution of these two design cases in the context of Smart Aarhus. Both cases were initiated as part of Smart Aarhus; one case was initiated as part of a working group on ITS, while the other arose as an opportunity to collaborate on the development of a media facade in relation to MAB12. As such they served multiple purposes within the initiative. In the following I will present how each case contributed to Smart Aarhus and their role as local examples.

5.4.1 Drive now?

The meetings in the underlying design process provided several opportunities to explore the traffic and congestion challenges within the city of Aarhus, as well as understanding the implications posed by traditional ways of addressing the challenges. The municipal traffic department needs different approaches to tackle the increase in traffic and congestion. The required investment strategy is both an expensive solution that would induce greater demand and is further challenged by the existing built infrastructure, as well as the current sustainability goals for the city.

The interaction between the different standpoints in the process, the sectorial traffic perspective and the interaction design perspective, provided opportunities for exploring existing assumptions. This made the 'business case' of the sector explicit, namely decrease traffic congestion and increase efficiency without the need for huge investments in expanding infrastructure (Appendix B:3,6). Moreover, the discussions around the possibility of opening up the data exposed a convergent view on the quality and detail level of the sectorial data versus the information needed by the citizens in route decisions. While the traffic department valued accurate data and a complete overview of the city (Appendix B:2), the application tries to balance this complex situational image of the traffic situation with a detail level that is adequate for ordinary citizens.

Participating in the project also changed the initial hesitation regarding opening up to the underlying data layer within the traffic department. As indicated in the above in the design process (see figure 5.3), it took a few interactions and meetings before we received access on the technical level, while the traffic department from the outset stated it as a possibility. The design case made the key participant within the traffic department realise that instead of developing their own applications and services for the citizens, their role would be to provide the data for others to develop upon (Appendix B:7). Recently, they have let CAVI and Smart Aarhus proceed towards sharing the data on an open data platform for further development.

Finally, the design case has acted as a broader prototype and example on how to approach ITS from a novel perspective and provide citizens with the ability to inquire into same types of data that are normally reserved for policy-makers, planning, and administration. The participants from the traffic department have already described the case in a Danish trade journal on traffic and ITS (Bloksgaard and Christiansen 2013), as well as presented the case externally in ITS communities and internally as an example of the potential in opening up data (Appendix B:5,7). In that regard the application is a prototype on and example of how to open up sectorial data, as well as indicates technical and organisational implications in the process.

5.4.2 City bug report

Despite the short design process underlying the City Bug Report concept, it provided an opportunity for probing critically into sensitive data and implications towards exposing municipal data at a large scale within the urban space. While there was no indication of the sensitivity or type of data on the visualisations, several parts of the municipality became concerned regarding the exposure of complaints and inquires made by citizens to the municipality (Appendix A:3) This can partly be attributed to the organisational context, wherein politicians needs to be prepared and briefed (Appendix A:6), and partly to the poor

communication from our side. Similarly, the project made existing regulations on civic communication apparent to us. While we regarded the reporting tool as a design experiment, the municipality responded promptly to missing information on the project. The communications department requested that we explicitly state that it was a research experiment and that Smart Aarhus and CAVI were responsible, and therefor the municipality was not obliged to answer or solve the issues, as they normally would be according to Danish law (Appendix A:3). Furthermore, the high visibility of the project made citizens and the press respond with curious inquiries, which the municipality was unable to respond to due to the lacking communication across the departments on the project (Appendix A:2).

As a prototype the installation and reporting tool inspired the participants from citizen service to put a similar report tool on their internal development agenda, as well as attend a seminar on data visualisation and approach a consultancy on civic service in the urban space (Appendix A:7,8).

Finally, the project prompted conversations among all the participants on the potential new role for citizens as a resource in qualifying and prioritising societal issues and urban 'bugs' and how the municipality should organise itself to absorb and react to bugs reported by citizens (Appendix A:4).

5.4.3 Contribution to Smart Aarhus

Both design cases have contributed to Smart Aarhus by generating visibility around the initiative and possible uses of data and technology in the urban space. Not only was the Drive Now? Application promoted internally in presentations, it was also used in presentations and promotional material (see appendix C), as a public example of the digital progress of the city of Aarhus. City Bug Report had a high visibility on the tower and in the local press (Aarhus Stiftstidende 2012a; 2012b) throughout MAB12 and afterwards. The installation on the city hall tower got extended until the 3rd of December, due to a visit from the Danish Minister of Housing, Urban and Rural Affairs, during which Smart Aarhus was presented.

As such each project has provided Smart Aarhus with external examples for promotion and tangible outcomes from the initiative.

Similarly, each case has been presented to the steering committee on several occasions and the installation on the tower got its exhibition period extended in order to be visible during a committee meeting and in relation with a visit by the Danish Minister of Housing, Urban and Rural Affairs, during which Smart Aarhus was presented.

In regard to the strategic goals of each design case, they were successful at providing show-cases, insights on the potential of opening up and displaying municipal data on novel urban interfaces, as well as indicating the challenges when seeking to make data transparent and open in the urban space. The traffic department changed from being reluctant to release data towards embracing the idea of sharing data, and citizen services are currently exploring other ways of visualising data and bringing citizen service into the urban space. This can primarily be attributed to the participation in designing the application and having it as an internal example of novel applications of open data.

5.5 Digital urban development revisited

Following the short presentation of the findings from the design experiments and their contribution to the Smart Aarhus initiative, I will now revisit some core elements of digital urban development drawing on the exemplary cases.

I introduced the design cases or prototypes as the junction in digital urban development. They are the setting wherein stakeholders and practitioners engage in probing into the existing and prototyping the future, through participating in cooperative doings. In this case I have approached as an interaction designer, but it equally concerns architects, urban planners or policy-makers and other interest groups related to urban development, policy-making and technology.

If the design cases should be a centre of focus within a smart city initiative or as part of developing an ICT strategy for a city, they require participation from both the strategic level and the operational level. The specific design case can be initiated by either part, but in order to inform the strategic level, they must have a wider scope than solving a sectorial challenge and seek to address themes and challenges inherent in the smart city. This is done by involving participants, from different areas in the city, by opening up the understanding of the situation and seeing it in a long-term perspective. Moreover, the design case enters an operational context in which exiting stakeholders, sectors and standpoints provide an initial frame for addressing a specific challenge. This entails that a design case is at minimum, initiated with two purposes in mind, namely a strategic and an operational purpose. In the case of the Drive Now? application, the strategic goal was to provide a concrete outcome for Smart Aarhus and investigate the potential in opening up traffic data from the municipal traffic department. At the operational level, the application was a provisional suggestion for solving issues around congestion in Aarhus. In the case of City Bug Report, the initiation came from the operational layer with a very concrete 'need' for an installation on the city hall tower in correlation with MAB12. Subsequently, the strategic level staged exploratory workshops in order to examine open data in a broad context, as well as to uncover interesting data to be visualised.

In that line, the design case and the underlying design process act as a probe into the existing, helping the participants understand local challenges, technical barriers and the practice in which the future design will enter. In the case with the Drive Now application, it acted as a probe in the sense that it yielded a better understanding of the specificities around the local challenge of congestion, as well as explicating the 'business case' of the municipal traffic department to a broader range of stakeholders. While this seems commonplace, the existing descriptions of the smart city have had difficulties in describing the business case for open data and the smart city itself (see section 3.2.3). The application as a probe made information on local challenges explicit, and thus they can be addressed and

explored in future design cases or through evaluating the application in itself. Similarly, City Bug Report acted as a critical probe into the existing situation and practice within the municipality, probing and challenging the organization around themes such as transparency and responding to direct requests from citizens.

