Master thesis

MEASURING THE SPILLOVER EFFECTS OF URBAN ICONS

Management in the Built Environment

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MEASURING THE SPILLOVER EFFECTS OF URBAN ICONS

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PREFACE

My first introduction to architecture took place when I visited the city of Barcelona as a 10-year old girl. During that trip, I became amazed by the beauty and grandeur of the yet unfinished, but yet iconic, Sagrada Familia by Gaudí. Experiencing the prestige of this urban icon enkindled my enthusiasm for the field of architecture, which has grown ever since.

This fascination of urban icons has sustained throughout my studies. My admiration for urban icons did not remain limited to the architectural appearance of these projects, but it was complemented by my interest in the impact such projects could generate. In my perception, urban icons are the ultimate resemblance of the power of architecture, as their impact can reach far wider than their function itself.

It is therefore not entirely coincidental that I have chosen to conclude my master's degree in Management in the Built Environment with a study on the impact of urban icons. By combining this subject with the exploration of the opportunities of big data analytics, I have intended to make a contribution to the establishment of a comprehensive toolbox of measurement methodologies that can provide more insight in the spillover effects that have been generated by urban icons.

Acknowledgements

This research could not have been accomplished without the extensive support I have received from my mentors, family and friends.

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Finally, I would like to thank my dear family and friends for accompanying me during these challenging and joyful years. In particular, I would like to thank my parents for unconditionally supporting me and for always giving me the freedom to chase after my dreams.

Nynke Wertenbroek

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ABSTRACT

Context

The development of urban icons has become a popular strategy for municipalities to reach envisioned spillover effects, e.g. by boosting the urban image or by functioning as a catalyst in the regeneration of an urban area. These iconic developments are not rarely associated with high public investments, which often tend to be based on ambiguous assumptions and ill-defined objectives.

Problem statement

Despite the high level of academic attention for the phenomenon of urban icons, the current state of research lacks the availability of a comprehensive methodology by which the spillover effects of urban icons can effectively be measured. Therefore, municipalities are yet unable to apply quantitative measurements to justify previous investments or to substantiate future investment decisions with regards to urban icons.
This research is focused on the establishment of an impact assessment approach, as it addresses the following main research question: *How can the spillover effects of urban icons be effectively measured?*

Methods

A qualitative strategy has been applied in this research. A literature study and case study have been conducted to establish the impact assessment methodology blueprint, by which the spillover effects of urban icons can be measured. Based on a literature study and focus group meeting with an expert panel, the implementation feasibility of the prescribed methodology has been determined.

Findings

An impact assessment methodology blueprint has been designed to comprehensively, quantitatively and longitudinally measure the spillover effects of urban icons at a high spatiotemporal resolution. The blueprint consists of three consecutive steps: (1) The integration of evaluation in the building process cycle, (2) the development of a big data-based project evaluation methodology and (3) the establishment of a data-driven urban planning practice. The results from the measurements can be applied to justify previous investments and to substantiate investment decisions.
The implementation feasibility of the prescribed blueprint is potentially obstructed by the methodological implications, consisting of the high required investments and the culture shift in the urban planning practice that the methodology implies. Furthermore, the effectiveness of the methodology may be negatively affected by a limitation of applicable data sources, as a result of issues regarding data reliability, privacy or ethical concerns.

Conclusion

In order to effectively measure the spillover effects of urban icons, municipalities should initiate a culture shift towards an approach in which research and urban planning are inseparably linked. Furthermore, municipalities should invest in the establishment of a methodology in which evaluation becomes an integral part of the building process cycle, big data sources are applied to effectively measure the impact of urban icons and a data-driven urban planning practice is established.

Key words

Urban icons | Flagship developments | Spillover effects | Project evaluation | Impact assessment methodology | Big data | Data-driven urban planning

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INTRODUCTION

1. Introduction

1.1. Personal motivation

Iconic buildings have always fascinated me: those buildings that you have to pay a visit to when you are in town, or the buildings that even persuade you to visit a city in the first place. But why is it that some buildings become a great success and others remain unnoticed? And who benefits from the success of these urban icons?

Although much has been written about iconic projects and their envisioned effects, many questions still remain unanswered. With this graduation research I aspire to take a next step in finding the answers to these questions by investigating the possibilities to measure the impact of urban icons, while exploring the opportunities of implementing the relatively new field of big data in urban management and research.

1.2. Problem statement

Many cities have invested in the development of iconic flagship projects, with the aim to boost their urban image or to generate spillover effects on their surrounding area. Although many studies have been done on the phenomenon of urban icons, most studies applied a qualitative approach and solely focused on the intended impact. Therefore, there is a need to extend the toolbox of research methods and to create an impact assessment methodology by which the different spillover effects of urban icons, including both the intended and unintended impact, can be quantitatively measured.

The urban data landscape has become increasingly diverse and complex due to the large amounts of data that are collected by the use of new technologies, e.g. sensor technologies and social media, besides the traditional collection of census data. In comparison to other fields of research and management, the implementation of big data analytics has yet lagged behind in the fields of urban research and management.

Big data analytics may provide the solution that is needed to extend the current toolbox of research methods to assess the impact of urban icons. The methodology may provide insight in aspects that cannot be measured with traditional census data. Furthermore, it has the potential to conduct more effective impact assessments, due to the higher variety of aspects, larger data volumes and higher spatiotemporal resolution. Besides that, it enables the use of more efficient, thus less time-consuming and less expensive, measurement methodologies. Moreover, the collection and analysis of large data volumes may reveal possible correlations between different aspects, which can be incorporated in the development of data-driven policies and strategies.

2. Relevance

2.1. Societal relevance

The development of iconic flagships has become a popular strategy for municipalities to boost their urban image or to generate a catalytic effect in the regeneration of an urban area. Many potentially iconic developments have been fully financed or financially supported by municipalities. These investment decisions are often substantiated by municipalities using references to famous examples of urban icons, like the Guggenheim Museum in Bilbao or the Erasmus bridge in Rotterdam.

However, these investment decisions are not rarely based on ill-defined objectives. Furthermore, it is not common for municipalities to conduct an ex post evaluation in order to examine whether the project has actually generated the effects that they had envisioned.
Because of the lack of clearly defined objectives and impact assessments after completion, municipalities are not able to justify their previous investments or to develop an evidence-based policy or strategy with regards to the investment in potentially iconic projects. Therefore, municipalities' investment decisions remain to be mainly based on assumptions with regards to the envisioned spillover effects instead of proven goal-means relationships.

The development of a big data-based impact assessment methodology may provide municipalities an effective measurement tool by which they can evaluate the effects that were generated by the projects they have previously invested in. The results of these impact assessments can be incorporated in future decision-making processes and be used as input for the development of data-driven policies or strategies.

2.2. Scientific relevance

Many researchers have studied the phenomenon of iconic flagship developments, in order to investigate which effects can be generated by such projects. However, some gaps remain in the current state of research, which can be filled by a new methodology to measure the spillover effects of urban icons.

In most studies on urban icons a qualitative strategy was applied through the conduction of several case studies. This approach can provide extensive insights in the effects generated by the particular projects, but it does not create quantitative evidence for potential correlations between project characteristics and the effects generated by it.
Besides that, many of these studies have been focused on one piece of the puzzle, e.g. the project's economic spinoffs or its contribution to the urban image, instead of having taken into account the wide range of potential effects they can generate.
Moreover, most research has been focused on the objectives of the stakeholders involved. In these studies, they attempt to prove whether the case study subjects have generated the effects that were envisioned by the initiators. Possible (negative) unintended impact is therefore disregarded in these studies.
Finally, research on the effects of iconic flagships often consists of a one-time study. There currently is a lack of longitudinal research that can provide insight in the process of change generated by urban icons on a longer term.

Considering these shortages in the current state of research, the toolbox of research methods to study the phenomenon of iconic flagship developments can be expanded by the establishment of a comprehensive quantitative impact assessment methodology, by which the intended and unintended impact can be measured on different moments in time.

3. Research proposal

3.1. Research questions and hypothesis

Main research question

Due to the current state of research and practice, the demand for a comprehensive impact assessment methodology has emerged, by which municipalities can effectively measure the spillover effects of urban icons. Therefore, the following main research question has been defined:

How can the spillover effects of urban icons be effectively measured?

Sub-questions

The following sub-questions have been defined for the different parts of the research:

Theoretical background
- *What are the gaps in the current state of research on the spillover effects of urban icons?*

Case study
- *Which types of effects are relevant for the evaluation of urban icons?*

Impact assessment methodology
- *By which assessment methodology can the impact of urban icons be effectively measured and monitored?*

Implementation feasibility study
- *What is the feasibility of implementing the impact assessment methodology blueprint in practice?*

Hypothesis

The exploration of the opportunities to apply big data in the impact assessment of urban icons will play a central role in this research. Based on this research perspective, the following hypothesis is formulated:

By the application of a big data-based approach, a comprehensive and feasible assessment methodology to effectively measure the impact of urban icons can be established.

3.2. Research classification

The research that has been conducted can be classified by the definition of the research approach and research strategy. In the next subsections, the research method will be classified on the basis of both distinctions.

Research approach

Based on the research approach distinction explained by Barendse, Binnekamp, De Graaf, Van Gunsteren, and Van Loon (2012), this research can be classified as *hybrid research*, which is a combination of empirical and operational research.

Empirical research is aimed to solve knowledge-related problems, in which explanations of existing phenomena are formulated (Barendse et al., 2012). The empirical part of the proposed research is made up of the theoretical background and case study.
Operational research is aimed to solve design problems, in which a new artefact or methodology is created (Barendse et al., 2012). The combination of the impact assessment methodology blueprint design and implementation feasibility study can be considered as the operational part of the proposed research.