Throughout the development of the design case and when it is finished, each case informs, shapes and suggests solutions to the specific challenge at hand, as well as the smart city. In each of the presented cases, the final outcome is a manifestation of the initial problem setting and the choices that have shaped the design. The design case, and especially the outcome, is also a way of prototyping the future. On a very concrete level the finished applications or services are put forth as design suggestions enabling further inquiry, discussion, use and critique, as it is possible for outsiders to ask, *"What makes this application smart?"* Similarly, it can act as a filtering prototype, source of inspiration or a shared reference among the local participants and stakeholders – i.e. *"if that is possible we could [. . .]"* or *"we could [. . .], just as we did with [. . .]"* – when engaging in new design case. This was the case with the City Bug Report for citizen service department within the municipality. Prompted by the design case they have been inspired to envision new possibilities for future projects, such as experimenting with aspects from the bug report tool in their own development cycle and investigating the role of citizen service in the urban space and how to use data visualizations.

Finally, and most importantly, each case slowly becomes a part of the emergent smart city and, the individual stakeholders understanding of the local version of a smart city. They will shape, albeit on a minute scale, a part of the urban layers. When someone uses the Drive Now? application or walks by the city hall tower, each design case is interpreted and 'read' in the context of the city. This prompts reflections, questions, and for some, unease, as was the case with City Bug Report. Moreover, the concrete outcomes as exemplary cases shape the common understanding of what is slowly emerging. When using Drive Now? in promotion material or as a novel example within a sector, a wider range of

stakeholders begin to see the possibilities and challenges in the future smart city. The result of this tiny exercise in digital urban development does not make a smarter city. It just provides a few new additions to the digital urban layer in Aarhus and a small indication of how the future smart city will emerge.

6 THESIS DISCUSSION

In the preceding sections I have covered a wide range of perspectives on the city, the role of technology and how to approach this complex subject. I will to tie the core elements together in this final discussion. The contribution of this thesis regards both the posed research question, the exploration of the program and the particular knowledge embedded in the constructed artefacts. I will start by discussing the strength and limits of digital urban development. I will discuss how others could approach the smart city concept from a more open and inclusive angle, than the deterministic and commercial approach that is so characteristic the existing definitions. I will discuss the similarities and shared challenges between my research methodology and digital urban development. Finally, I will present the implications to design.

6.1 Digital urban development

The smart city is often described as a coherent solution to the present urban challenges in the immediate future. Some definitions implicitly point to investments in ICT infrastructure, while others imagine that when the urban systems are completely interlinked and integrated, they will provide a full overview of the city and enable smarter analysis and planning. By proposing digital urban development as a frame for operationalising the smart city, it is crucial to point out that the notion of a smart city is a dual challenge. First, to become a smart city, city leaders must first understand what the smart city means in a local context. They have to set a vision and continuously develop and challenge the vision, in order to avoid the failures of previous techno-urban endeavours. Second, implementing smart city 'solutions' in a local context is a

challenge in itself. This is not just a technical challenge, as many of the benefits from services and ICT comes when they can be integrated into the existing practice. Before we can combine and integrate IT-systems across the city, we must first learn to combine and integrate multiple ways of understanding and experiencing the city. I have suggested digital urban development as a way of approaching this dual challenge as an open-ended process in which city leaders strategically engages in design cases as vehicle for understanding the local smart city. By participating across sectors, organisations and ultimately the social and digital divide, in collaborative doings or the design of things, all citizens can take part in shaping the future city. As each design case evolve into a finished service or product, hopefully it will capture and manifest the pluralism of the many standpoints and station points. Either way, the design cases are at best provisional and provide an example to reflect upon, discuss and evaluate in the context of the overall vision.

Through my participation in Smart Aarhus and the design cases, I have found that the cases can provided valuable insight to both the participants and the smart city initiative. The design case contributes in two ways: It provides a prototype solution to the specific local challenges and it changes how the participants perceive and envision the possibilities in the technology and the smart city.

A large part of the strength lies in the combination of multiple perspectives. I have tried to illustrate that digital urban development could be a middle ground in which urban planners, policy-makers, designers and the technical fields can participate with their individual strengths and supplement their existing tools and methodology. Finally, digital urban development is an attempt to highlight the merits of interaction design, while at the same time urge practitioners and design researchers alike, to engage in exploring the smart city concept by providing more examples and prototypes which can be discussed among peers, citizens, policy-makers and city planners.

6.2 Limitations to digital urban development

The outcomes of the presented cases are either prototypes or installations that have run for a short period. This means that it has been difficult to determine whether the notion of the design case as a junction between the strategic layer and the operational layer is scalable to include larger digital urbane development projects. When a project requires larger investments or involves more sensitive technical systems within the city administration, it will be difficult to engage in an exploratory design case with multiple stakeholders and participation from citizens. When projects scale up, the process model tends to become more rigid. Moreover, many fields still favour the waterfall model, and the economic interest will implicate an open process. Projects above a certain threshold require an initial tender and a larger development team.

Moving between the strategic and operational levels requires some insight or access into both areas. If the strategic level imposes naïve assumptions on the operational level, it can be difficult to ensure the broad participation in a design case. This could mean that the participants will be anyone else, but the existing sectorial representatives, as they would simply continue to their own challenges in their own way. This is sometimes evident in the clash between the energy and transportation sector and the sustainability agenda. Moreover, if the strategic motivation for initiating a case is too open to be addressed at the operational layer, this could create a standstill due to analysis paralysis or incomparable agendas. This is often shown when initiatives explicitly seek to find *the* smart city business case for a cross sector case.

Lastly, it is difficult to see digital urban development would scale within a smart city initiative with a different organisational setup or defined more narrowly. If the initiative is anchored closely to a sectorial definition, such as smart grid or, or within the IT department, it might be difficult to even convince the strategic level to engage in exploring something they believe they have solved ready. And

without anyone actually questioning the smart city concept or the implications in infrastructural investments as the first move, it would be difficult for outsiders to challenge and participate in the process. There is an inherent danger, even in my proposal that the stakeholders succumb to solving sectorial challenges with sectorial tools. This is a well know challenge within user-centred design and iterative process models – as both are used as a label of approval.

6.3 Methodological implications

Digital urban development contains elements that resemble the notion of design research (see section 2.6) and the research methodology use in the thesis work. The strategic lever acts as a design-oriented way of using artefacts and cases as probes, while the operational level show the problem-solving orientation of research-oriented design. Moreover, the two different levels within digital urban development closely resemble the research methodology of the thesis. In my research methodology design experiments are the events in which design researchers and stakeholders meet, in order to investigate a research question and explore the framing program. This is not coincidental and research through design has inspired digital urban development in several ways. However, this means that the same issues that challenge the research community within interaction design, also implicates digital urban development as a way of producing knowledge.

The two types of knowledge that need to be balanced in a design case or in digital urban development require a dual focus from the participants. Just as design researchers engage in design activities and tend to suspend their role as researchers, the design cases can become too focused on solving the challenge in the design process. Just as discussions (see Zimmerman et al. 2010) within the design research community criticises research through design for being poorly documented and that the final artefact is regarded as a research outcome in itself, this implicates digital urban development as a method. Without a systematic way of sharing the knowledge gained across the two levels and between the broader group of stakeholders, the insights and experiences could end up being too closely

connected to the specific case and the participants as implicit and tacit knowledge. There is even the concern of cherry picking from a specific case that supports a strategic agenda.