Research strategy

Based on the research strategy distinction explained by Bryman (2015), this research can be classified as *qualitative research.*

Qualitative research is characterized by the inductive view on the relationship between theory and research, whereby theory is generated out of research (Bryman, 2015). The structure of this research, in which the findings from literature and the case study are used to design a new impact assessment model, can be characterized by its inductive approach. Furthermore, the research strategy can also be classified as qualitative research based its exploratory nature.

3.3. Research design and report structure

Research design

The research design is divided into four parts: the theoretical background, the case study, the impact assessment methodology and the feasibility study. The parts are sequenced in a way that each part generates input for the consecutive part.

The research design is structured in the following way:

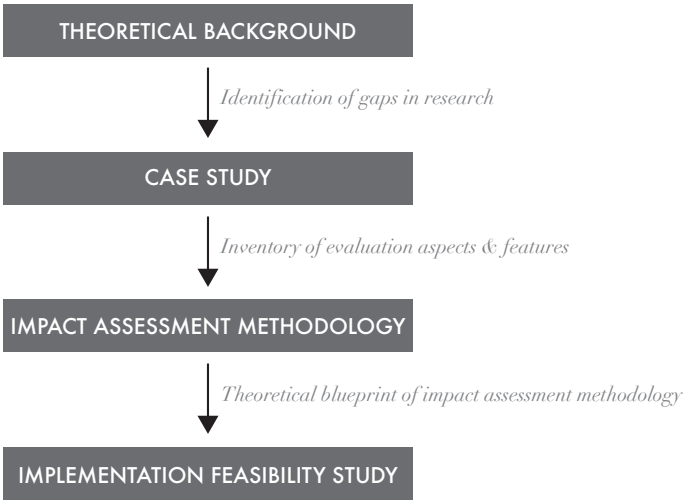


Figure 1: Research design (own illustration).

Report structure

The report structure is derived from the research design, as each part will comprehend one chapter. This introductory chapter will be followed by respectively the theoretical background (page 10), case study (page 15) impact assessment methodology (page 28) and implementation feasibility study (page 51).

THEORETICAL BACKGROUND

1. Introduction

In this chapter, an exploration will be made of the current state of research with regards to the phenomenon of urban icons and their spillover effects.

The following research question will be answered in the following paragraphs: *What are the gaps in the current state of research on the spillover effects of urban icons?*

Firstly, an overview will be provided of urban icons' characteristics and functions. After that, the different types of intended impact will be discussed. Furthermore, an overview of the existing studies on the impact assessment of urban icons will be given. Finally, the gaps in the current state of research will be identified in order to answer the research question.

2. Characteristics and functions of urban icons

2.1. Characteristics of urban icons

Cities have realized that iconic buildings and structures can be used as a means for their urban promotion and marketing campaigns. Besides that, iconic structures can be used to function as a catalyst in urban regeneration, which is called 'public led gentrification' (Verheul, 2012).

Although different researchers have described the characteristics of urban icons or flagships, there is no set formula for the shape or programme that flagships consist of. Doucet (2010) stated that urban icons frequently include high-end housing, cultural facilities, retail, tourist attractions, hospitality services, command & control office space and iconic architecture. Sklair (2006) has defined two characteristics of iconic architecture: urban icons are famous and have a symbolic or aesthetic meaning.

2.2. Functions of urban icons

Several theories have been written about the effects that are envisioned or observed in iconic developments. According to Doucet (2010), flagships have three drivers that they aim to attract: tourism, inward investment and high-end housing. From these three drivers, seven possible goals of flagship projects were defined:

- Image enhancement
- Catalyst for growth and investment
- Creation or promotion of a tourist attraction
- Gentrification
- Climbing the urban hierarchy
- Trickle-down theory
- Direct social aims

Not all of these goals are undoubtedly present in each flagship development, as the focus may lay on a different aspect for each project (Doucet, 2010).

According to Verheul (2012), urban icons have four functions that are interrelated:

- Symbolic value
- Sacralisation of urban icons (tourism)
- Urban pride and identity
- Economic or social spin-offs

3. Intended impact of urban icons

Cities often invest heavily in the development of urban icons and the substantiations for these investments are often based on the intended impact of the projects. The following sections will provide an overview of the different types of impact that is often envisioned with the development of iconic flagship projects.

3.1. Symbolic value

One of the characteristics of iconic architecture is the symbolic or aesthetic value of a building. This value implies that a building has a special meaning that is symbolic for a culture and/or a time, which includes an aesthetic component (Sklair, 2006).

Urban icons offer a form of recognizability and stimulate the imagination (Verheul, 2012). Hospers (2009) also addressed the importance of imageability: which landmarks will be photographed by tourists and will be put on a postcard?
Some argue that iconicity in postmodern times is entirely a matter of image, in which drawings and photography contribute widely to the establishment of iconic status (Sklair, 2006).

3.2. Tourism

The growing importance of icons is related to the 'sacralisation' of iconic buildings. As iconic architecture used to be a means to express monumentality for religion or royalty, it has now become a means to express capitalism (Verheul, 2012). Cities that do not posess historic or natural landmarks must be proactive in the creation of places and events that attract tourists (Doucet, 2010).