The digital urban development and research through design share a duality and conflict in modus operandi. Just as I have found it exceedingly difficult to separate my research from my design activities and maintain some distance to my research 'objects', it is very difficult and requires training to move between providing general insight towards a research question or strategic agenda, while at the same time being deeply involved and committed to address a particular challenge towards generating a particular solution. Within the design research community, as regarding digital urban development, it is important to ask *"who should do the research and who should design?"* Does a policy-maker, city leader or researcher make you a good designer, or does a good practitioner make a good researcher or policy-maker. The challenge lies in serving two masters at the same time – the particular design and the general insights – and inevitably either one will be the prime focal point for action, as it is a difficult mental and organisational exercise to serve multiple agendas in action. This poses another relevant question for both interaction design and digital urban development: *"should practitioners become researchers or should researchers become practitioners?"* I will argue that it is, with some exploration and experience, possible to shift the two modus operandi and provide knowledge *for* practitioners through design activities, and knowledge *on* the city and how we do it by participating in collaborative doings.

6.4 Implications for design

Before I present my final conclusions within the context of the thesis, I will shortly present some of the implications for design drawn from my work. These can be understood as specific focal points or design strategies when approaching digital urban development and the smart city.The first and most important implication is the challenges posed from previous techno-urban initiatives to the smart city (see section 3.1.7).

These challenges should be the departure point for digital urban development and local smart city initiatives. If coming initiatives do not address the technological determinism, the heavy influence from a commercial approach or democratic implications posed by centralistic and top-down initiatives such as the U-city (see section 3.1.5).The emergent and evolving nature of a city means that it is out of immediate control and design. This entails that operationalising a smart city should happen within design cases that in turn provide concrete suggestions for solving challenges, as well as providing insight to the strategic level and the emergent smart city vision.

The complexity of the city and the multiple ways of experiencing the challenges entails that digital urban development to a large degree prescribes changing station point and standpoint by involving multiple perspectives and actively balance different ways of interpreting the existing city and the smart city vision. By making each perspective a part of the process and providing opportunities for eliciting and developing standpoints, it is possible to find a common departure point for addressing the challenges of the smart city.It is not possible for everyone to participate at both the strategic level or in the individual design cases. Therefore, it should be a design strategy to initiate design cases that covers a broad spectre of stakeholders, social groups and citizens. By doing so, it is possible to balance and include a holistic view of the city, standpoints and station points, in the emerging smart city.

Finally, digital urban development requires a citizen centre perspective. This means that one should strive to involve a broad spectre of citizens at both the strategic and operational level. This can be done either through direct engagement with citizens in design workshops, co-design, evaluation and prototyping, and by 'siding with the citizens', just as early participatory design sided with the worker. We have moved beyond attempting to democratise technology at the workplace, now we need to democratise technology in society and the city at large.

7 CONCLUSION

In this thesis I set out to answer the question *"How can interaction design provide a useful theoretical and methodological point of departure for operationalising the Smart city concept in the context of a specific city?"* The answer is provided in the form of a reconceptualisation of the smart city concept from an interaction design perspective as *digital urban development.*

In section 2, I outlined the convergence between interaction design and the city. I briefly presented the notion of urban layers as physical, institutional and social, before outlined specific characteristics inherent to the urban digital layer. In section 2.2, I presented the initial theoretical foundation from interaction design. Interaction design is separate field that emerged from Human-Computer Interaction (HCI), with a different focus and strong roots in the Scandinavian systems design tradition. This is reflected in the emphasis on user involvement throughout the iterative process, as well as the ideological grounding in user experience and values. Based on the notion of wicked problems and design research driven by design experiments as a mode of inquiry, I argue that there is an epistemological turn presented by interaction design, and that this is reflected a reaching out into a larger societal context.

In section 3, I presented the smart city term and its core elements, first through an examination of preceding techno-urban conceptions, followed by a critical reading of the emerging literature and reports on the subject. This lead me to present the smart city as both problematic, in section 3.3, as well as being an opening towards a smarter city in section 3.4. In my conclusion on the smart city,

I presented the smart city as both a challenge and an opportunity to approach the city from a holistic perspective. Moreover, I argued that the merits of a smart city is the challenge driven approach and that we must take care not to repeat the narrow focus on technology so dominating in the smart city genealogy.

Then I turned to the core contribution of the thesis – *digital urban development*. In section 4, I present digital urban development as a reconceptualisation of the smart city with a focus on operationalising smart city elements in the context of a specific city, its digital layer, and existing urban life. I argue that the smart city per complexity is beyond direct design, and instead suggests that we focus on engaging in design cases, and that design cases serve two primary purposes in digital urban development. My point is that by using design cases as a strategically vehicle for exploring the local smart city vision, while providing a suggestion for a concrete challenge, the cases act as probes into the existing layers of the city, and as prototypes of future possibilities. By engaging in multiple design cases across different application areas and stakeholders, this enables the strategic level to explore across multiple perspectives and applications area, and thus the cases partly facilitate a holistic approach, and partly prototypes the emerging smart city.

In section 5, I presented the Smart Aarhus initiative and two design cases in order to exemplify digital urban development in a smart city context. I show how the two cases – Drive Now? and City Bug Report – both contributed on an operational level by addressing specific needs, and on a strategic level by providing insight into the Smart Aarhus initiative. In section 5.5 I revisited digital urban development and discussed how design cases can contribute to the operational level and the strategic level of the smart city. In section 6, I have reflected on possible limitations to digital urban development and proposed some implications for design.

I will conclude this thesis by stating that although digital urban development is a preliminary attempt to provide a reconceptualisation of the smart city and scaffold a framework for operationalising the concept, I will argue that the design cases have provided what I sat out for. Both cases have contributed on the operational level, by providing a prototype that inspired and opened up the understanding of concepts like citizen-centred solutions, opening up data and bringing data into the urban space. Moreover, both cases provided a common reference, visibility and showcases for Smart Aarhus that show minute indications of what a smart city might be in Aarhus. This is evident from the many internal and external uses of the two cases in presentations and publications. However, it is still no simple matter to capture the concrete challenges encountered in both cases and disseminate these local findings to Smart Aarhus.

7.1 Further work

The work presented has been an attempt to scaffold a framework for simultaneously explore and prototype the smart city. This subject required extensive studies and interdisciplinary engagement beyond the scope of a thesis. I acknowledge that my curiosity has opened far more questions than I have answered. While the thesis work has provided me with an understanding of the smart city term, it has only provided an example of how it can be operationalised. Whether we name it the smart city or the digital urban layer, the complex convergence between the existing city and digital technologies is for most of us unchartered country. Therefor, the most inspiring task ahead is to provide more cases that can act as examples, probes and prototypes in further understanding the interplay between the urban layers. More precisely, I would like to further explore how we can start building a common language to describe and comprehend the complexity across multiple perspectives in a city, through collaborative doings.

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9 APPENDIX

Appendix list

Included in the thesis

Appendix A: Interview with participant from City Bug Report

Appendix B: Interview with participant from Drive Now?