One of the successful examples is the Guggenheim Museum in Bilbao, which has become the image of the 'Guggenheim effect'; the term to describe the effect of revitalizing a city's urban and economic fabric with a cultural artefact (Plaza, Tironi, & Haarich, 2009). The attraction of tourists is one of the goals of the post-industrial economy and is one of the three main drivers of flagship projects. Flagships can be seen as examples of urban entrepreneurialism, which is a concept characterized by the aim to attract inward investment and which is mostly geared to outsiders instead of local residents of a city (Doucet, 2010). This primary focus on outsiders has risen the question whether local residents will also benefit the effects generated by the development of flagship projects.

Nowadays, urban tourism is inseperable with photography and buildings have become iconic because they are being reproduced. Because of the images shared in different forms of media, people shape an image of a place before visiting it (Verheul, 2012). These types of media construct and regulate the varied gazes of tourists. Despite the growing importance of imagery through the mass media, tourism is not only reduced to visual experiences. People want to see, hear, smell, touch and taste the places they gaze upon (Larsen & Urry, 2011).

We live in an era called the 'experience economy' in which cities have become experiences instead of places. In the experience economy, cities have become places for consumption in which icons have become important marketing products (Verheul, 2012). The pleasures of tourism are now grounded in the enjoyment of 'gazing' or visually consuming places that are out of the ordinary (Larsen & Urry, 2011).

3.3. Economic spin-offs

By investing in prestigious projects, municipalities aim to generate economic spin-offs for gentrification, like increasing the average income and lowering the crime rates within a neighbourhood. However, it remains questionable whether the envisioned spin-offs are not merely an indication of the transfer from problematic situations from one neighbourhood to another neighbourhood (Verheul, 2012). Although local politicians often claim that flagships have a beneficial outcome for the city's residents, it has been argued that flagships will continue to reinforce social, economic, cultural and spatial divisions within the city. Today's megaprojects are believed to be more concerned with wealth creation, rather than wealth distribution (Doucet, 2010).

Besides the generation of economic spin-offs, flagship projects can also be used as a strategy to have a catalytic function on the urban development of the surrounding area. Claassen, Daamen, and Zaadnoordijk (2012) dinstinguish four types of catalysts, which either have a permanent or temporarily catalytic function and are either product-based (becoming a symbol itself) or process-based (attracting investing actors).

The Sydney Opera House is a famous example of the economic spin-offs that can be generated by urban icons, as the real estate value of surrounding properties has skyrocketed and revenue of surrounding shops, restaurants and hotels have increased significantly since the project was completed (Verheul, 2013a).

3.4. Public pride and urban identity

Cities are more than ever concerned with their identity, image and brand value (Hospers, 2009). The study by Lynch (1960), in which the five elements that build up a city image were determined, can be used by city marketers to understand the city's imageability. Understanding of a city's imageability, how a city is framed in our head, can provide insight in what a city has to offer (its identity) and how it is perceived by the public (its image) (Hospers, 2009).

Anholt (2008) distinguished three elements that are interrelated in the branding of a city: strategy, substance and symbolic actions. A city should not only know where it stands and where it should go, but it should also execute its strategy and develop actions that have an intrinsic communicative power. The development of iconic buildings is nowadays commercialized and popularized (Verheul, 2012) in an attempt to contribute to the image and branding of a city. Urban spaces that contribute to the branding of a city are also called 'brandscapes' (Verheul, 2013b). It is a misconception that the size, ambition and costs of initiatives to brand a city are directly proportional to their value. For example, in the City Brands Index the Manneken Pis statue was mentioned 20 times more than the atomium building and European headquarters in Brussels (Anholt, 2008).

The media plays a large role in the reproduction of images of a city in people's minds (Hospers, 2009). The mass culture can influence the fame and possible visitors' perception of icons. The imagery and tourist perception are determined by a 'hyperrealistic' process of meaning (Verheul, 2012). This statement relates to the hypercity theory by Nas (2016), which states that the symbolic side of a city is so compelling that it can be seen as being detached from reality. The hypercity or hyperreality lives a life of its own and is suitable for manipulation. However, cities are not only landscapes, but also sensescapes: people's mental maps of a city turn out to be formed by their 'sense of occassion', of experiencing the smells and sounds of a place (Hospers, 2009).

Recognizability of icons can vary between persons (Hospers, 2009). Francescato and Mebane (1973) showed there are differences between city images that are perceived by people from middle or lower classes, natives or non-natives and younger or older residents. The cultural value of icons can differ between target groups and can thereby differ between local residents and visitors (Verheul, 2012). This 'observer variation' makes it hard to come up with a common and objective image of the city, as the perceived image of a city is based on the different backgrounds and experiences of the people that are questioned in studies on urban image (Hospers, 2009).

3.5. Social spin-offs

According to Verheul (2012) urban icons can generate social spin-offs, which can be represented by the increase of employment, the decrease of criminality or the improvement of the public domain in the surrounding area.