Appendix C: Promotion material from Aarhus Kommune on Drive Now?

included on media

Appendix M1: Raw audio from interview A

Appendix M2: Raw audio from interview B

Appendix A: City Bug Report Interview

The respondent is the key participant from the citizens service department within the municipality.

The interview was conducted in Danish and has been transcribed in Danish. I the context of the thesis I have only included the most relevant parts. I have provided a preliminary condensation in English. These are merely key words and do not reflect the full interview.

Segment 1: On the initial involvement in City Bug Report

Time: 00:15:17

Interviewer: Nu prøver jeg lige at vende mig lidt over mod projektet ude på rådhuset. Kan du prøve at sige hvordan du blev involveret i projektet?

English: Can you describe how you where involved in the project?

Time: 00:15:30

Respondent: Jeg blev involveret ved at Line Knive henvendte sig til mig og sagde at vi har det her projekt, hvor jeg så fik tilsendt projekt beskrivelsen. Og i det her projekt leder de efter gode cases, altså gode data som man kunne anvende til det. Om vi havde lyst til at sætte os sammen med jer, for at finde ud af noget. Det var 3 uger før det gik i luften. Vi havde oplevelsen af at det var meget sent at vi kom ind i projektet. Vi tænkte egentlig, at vi vil se om vi kunne komme med et eller andet. Men projektet var, vi oplevede at projektet var klart. Alt det tekniske var, der var bestil LED lamper. Det var et spørgsmål om hvad der skulle vises deroppe.

English: I was approached by Line [Member of the Smart Aarhus secretariat]. She described the project and asked if we wanted to provide data and participate. When we where involved the project seemed well defined and almost ready. The technical parts were already in place.

Time: 00:16:31

Interviewer: Hvad var dine indledende tanker omkring projekt beskrivelsen og...

English: What were your initial thoughts on the project?

Time: 00:16:37

Respondent: Det synes jeg faktisk var rigtig - det har vi også snakket om sidenhen. Vi blev da også grebet af det faktisk fordi der er nogle gode muligheder i og. Altså man kan sige, på en eller anden måde så skal vi jo, så er vores opgave at markedsføre det her digitale univers som

borgeren skal til at træde ind i på en eller anden anderledes måde. Fordi vi ved jo at 80 procent af borgerne de kan. Det ved vi bare. Men derfra til at de gør det, der skal markedsføring til. Det var lidt spændende i det lys. Vi kunne komme udover rampen på en sjov måde. Det var meget fint.

English: Later on when we reflected on the idea. It caught on to us because we saw some good opportunities in it. A part of our work is to promote digitisation, and this seemed like a good opportunity.

Time: 00:18:06
Respondent: Jo, men altså. Jeg synes i det hele taget at hele den der gennemsigtighed og måden at vise data på en anderledes måde og gøre tingene smartere er et spændende perspektiv. Set i det lys, så var det et godt projekt.

English: I think the whole notion of transparency and displaying data in different ways is an interesting perspective.

Segment 2: Impressions on the installation on the tower

Time: 00:18:25
Interviewer: Hvad var dit indtryk af installationen på tårnet i forhold til de data og jeres rolle i projektet.

English: What is your impression regarding the installation on the tower, the used data and your role?

Time: 00:18:35
Respondent: Man kan sige at. Jeg sad med Bodil fra regnskab, som sagde: "Godt det blev taget ned det projekt." - Fordi, jeg tror at der er rigtig mange i kommunen, der har oplevet borgere spørge, bare fordi man sidder på rådhuset, så har de spurgt: "Hvad har I gang i med det projekt?" Det var rent faktisk utrolig synligt. Alle ser jo det rådhustårn og alle spørger hvad det kan være for noget, så der var rigtig mange med, det var et glimt i øjet, fordi hun vidste ikke så meget om det. Der var mange der spurgte, men hun viste ikke så meget om det.

English: I talked to a person in accounting. She was glad when the installation was taken down, because citizens approached her with questions, just because she worked at city hall. The project had a high degree of visibility, while most people did not know what it was about.

Time: 00:19:17
Respondent: Jeg synes faktisk at det var meget synligt. Jeg var ikke klar over hvad man kunne vise. Jeg troede at man kunne nogle mere detaljerede ting, lige da jeg fik projektet præsenteret. Der tænkte jeg at man kunne vise noget der siger noget i sig selv på tårnet. Det kan man ikke, man kunne vise et eller andet, der gjorde at man var opmærksom på tårnet og så skulle finde

informationen et andet sted. Der synes jeg måske at, der ved jeg at der er mange der kun har set tårnet og slet ikke ved hvad den bagvedliggende idé er.

English: I think it was very visible. I did not know what you actually could show on the facade. Initially, I thought you could display something in detail. This was not the case and you needed to seek information somewhere else to understand the project. I don't think that many understood the underlying concept.

Segment 3: The significance of using real citizen data.

Time: 00:20:03
Interviewer: Hvad betyder det at det er reelle tal og data?. Faktisk noget det er er myndighedsnært og alvorligt. Det kunne jo ligeså godt være en tilfældig animation.

English: What does it mean that the project involved real data opposed to an animation?

Time: 00:20:25
Respondent: Jeg vil jo sige, at det var det der triggede os i projektet da vi læste projektbeskrivelsen og snakkede med jer. Når det så er sagt, at der ligesom manglede en forbindelse mellem hvad man så og hvad det faktisk afbillede for borgerne. Det kunne ligeså godt være noget andet.

English: That was what intrigued us when we read the initial project description. That being said, the project missed a connection between what the citizens saw on the tower and what it actually was.

Time: 00:21:14
Respondent: Jeg vil sige at det triggede os og det er det der er gode perspektiver i, at vise nogle reelle data på en eller anden måde i by billedet.

English: It did intrigue us and there are some good perspectives in showing real data in the city.

Time: 00:21:24
Interviewer: Tanken var også at det giver transparent for borgeren, det bliver lige pludseligt alvorligt for kommunen som organisation. Den tosidede del af transparens.

English: The idea also involved a new level of transparency for the citizens, in the sense that it would be exposing the municipality?

Time: 00:21:36
Respondent: Jo, der er jo ingen tvivl om at alvorligheden, den tog vi jo med postliste sagerne. Der er ingen tvivl om at på rådhuset der var det meget alvorligt. Det kan du måske også se af den korrespondance der var med kommunikations afdelingen. Der var jo mange der egentlig var meget bevidste om at det var nogle reelle tal. Det var måske mere hjemmesiden end det på tårnet, kan man sige. Der var meget fokus på at der rent faktisk var noget her, hvor borgerne

kunne have en forventning til noget. Som vi skulle være sikre på at vi kunne indfri og følge op på. At det kan holde vand i, hvad ved jeg. Nogen har tænkt om det kan holde til forsiden på Ekstra Bladet. Det er lige pludseligt så synligt som det var.

English: There was no question regarding the seriousness for the municipality. People took it very seriously at city hall. This is indicated by the requests from the communications department, regarding the information on the website. We realized, that citizens might expect issues to be dealt with. Somebody has considered if this could hold stand a front page in the press. It became very visible very fast.

Time: 00:22:53
Respondent: Når man tænker frem, så tænker jeg også at man kunne blive endnu bedre til at finde nogle mere egnede data til sådan noget. Fordi postliste sager er på en eller anden måde smule abstrakt. De ved selvfølgelig godt at man kan fortælle noget og lave en sag.

English: When reflecting a bit more on the case, I think it would be possible to find data that better suited the purpose. The provided data was to abstract.

Time: 00:23:20
Respondent: Der er strikse regler for når en borger henvender sig til kommunen. Hvad der skal ske og hvordan man skal respondere indenfor en bestem periode og sådan nogle ting.

English: There are very strict rules regarding requests and complaints from the citizens. The municipality needs to respond within a given period.

Segment 4: The citizens as a ressource

Time: 00:25:07
Interviewer: Hvis vi vender os til hjemmesiden, hvad synes du så om tanken om at borgeren bliver en ressource der påpeger eller synliggøre nogle problemstillinger. Den der tanke om at man kan ind rapportere ting?

English: If we return to the homepage – the reporting tool – what do you think of the notion regarding using the citizens as a resource in pointing out issues and the ability to report these?

Time: 00:25:26
Respondent: Det synes jeg er rigtig fedt. Og jeg tror også at det kan have en fremtid. Den måde vi præsenterede, altså den måde vi begyndte og tænke på det her City Bug projekt på, det var jo det der med, at vi kunne forstille, det skrev jeg et oplæg til, hvordan man kunne forestille sig at den hjemmeside var bygget op. Man kunne forestille sig, at borgerne indrapporterede noget de havde set, de oprettede en sag og det er så kun de sager som ikke berører noget følsomt. Men mere almindelige ting. At man så kunne indbygge en høringsrotation i det. Det snakker vi stadigvæk om som noget der er rigtig spændene. De kan oprette en sag, de kan indrapportere

noget som de synes kunne gøres bedre eller en fejl eller et eller andet. Så kunne den blive offentliggjort på den her portal, så kunne andre interessenter og andre borger, men det kunne også være interessegrupper. [...] Så kunne man invitere interessegrupper til at komme med deres høringsvar til borger henvendelsen. Så kunne man berige det hele, og så kunne borgeren tage stilling til om man ønske at gå videre med det og oprette en sag. Så har man næsten overstået høringsdelen på forhånd eller kvalificeret den allerede.

English: I think it is really cool. I think it has a future. Following the initial presentation of City Bug Report, I wrote a suggestion for how the service could look. We envisioned that the citizens report something they have seen and then make a report. Subsequently, others would be able to contribute and comment on each report. After a short period, the report would be handed to the authorities, enriched by the pre-hearing on the platform

Time: 00:27:41
Interviewer: Hvad tænker du i forhold til at man kan udnytte borgeren som en ressource? Der er nogle øjne og en tilstedeværelse som man ikke kan matche?

English: What do you think regarding the citizens as a ressoruce?

Time: 00:27:53
Respondent: Det synes jeg er helt oplagt

English: I think that is obvious?

Segment 5: Reflections from the experiment

Time: 00:28:00 Interviewer: Hvis du ser på det på tårnet og den her platform som et eksperiment, hvad synes du så at man kan tage ud af det, både for kommunen og med et borger perspektiv? Hvad betyder den her slags eksperimenter for kommunen?

English: When looking at the installation at the tower, what have you learned? What does such an experiment mean for the municipality?

Time: 00:28:15
Respondent: Det betyder for kommunen, at vi tør give slip på et eller andet og så se hvad der sker. Det synes jeg er lidt spændende faktisk. Det kommunen kan lære af det er også at man [pause] Hvad kan man mere sige at kommunen kan lære af det? [pause] Det vi har lært at det, det er at sige, at når man laver sådan noget med. Man har lært det at når hjemmesiden bygges op, så skal den være rigtig gennemtænkt fra dag et, så man er. Nu er det jo bare et eksperiment, er der nogle. Det man kan lære er at når man skal gøre det i virkelighede, så gøre det rigtigt. Så man rent faktisk kan gribe borger henvendelsen, så man også kan sagsbehandle på den efterfølgende.

English: It means that we are can let go and see what happens. We learned the importance of getting it right from the outset, if we want to develop the reporting tool for real. We have learned what to do if it becomes reality and prepare for actually dealing with the reports from the citizens

Time: 00:29:22
Interviewer: Så du tænker at der også skal være et bagland der er parat til at tage dem alvorligt?

English: So you think you need to prepare the organization back-end to handle the requests?

Time: 00:29:24
Respondent: helt sikker. Det snakkede vi også om i projektet. Der skulle også være nogen der tog sig af de her henvendelser efterfølgende og på en eller anden må sørgede for at svare på det. I løbet af projektet. Det var også nogle af de rettelser der blev lavet på hjemmeside, det var jo også at gøre opmærksom på, at det skal i ikke forvente. Jeg mener faktisk at, og det har vi snakket om inde hos os, at der er faktisk en rigtig god ting i at inddrage borgerne på en eller anden måde og så udnytte den ressource. Vi har prøvet forskellige ting og jeg tror at det her kunne være, det er en meget interessant måde at gøre det på. Også at kombinere det med at få det ud i byrummet. Det kan man gøre på forskellige måder. Tårnet er selvfølgelig helt oplagt. Man kunne også gøre det på andre måder. Man kunne også lave noget ude i by billedet. Man kunne lave noget der var knyttet til bydele, altså sige at man havde forskellige bydele, hvor man havde forskellige informationstavler ude i bydelen. Man kunne godt forankre det lokalt i byen.

English: Definitely, This is one of our main reflections. The municipality needs someone to deal with the reports as soon as they come. We think it is a potentially good way of using the citizens as a resource. It is a very interesting approach, combining such a tool with something in the urban space. It opens up for the possibility to connect the project to specific communities via information screens and such.

Segment 6: Working in a political context

Time: 00:44:54
Respondent: Politisk, det skal modnes politisk. Det skal det bare.

English:Politically, these things need maturing

Time: 00:45:01
Interviewer: Det er en udfordring omkring kommunikation?

English: Is that a challenge around communication?

Time: 00:45:00
Respondent: Det er i sig selv en udfordring. Det er det. Nu har jeg været i det private før i lang tid. Det er noget der er gået op for mig da jeg kom herind [City hall] Det er både det der gør det spændende, men også nogle gange det der gør det lidt frustrerende. At man jo ikke altid

bare kan gøre ting. Men at man hele tiden skal have det clearet politisk også op gennem ledelses niveauer. Der er forskellige fora man skal have det godkendt i.

English: That is one challenge. I used to be in the private sector. Since I started working within the municipality, I became aware of the political implications within the organization.

Time: 00:45:46
Interviewer: Er der et vist råderum til eksperimenter?

English:Do you have 'space' for such experiments?

Time: 00:45:52
Respondent: Kadencen er at vi finder på en masse spændene projekter inden hos os. Nogle projekter informere vi bare rådmanden om på et rådmandsmøde, så rådmanden er orienteret. Men der er også projekter, hvor vi præsentere det som et oplæg eller notat. Fortæller at det har vi tænkt os at gøre, er der noget vi skal være opmærksomme på eller må vi godt det, før vi gør det?

English: Normally, we come up with several projects. Some projects are simply informed to the alderman, while others need approval.

Time: 00:46:22
Respondent: og så er der nogle ting vi bare gør og så efterfølgende at vide at. Det der tit sker, er at vi laver et eller andet og så er der en masse borgere der henvender sig direkte til rådmanden og siger "hvad har I gang i?". Og så er det man bliver kaldt ind på kontoret og siger "ok, hvorfor er det lige vi laver det her?". Så skal man klæde rådmanden på eller man får en, hvad hedder det. Man får en næse eller noget. Derfor er lederen meget opmærksomme på at cleare tingen længere oppe i systemet. Det er nogle gange frustrerende. Men det er en del af at være en politisk styre organisation.