The development of iconic projects is often supported by cities as a means to regenerate less favoured urban districts, which process is called 'public led gentrification'. Although this process can result in lower criminality and unemployment rates, it remains questionable whether these social problems have been reduced or replaced to other neighbourhoods (Verheul, 2012).

Moreover, the decision to invest in flagship developments is often substantiated by local authorities with the argument that the project will become beneficial for the residents of the city. However, the effects do not always turn out in favour of the local citizens (Verheul, 2013a), but only in favour of the elite, that consists of potential investors and tourists (Verheul, 2012).

3.6. Cultural spin-offs

The development of urban icons can contribute to gentrification and generate cultural spillover effects (Verheul, 2012). An example of the potential cultural spin-offs is addressed in the study by Plaza et al. (2009), who investigated the impact of the Guggenheim Museum on the city of Bilbao, often referred to as the 'Guggenheim effect'. The project did not only transform Bilbao into a tourist attraction, but the museum also affected the local art sector as the development influenced the art-supporting policies and it rearranged the city's art market.

4. Current state of research

4.1. Qualitative research on iconic flagship developments

In most studies on the phenomenon of iconic flagship developments, a qualitative research strategy has been applied. A broad range of aspects has been addressed and multiple methodologies have been applied in the studies on this subject.

Verheul (2012) conducted a discourse analysis on the role of public authorities in the development of urban icons. By analysing the initial objectives of the involved stakeholders and evaluating the projects after completion, he gained insight in the effects that the projects have generated and the influence of public authorities in that achievement.

Doucet (2010) conducted two extensive case studies of Glasgow Harbour and Rotterdam's Kop van Zuid, in which he both examined the role and objectives of the stakeholders in the development, but also analysed the local residents' viewpoints and perceptions of the two projects.

Sklair (2006) explored the role of iconic architecture in the context of capitalist globalization, in which iconic developments have transformed into corporate symbols.

Hospers (2009) advocated the application of the 'mental map' methodology that was developed by Lynch (1960), in which people are asked to draw a simple image of how they view a specific city, in order to examine which places are perceived to contribute to the image of a city.

Romkes (2016) did research on the catalytic effects of the flagship developments in the area of Overhoeks, Amsterdam. The social indicators that were used consist of image, social nuisance and social cohesion. In the case study, some positive and some negative catalytic effects were discovered.

Claassen et al. (2012) conducted four case studies in which the strategy and outcomes of different types of catalytic projects in urban development were examined. They concluded that the effects of catalysts were not predictable solely based on their typology, because the projects' effects are strongly interrelated with their context.

4.2. Quantitative research on iconic flagship developments

Several quantitative studies have been conducted to explore the effects of urban icons. Similar to the qualitative research mentioned in the previous section, the range of subjects and methodologies that have been applied is broad.

Crandall, Backstrom, Huttenlocher, and Kleinberg (2009) studied the symbolic value of iconic projects by analysing the amount of online shares of the different buildings' images on Flickr. By this analysis, they were able to identify the most popular buildings, both worldwide and on city level.

Plaza et al. (2009) did research on the effect of the Guggenheim museum in Bilbao on the city's local art scene. By comparing different indicators, including the public funding and the number of cultural establishments, they were able to observe the changes that occurred in Bilbao's art scene since the completion of the Guggenheim museum.

Oligschläger (2015) conducted a hedonic price analysis on the real estate surrounding different iconic projects in the Netherlands. With that methodology, he was able to examine whether urban icons had generated an economic spinoff that increased the real estate value of surrounding properties.

Van der Drift (2015) identified the most photographed places in the city of Amsterdam, in which a distinction could be made between the photos taken by tourists and locals. The analysis of photo shares on Flickr also provided insight in the popular touristic routes within the city and the time of day that each location was most popular.

5. Summary and conclusions

Although iconic flagship developments have become a much studied subject, the current state of research still does not provide a comprehensive toolbox of measurement methodologies by which we can fully examine and understand the phenomenon of urban icons.
The following subsections will provide the answer to the research question: *What are the gaps in the current state of research on the spillover effects of urban icons?*

Firstly, most studies on urban icons employ a qualitative research strategy. Although this research does result in interesting insights on the roles of the stakeholders and the observed effects of the projects that were analysed, they do not provide any conclusions that can be considered as non-project specific. Therefore, there is a need for a quantitative approach, that enables researchers to compare multiple projects and potentially find interesting correlations between the project characteristics and effects.

Secondly, many researchers have studied one piece of the puzzle with regards to the iconic developments and their impact. However, there has not been any comprehensive study yet in which all possible effects of iconic flagships will be examined. Therefore, there is a need for an all-encompassing method that covers more pieces of the puzzle.

Furthermore, most of the research regarding urban icons has been focused on the projects' objectives that were defined by the stakeholders. These studies included an evaluation, in which an investigation was made whether the pre-set goals were achieved after completion of the development. However, research has shown that developments can also generate unintended negative impacts on the surrounding area. Therefore, a comprehensive measurement methodology is needed that does not only cover all positive pieces of the puzzle, but also examines the unintended and potentially negative impact that iconic flagship developments may have caused.