English: And then there are projects that we just initiate. The citizens approach the alderman with questions, and we have to explain ourselves. We need to prepare the alderman. If now, we might get a reprimand. This makes the leaders very attentative to getting approval from above.

Segment 7: How have City Bug Report influence your work

Time: 00:53:45
Interviewer: Har projektet på tårnet givet anledning til nogle nye diskussioner omkring transparens og åbenhed?

English: Did the project initiate new discussions around transparency and openness?

Time: 00:53:54
Respondent: Ja det har det. Det har dels at vi er begyndt at interessere os lidt mere for hvordan

data kan vises. Vi var med til den der, Alexandra instituttet havde den der konference eller workshop dernede, som hed Big Data. Der var vi for eksempel med. Det havde vi nok ikke været hvis vi ikke havde været med i det her projekt. Det var jo bare fordi at vi tænker, hvordan kan vi egentlig bruge de data vi har. Hvordan kan vi vise det for borgeren på en smart måde. Det har det i hvert fald gjort.

English: Yes it has. We have started investigating how to display data. We participated in a Big Data seminar at Alexandra Institute. We would not have participated if not for the City Bug Report project. We want to investigate how to use our existing data in new smart ways.

Time: 00:54:21
Respondent: Og så har vi jo brainstormet på nye projekter. Der står sådan noget, der står den her faktisk i som noget vi kunne tænke os at arbejde videre med. En "Høringsportal" tror jeg vi kaldte det. [...] Det kunne vi godt tænke os at arbejde videre med. Det har det også give anledning til.

English: Furthermore, we have brainstormed on new projects. An something similar to the City Bug Report tool is included as a "Public Hearing Portal"

Time: 00:54:51
Respondent: Så har det givet anledning til at vi er i dialog med Alexandra Instituttet omkring borgerservice i byrummet. Fordi vi tænker at det er meget. Vi er blevet opmærksomme på at der faktisk er rigtig mange borgere der ser det der. De ved bare ikke lige hvad det der er. Hvis man blev endnu skarpere på og at det man viser også giver mening når man ser. Så tror jeg det er meget stærkt. Så skal man stadigvæk have noget bagved selvfølgelig, men det giver umiddelbart mening og kigge på et eller andet i byrummet.

English: It has also given occasion for initial dialogues with the Alexandra Institute around citizen services in the urban space. We have reflected on the project outcome and it has made us aware of the potential in using the urban space for these kinds of things.

Segment 8: Personal reflection

Time: 00:55:38
Interviewer: Har det fået dig personligt til at tænke anderledes omkring digital kommunikation, digitalisering og borgerservice?

English:Are you thinking differently in relation to digital communication, digitization and citizen service on a personal level?

Time: 00:55:45
Respondent: Ja, det synes jeg faktisk. Jeg er blevet meget inspireret af det her eksperiment. Det var jo et eksperiment, jeg synes også at, spørgsmålet er om det lykkedes eksperimentet. Men et

eller andet sted gjordet det jo fordi, jeg synes faktisk at det er spændende fordi vi har det på som et punkt, et potentielt projekt ude i fremtiden. Men også det at vi laver det der med Alexandra instituttet, med borgerservice i byrummet. Det er også inspireret af det her. Helt sikkert.

English: Yes I think so. I am very inspired by the project. As an experiment it was successful to some extend, since we have adopted aspects of the idea about citizen service in the urban space.

Appendix B: Drive Now? Interview

The respondent is the key participant from the traffic department within the municipality.

The interview was conducted in Danish and has been transcribed in Danish. I the context of the thesis I have only included the most relevant parts. I have provided a preliminary condensation in English. These are merely key words and do not reflect the full interview.

Segment 1: Intial involvement in Drive Now?

Time: 00:07:41
Interviewer: Øh, så prøver jeg lige at skifte lige præcist det projekt vi har være involveret i. Så prøve at høre hvordan du kom ind i projektet, øh

English:: Now I will change to the concrete project. How did you get involvet?

Time: 00:07:53
Respondent: Jamen øh, det tror jeg, at jeg gjorde ved et tilfælde. At øh, som jeg kan forstå det, så manglede man lidt en case eller også så var der nogen, eller en eller anden der havde hørt, at der måske var noget spændende. Så blev jeg smidt på og det var sådan set fint nok. Øhm, og man kan sige at projektet er sådan set levet uden, jeg ved faktisk ik' hvornår det blev sat i gang. Men der har noget ting uden at der rigtig har været nogen fremdrift kunne jeg næsten forstå.

English:: That was more or less coincidental. I could understand that someone needed a case or knew about our data. I don't know exactly when it started

Time: 00:08:37
Interviewer: Der er sådan set ikke så meget historik forud for workshoppen. Øh, hvad øh, hvordan har du oplevet din rolle i projektet.

English:: Well, not much preceded the workshop. What is your role in the project?

Time: 00:08:51
Respondent: Jamen, det har jo været meget sådan øh, hvad skal man sige øh, levere hvad vi har og så se faktisk kunne se, hvad i så kunne få ud af det. Der har ikke været så meget sparring, men det har måske egentlig, sådan se være meget fint. Øh, fordi vi har jo en eller anden ingeniørmæssig holdning til hvordan tingene skal være. Det er ikke nødvendigvis sådan at trafikanterne vil have det. Så det synes jeg faktisk at det har været fint, at vi har kunne hjælpe med at supportere, bland andet med data og så videre, som det nu har været muligt. Og så har i øh, forsøgt at få noget ud af det. Jeg synes faktisk altså, det er ikke sikkert at der er noget som trafikanterne kan bruge, men der er noget at øh. Og jeg tror ikke der nogen tvivl om at vi åbner op for data. Og det er også det som Michael Kirkfeldt han siger "Vi skal have de her data ud og ligge".

English:: Well, I think we just offered what we had and then wanted to see what could come out of it. And then we have offered support and advice where we could. And then our role is too open up the data. Michale [department head] have clearly stated that we want the data to be open.

Segment 2: Contribution to ITS or the field

Time: 00:12:04

Interviewer: Hvad tænker du, når man laver sådan en. Nu sagde du en ingeniørmæssig baggrund. Den vanlige type projekter. Hvad tænker du sådan en anderledes case kan biddrage til ITS som fagområde eller som en måde at tænkte trafikken på?

English:: How do you think a different case can contribute to ITS or the field?

Time: 00:12:24

Respondent: Den kan jo bidrage til, at det nok ik. Vi har meget driftsmæssigt fokus, ofte når vi for lavet vores ting. Men det er jo ikke det trafikanterne vil have. Derfor tror jeg det er smart at, også det der med at åbne data. Der er sandsynligvis meget bedre til at lave de her applikationer end vi er. Alternativt, hvis vi selv skal producere nogen, så er det nok nogle udefra som har styr på og få lavet de her, hvad skal man sige, lag - præsentationslag til vores trafikanter, således at det ikke er os der sidder og definere dem herinde. Vi har meget fokus på grafer, data - og gerne mange data. Men jeg har lidt på fornemmelse at [. . .] Det kan man også se på det i har lavet, at det er simpelt, der er meget få oplysninger. Og det er sikkert der man skal hen af. Men vi som ingeniør, vil jo gerne have meget mere information. Men det kan man jo så på en hjemmeside, hvor folk de kan søge endnu mere hvis de har behov for det. Det er klart, det er ikke i mobile at det skal ligge.