Finally, most studies are focused on a one-time comparison between a before and after situation. There are no known longitudinal studies that have examined the effects of urban icons over a longer period of time. Because change happens gradually and the pace of change can differ over time, a research methodology needs to be developed that can be conducted on a long term and over multiple intervals of time.

In this research I will address the aforementioned shortcomings in the current state of research and I will aim to design an effective impact assessment framework, by which the intended and unintended impact of urban icons can be quantitatively and comprehensively measured over a longer period of time.

CASE STUDY

1. Introduction

This chapter encompasses a case study of the Markthal, an iconic development in the city of Rotterdam.

This case study has been conducted in order to gain understanding of the objectives associated with the development of this urban icon, the strategies that were applied by the main stakeholders and the outcomes that can be observed since its completion.
The results of the case study will provide insight in the complex set of multi-actor decisions within the project. Besides that, the results of the case study have been used to determine the project-specific elements of evaluation that will be integrated in next chapter's impact assessment methodology blueprint.

Based on the analysis of project documentation and semi-structured interviews with the main stakeholders involved in the development, the following research question will be answered in this chapter: *Which types of effects are relevant for the evaluation of urban icons?*

In the next paragraphs, an overview will be given of the objectives, strategies and outcomes associated with the development of the Markthal. In the final paragraph, the match between objectives and outcomes will be determined and the research question will be answered.

1.1. Case selection criteria

Multiple case selection criteria have been defined, which have been applied to select the most suitable case study subject. The following selection criteria have been applied:

Iconic status

The case study subject should either have been envisioned to become an iconic building during the development or it should have been appreciated as an iconic building by the public or media.

Data availability

The case study subject should entail a sufficient data availability, both in terms of traditional census data and data generated from social networks. Due to the availability of data from social networks, the subject is preferably completed within approximately 5 years ago. Due to the availability of traditional census data, the subject should not be completed within the last 2 years.

Location

The case study subject should be located in a city that has actively facilitated and supported the development of iconic buildings. Proximity of the location is preferable, due to its potential to conduct field research or interviews.

Involvement of a municipality

The case study subject should have been developed with active involvement of a municipality. This is based on the broad range of objectives that municipalities take into account when making an investment in a project, in contrary to the drivers of commercial developers and investors.

1.2. Case introduction

The case study subject that has been selected is the Markthal (figure 2), which is located in the city of Rotterdam. The Markthal is a mixed-function project, which consists a large market square with retail

(4.600 m2), bars and restaurants (1.600 m2), that is overarched by 228 apartments. A large underground parking is located underneath the building, providing space to over 1000 cars (Markthal, n.d.).

Figure 2: De Markthal, Rotterdam (Provast, n.d.).

Suitability as case study subject

The Markthal can be considered to be a suitable case study subject as it meets all of the previously described selection criteria.

The imposing building, which was designed by MVRDV, has generated much attention from national and international press. Within the first days after its opening, the Markthal was already branded as Rotterdam's new icon by architecture critics (Archdaily, 2014) and the project has even been compared to the iconic Bilbao Guggenheim Museum (Miles, 2015).

The project was completed on October 1st 2014. The data availability since this completion date is sufficient, because it entails the availability of multiple years of census data and social network data. Besides that, an independent research organisation has been commissioned by the owner to analyse the visitor movement and spending behaviour inside the building.

The Markthal is located in Rotterdam, a city that has actively facilitated and supported the development of iconic buildings within the last decades. In the last years, the Rotterdam skyline has been extended with the iconic Markthal, De Rotterdam and the new central station.

The municipality of Rotterdam has been actively involved in the development of the Markthal. The municipality played an active role in the regeneration of the Laurenskwartier area, within which the Markthal is located, by using its preferential right to buy deteriorated real estate in the area.
The idea to develop a market hall was initially proposed by the municipality, which put out a tender to select a consortium to develop the plan.
Eventually, the municipality turned out to have an indispensable influence on the financial feasibility of the project by its investment in the parking garage and by the exploitation of a temporary leasehold construction for the land.

Main stakeholders

In the next paragraphs, the objectives, strategies and outcomes of the Markthal project will be analysed from the perspective of the main stakeholders involved in the project.

The following main stakeholders have been involved in the project:

- Municipality of Rotterdam — *as public planning body, initiator of the project, investor of the parking garage - interviewee: Matija Stanicic*
- Provast — *as developer of the project - interviewee: Hans Schröder*
- Klepierre — *as current owner of the commercial floors - interviewee: Marcel Kroes*

- Vesteda *as current owner of the leasehold dwellings*
- MVRDV *as architect of the project*
- Rotterdam Partners *as public relations manager - interviewee: Kim Heinen*

Timeline

The following timeline will provide an overview of the most significant events that took place during the development of the Markthal:

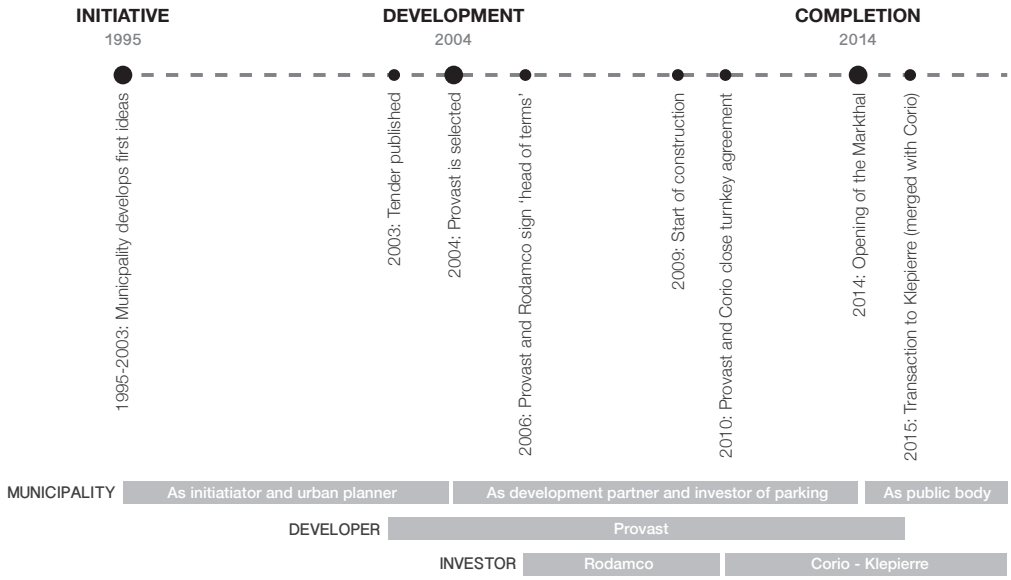


Figure 3: Timeline of the Markthal development (own illustration, information retrieved from Schröder and De Wit (2017)).

2. Objectives

This paragraph will provide an overview of the different objectives that were envisioned by the main stakeholders in the development of the Markthal. A distinction has been made between the project objectives, the objectives associated with the urban regeneration of the Laurenskwartier and the image-related objectives.

2.1. Project objectives

Building programme

The initiative to develop a market hall at its current location was taken by the Municipality of Rotterdam. Multiple factors had motivated the municipality to take this initiative. Most importantly, European legislation concerning the sale of fresh goods would become stricter, which threatened the ability to sell fresh goods like meat, fish or cheese, in regular market stalls. Therefore, the municipality decided to develop a plan by which the possibility of selling fresh goods at the location of the traditional Binnenrotte market would be maintained (Schröder, 2018; Schröder & De Wit, 2017; Stanicic, 2018). Furthermore, as part of the regeneration of the Laurenskwartier, the municipality aimed to create a building with a special function that would attract more people to the area (Stanicic, 2018). The idea to develop a market hall was triggered by the visit of municipal officials to multiple market halls in other European cities (Schröder, 2018). On top of the market hall function, the required building programme also included dwellings and a parking garage.

The initially envisioned segmentation of market stalls was influenced by the changing European legislation and aimed to move the market stalls with fresh goods from the Binnenrotte market to the market hall. Throughout the development process, the European rules turned out to become less strict

and the market floor concept was adapted to a combination of different segments, both a higher and lower segment, and a variety of products, including mainly meat, fish, fruit and vegetables. The larger units on both sides of the market floor would include a combination of bars, restaurants and food-related retail (Schröder, 2018).

In the tender for the market hall project, the municipality demanded a building programme that included a number of dwellings. Eventually, 228 dwellings were realized, including 102 rental apartments and 126 sale apartments (Schröder & De Wit, 2017).

The required programme also included a parking garage. The parking garage initially had to provide parking space to the residents and visitors of the market hall. However, during the development process the municipality decided that the parking garage would also need to facilitate visitors of the shopping area, library and train station in the area. Therefore, the municipality increased the amount of required parking space from 450 to 1200 spots (Schröder, 2018; Schröder & De Wit, 2017).

Target groups

Based on market research, developer Provast determined 3 main catchment areas for the market stalls, retail, bars and restaurants, as pictured in figure 4. The primary catchment area consisted of the residents that live within 10 minutes' travel time by public transport. This catchment area was expected to generate 47% of the total revenue. The secondary catchment area consisted of the residents that live within 15 minutes' travel time by car. The secondary catchment area was expected to generate 30% of the total revenue. The tertiary catchment area consisted of the residents that live within 30 minutes' travel time by car. Together with the touristic visitors, the residents in the third catchment area were expected to generate 23% of the total revenue. The annual amount of visitors was expected to lie between 4,5 and 7 million visitors (Markthal Rotterdam B.V., 2013).