English:: We have a close focus on operation when we develop new things. That is not what the drivers want. That is why opening up the data is smart. Then others can take care of presenting the information and develop new service. Moreover, as engineers we like graphs, data and big data. What the application does is that it presents it in a much simpler fashion. That is properly the direction to go towards drivers.

Segment 3: Prototypes and potential

Time: 00:16:39

Interviewer: Så havde vi et kort koordinerings eller status møde i september 2012. Hvor vi snakkede om forskellige data kilder. Der havde vi faktisk taget en tidlig prototype med. [. . .] Hvad tænker du om den måde at man arbejder med at inden der faktisk er data på bordet, så begynder man at sige : "Sådan kunne det se ud"

English:: We had a brief coordination and update meeting in September 2012, where we presented a preliminary prototype. What do you think of that way of working?

Time: 00:17:04
Respondent: Jamen, det er helt fint, fordi det viser lidt om potentialet. At den. Jeg tror også I fandt ud af at der nok var en del der gerne ville have den. Der var ihvertfald også en del der har set den herinde [trafik og veje]. Jeg synes det viser lidt om potentialet. Hvad kan vi egentlig med det her. Og der er ingen tvivl om at hvis man bruger nogle af de GPS data der ligger, kombineret med de her real-tids data vi har, så kunne få en rigtig skarp applikation. Så jeg håber det bliver noget vi ligger ud, således at folk de bare kan lavet det så vi kan se hvad der kommer eller om vi selv poster penge i den første. Det må vi så lige se.

English:: That is fine. I think you experienced that it became popular. My colleagues in the traffic department saw it as well. I think it shows the potential and with real-time Time data and historical GPS date, it is possible to make a good application. I hope we push that out. Then we will see if others makes something interesting or we will provide a budget for a finished application.

Time: 00:17:58
Respondent: Jeg tror det er vigtigt, det her med at hvis man viser et kort. Det er lidt det samme som hvis man viser et trip-kort, det kan være ganske fortrinligt. Men det er lidt svært for trafikkanterne og, hvad skal man sige, og dissekere de her informationer. Os som fagpersoner, vi har et helt andet overblik end den gennemsnitlige trafikkant. Der tror jeg man skal passe på med hvad det er man forventer at trafikkanterne de kan. Og det der er godt ved app'en, det er den her simple. Du kan definere nogle ting i forvejen og så skal du bare trykke en gang, så får du noget information. Så ved jeg godt at man kan krydre med noget mere. Man kan kigge på noget historisk, har jeg en fordel ved at køre på et andet tidspunkt og sådan nogle ting. Men bare det der med at, altså det skal være så nemt. Man skal ikke sidde og kigge på et kort i en halv time. Det får vi ikke trafikkanterne til. Men kan du få sådan nogle simple bullet points, "du skal ikke køre nu, der er kødannelse" Og hvis man måske kan krydre med hvornår man forventer at det er, at man kan reducere rejsetiden igen, når køen er væk. Eventuelt hvis den kan fortælle at når man har valgt en rute, at det faktisk er bedre at køre ti minutter før. Det er sådan noget der er forholdsvist nemt for trafikkanterne at forstå og det er noget hvis der så bare er en procent-del der bruger det til noget så får vi allerede en gevinst, der ikke. Får vi fjerne toppen af spids belastningen, så får vi også fjernelse af den forsinkelse der ligger i spids belastningen.

English:: Showing a map can be good, but a little hard for the drivers to dissect. I think it is important to consider what to expect from an average driver. The application [Drive now?] is simple. You just define some preliminary information, press the button and get information. I know you can add stuff, but it has to be easy for the drivers.

Segment 4: ITS and understanding the needs of drivers

Time: 00:19:30

Interviewer: Tror du at ITS som fagfelt har svært ved at se det fra trafikkanternes side?

English:: Du you think the field of ITS have difficulties seeing it from the drivers perspective?

Time: 00:20:01

Respondent: Jeg tror det er svært at finde de her gode løsninger. Jeg ved at Harry fra Aalborg Universitet, at det er lidt svært at tænke den her killer-app, som folk de gerne vil bruge. Og det er jo ikke sikker at det er som så, men at det kan være at det er integrationen af borgernes data i andre [service], Hvis eksempelvis en af navigationsfirmaerne eller Google tager de her data til sig, så vil det se helt anderledes ud. Der gå nogen år før de har realtids data nok til at kunne lave det samme. Men hvis de kan trække på vores data for at give en bedre. Så er det også fint for os, fordi vi får en bedre trafik afvikling og en bedre udnyttelse af vores infrastruktur.

English:: I think it is hard to find the good solutions, the killer application. Perhaps when commercial navigational companies or Google get access to our data we will see an impact on the traffic and make better use of our infrastructure.

Segment 5: Using the application in presentations and communications

Time: 00:27:50

Respondent: Det kunne være interessant med en opdateret app, som en "se hvad man kan med de her data". Og så skal data jo ligges åben. Sådan at man kan få fat i dem.

English:: It could be interesting with a newer version of the application to indicate "what is possible with the data" And then we need to provide the data.

Time: 00:28:03

Interviewer: Hvordan har i brugt den [app'en] internt. Er det en i har vist til kolleger eller?

English:: Have you used the application internally?

Time: 00:28:12

Respondent: Det er en vi har vist til kollgear, også fordi folk spørger "Hvad er det vi skal bruge de her til?" Man kan sige at den her app, om ikke andet, så den gode ting at vi forholdsvis tideligt kunne vise – "Prøv at se her" – Hvis vi kan præsentere det her for trafikkanterne, tror i så ikke de vil bruge den. Der er der ingen tvivl om, det kan alle se, at det her, der kan komme et slut produkt som er noget folk kan bruge på daglig basis. For at finde ud af om det er, er fornuftigt at køre eller ej.

English:: We have shown it to collages. The good thing is that with the application we can show provisional example of the possibilities. There is no doubt that everybody can see the final product in this.

Time: 00:28:47
Interviewer: Har i brugt den eksternt også? Har i brugt den i formidling.

English:: Have you used it externally?

Time: 00:28:53
Respondent: Jeg har brugt dem på nogle brugergruppe møder vi har i Nordisk vejforbund, hvor jeg sidder i en gruppe hvor den er vist. Men ellers så har det være meget internt. Jeg tror nogle af mine chefer har brugt den ekstern osv. Der nogen der har set den ude omkring.

English:: I have shown it in an trade network and some of the department heads have presented externally.

Segment 6: How to use the application as an example

Time: 00:30:40
Interviewer: Hvad tror du sådan, at nu startede du også selv med at sige at den skulle bruges i Smart Aarhus som en quick-win. Hvad tror du sådan nogle cases betyder for fx Aarhus Kommune. At de begynder at begive sig ind i det der app marked og har nogle ting de viser frem.

English:: You started by saying it should be a Smart Aarhus showcase. What do you think it means when the municipality starts building applications and show them to the public?

Time: 00:31:00
Respondent: Jeg tror at det viser at der noget innovation i byen og at vi ikke bare vil gå traditionelle vej. Også at vi ikke bare bygger os ud af problemerne ik. Som er nok den traditionelle vej i den branche jeg sidder i. Nu holder folk i kø, så bygger vi et ekstra spor. I stedet for at begynde at tænke på nogle andre ting, jamen altså kan vi gøre noget anderledes i stedet for. Det tror jeg er vigtigt at signalere.

English:: I think it shows that the city innovates and not only rely on traditional approaches. Instead of building our way out of the congestion, we can start thinking in alternatives.

Time: 00:31:36
Interviewer: Hvis vi nu forestiller os en lidt mere færdig applikation, hvordan tænker du så at den kunne indgå i jeres arbejde.

English:: If we imagine a more finished application, how could that be a part of your work?

Time: 00:31:52

Respondent: Jamen, altså. Hvis vi skal have en færdig applikation, så skal den helt klart være til trafikkanterne. Så det vil sige, at hovedformålet det er kunne påvirke trafikkanternes adfærd, således at vi får en bedre udnyttelse af vores infrastruktur, det vil være målet med det. Det der med at kunne give trafikkanterne den information, også således at de bruger mindst mulig tid på vejene. Fordi, hvad skal man sige, tiden i bilen er for det meste spildtid. Hvis vi kan reducere den, så har folk lidt mere tid til noget andet.

English:: A finished application is for the drivers. The main purpose is to change the behaviour of the drivers in order to make better use of the current infrastructure. It is also to avoid wasting

Time being stuck in traffic.

Segment 7: Reflection on the project.

Time: 00:40:27

Interviewer: Det her projekt vi har været igennem med idé udvikling og alternativer, har det fået dig til at tænke anderledes omkring ITS

English:: Did the project make you think differently on ITS?

Time: 00:40:40

Respondent: Nej, det har ikke fået mig til at tænke specielt anderledes, men det har fået mig til at åbne øjnene op at der er nogen ting vi ikke selv skal lave som det vigtigste. Inden at vi havde mødet med jer, der tænkte vi skal da bare lige og så sætte nogle software folk til at lave noget. Der er det nok i højere grad , det vi skal. Vi skal sikre at data er der og så skal vi have andre til at lave de her ting, så vi får det præsenteret ordentligt. Men også åbne data op så det kan komme ud til så mange som muligt. Således at det er det samme der bliver meldt ud de forskellige steder. Så tror jeg at, selve trafikkant formidlingen med meget detaljeret information, den skal vi på en eller anden måde selv hoste. Og have til at ligge med historisk data, så når folk vil ind og grave i dem. Fx når der kommer et universitets projekt, så ligger data klar til at bruge.

English:: Not really. But it has made me realise what we should and shouldn't do. When we initially met, I thought that we only needed to define the core elements and then give it to some software developers. Instead, we should provide the data and then others can develop the solutions. We need to open data up for traffic information and other curios initiatives.

Appendix C: Promotion material from Aarhus Kommune on Drive Now?

Aarhus slipper sine data fri

Borgmester Jacob Bundsgaard i et server-rum, hvor firmaet Cabi i Aarhus administrerer og opbevarer en stor del af Aarhus Kommunes data.

Aarhus Kommune har givet firmaer, private, organisationer og andre mulighed for at få adgang til en lang række data – og leverer på den måde grundstof til nye apps i din smartphone

"Landets kommuner sidder på en guldgrube af digitale data, som bare venter på at komme frem i lyset og blive brugt. Data er et vigtigt grundstof til vækst og udvikling i det moderne samfund. I Aarhus har vi valgt at gå offensivt ud og har derfor allerede åbnet en hjemmeside, hvor en stribe data-sæt er lagt ud til fri udbenyttelse".

Aarhus-borgmester Jacob Bundsgaard er overbevist om, at tanken om Åbne Data vinder frem, for med den kraftige udbredelse af smartphones og tablets kan de digitale data blive til glæde og gavn for rigtig mange i hverdagen. Det er netop ved at kombinere de forskellige data, at de nye applikationer til smartphones er blevet populære.

"Vi skal hele tiden arbejde for effektivisering og nytænkning, så vi kan sikre fremtidens service og velfærd. Derfor er der et stort behov for innovation og for en ny arbejdsdeling mellem det offentlige og private. En måde at åbne for nye services er ved at frigive kommunens mange data til genbrug i andre sammenhænge", siger Jacob Bundsgaard.

Åbne Data – altså fri adgang til og behandling af offentlige data – er en trend, der løber over det meste af den digitale verden lige nu. I England har man gennem en årrække frigivet offentlige data på data.gov.uk. Og i Danmark har regeringen og KL tidligere i år indgået en aftale om grunddata.

Aarhus udnytter styrkeposition

I Aarhus vil man udnytte sin styrkeposition inden for IT og være på forkant. Det er sket ved at oprette hjemmesiden om Open Data Aarhus (oken.odaa.dk). Aarhus er overbevist om, at der ligger et stort udviklings-, vækst- og effektiviseringspotentiale i det hav af offentlige, indsamlede rådata, som Aarhus Kommune ligger inde med. Det gælder eksempelvis geografiske kort, juridiske data, trafikdata samt finansielle, demografiske og økonomiske oplysninger.

"Ved at stille de offentlige data til rådighed for virksomheder og kreative iværksætte kan vi skabe nogle gunstige vækstmuligheder for både nye og etablerede virksomheder og dermed få flere arbejdspladser. Samtidig bidrager vi til, at der bliver skabt nye og brugbare services for borgerne, der både vil styrke demokratiet og skabe en mere transparent og demokratisk forvaltning", siger borgmester Jacob Bundsgaard.

Arbejdet med Åbne Data er et af de væsentligste indsatsområder i Smart Aarhus, et partnerskab mellem Aarhus Kommune, Aarhus Universitet og en række andre organisationer.

Hvad er Smart Aarhus?

Smart City er en betegnelse for en udvikling af store og mellemstore byer i retning mod mere digitaliserede, intelligente og bæredygtige bysamfund.

I centrum for smart city-udviklingen står kreativ brug af digital teknologi. Datakraft og internet i al ting. Konkret handler det fx om højhastighedsnetværk, letadgængelig eller gratis trådløs internet (Wi-Fi), store og små skærme i de offentlige rum, intelligente huse, facader og gadelys, interaktive sensorer og kameraer, databaser og websites.

Smart Aarhus er et partnerskab mellem Aarhus Kommune, Aarhus Universitet, Alexandra Instituttet, Region Midtjylland, Teknologisk Institut, VIA University College og en række private virksomheder om at bruge digitaliseringens muligheder til at skabe fremtidens bæredygtige by.

Du kan læse mere om Smart Aarhus på smartaarhus.dk

Sådan kan åbne data bruges

Det er mystisk i Aarhus. Trafikken er tæt, og du overvejer at starte bilen. Er det bedre at vente? Skal jeg køre nu – og hvilken vej?

Det kan du få svar på ved hjælp af en app, der netop nu er under udvikling i Aarhus, og den er et godt eksempel på, hvad man kan lave, når kommunen og andre frigiver data. App'en bygger på blandt andet data, som Aarhus Kommune i forvejen anvender til trafikmålinger, data, som kommer fra de enkelte bilisters mobiltelefoner og tablets, udsendes via Bluetooth og opfanges af en række sensorer langs vejene. De mange data fra bilisterne vil i kombination med vejdata give et præcist billede af bevægelsesmønstre og trafiktæthed.

App'en findes foreløbig kun i en betaversion, men ventes færdigudviklet i år.

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