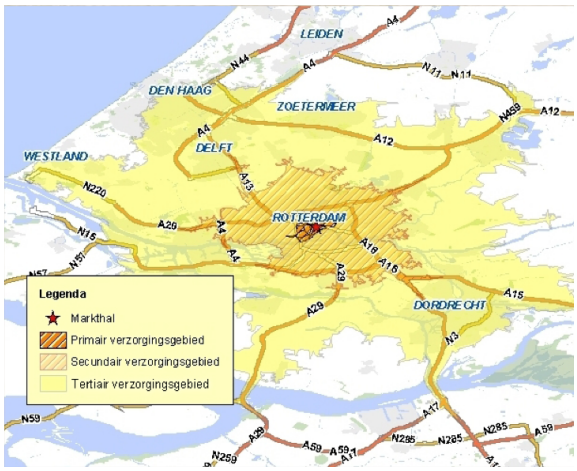


Figure 4: Main catchment areas for the commercial functions in the Markthal (Markthal Rotterdam B.V., 2013).

The catchment areas and percentages that were defined based on the market research commissioned by Provast did not align with the audience that Corio had initially envisioned for the Markthal. Director of the Markthal Marcel Kroes (2018) stated that current owner Klepierre's vision for the Markthal is targeted at both tourists and residents of the surrounding area. He could not disclose any numbers that represent the exact ratio between the types of targeted audience.

As discussed in the previous subsection, the targeted audience for the parking garage did not only consist of the residents and visitors of the Markthal, but also included visitors of the surrounding shopping area, library and the nearby Blaak train station (Schröder, 2018; Schröder & De Wit, 2017).

2.2. Laurenskwartier regeneration objectives

Improvement of the public space

Due to the outdated public space and the segregation of functions, the Laurenskwartier had become a desolate area throughout the last decades. As the photograph in figure 5 implies, the public space of

the area required serious improvements. Therefore, the municipality aimed to regenerate the area and to make changes to its public space (Stanicic, 2018).

The Laurenskwartier area was selected by the Rotterdam city council as one of the 13 'VIP areas', which represent the city's focus locations for urban regeneration. The goals that were set for the regeneration of the Laurenskwartier were focused on improving the attractiveness on the field of architecture, increasing the liveliness by the inclusion of active functions in the plinths, attracting new residents and decreasing the parking pressure in the area (Gemeente Rotterdam, 2010).

Figure 5: Image of the Hoogstraat (Laurenskwartier) before the construction of the Markthal (Rotterdam010, 2008).

One of the municipality's objectives that were associated with the Laurenskwartier regeneration included the prevention of shoplifting and pickpocketing in the nearby shopping area and the prevention of nuisance caused by the visitors of the nightlife facilities in the area. Furthermore, the municipality has mentioned the importance to preserve the safety, accessibility and liveability of the area during the expected large amount of construction works (Gemeente Rotterdam, 2010).

Catalytic function

In the masterplan for the western part of the Laurenskwartier, the Markthal was mentioned as a potential catalyst, which would not only generate a spatial and programmatic impulse, but which could also stimulate new development initiatives in the area (Gemeente Rotterdam, 2008). This contemplated function was confirmed by Stanicic (2018), who mentioned that one of the reasons why the development of the Markthal was initiated was to attract more visitors to the Laurenskwartier area.

2.3. Image-related objectives

Iconicity

According to Schröder (2018), the municipality did not initially envision the potential to establish a new icon for the city by the development of the market hall.
Stanicic (2018) stated that when putting out the tender for the market hall, the municipality initially did plan to create a special building, both in terms of its function and its iconic image. This ambition was confirmed in the vision document for the Laurenskwartier (Gemeente Rotterdam, 2010), in which the municipality mentioned its aspiration to transform the area to an architecturally attractive location, based on the iconic architecture of the Markthal, Kubuswoningen, Willemsbrug and Laurenskerk.

Urban image of Rotterdam

The Rotterdam Partners organisation was actively involved during the development of the Markthal. The task of Rotterdam Partners is to advance the economy of Rotterdam, of which city marketing is one of the key components. Rotterdam Partners aimed to promote the Markthal development among international press, in order to induct a more positive image of Rotterdam and to attract more (national or international) tourists to the city (Heinen, 2018).

3. Strategies

In the following sections an overview will be given of the strategies the main stakeholders have applied in order to reach the aforementioned objectives that were associated with the Markthal development.

3.1. Strategies to reach the project objectives

Building programme

The municipality of Rotterdam played a proactive role in the regeneration of the Laurenskwartier area. By using its municipal preference right, the municipality acquired multiple real estate objects in different areas of the city, including the Laurenskwartier (Schröder & De Wit, 2017; Stanicic, 2018). As the owner of the plot on which the Markthal is now located, the municipality was able to put out a tender and invite market parties to develop the envisioned building programme. The programme requirements of the tender included the combination of dwellings, a parking garage and an indoor market floor (Schröder & De Wit, 2017).
The municipality selected three market parties to make a design in the second round of the tender. Provast handed in an integrated design by MVRDV, in which the dwellings overarched the commercial spaces and the market floor (figure 6). Based on the design by MVRDV and their bid for the land, Provast was awarded to develop the Markthal. After winning the competition, Provast conducted a financial feasibility study together with the municipality. Based on the positive outcomes of this study, Provast was able to continue the development (Schröder & De Wit, 2017).

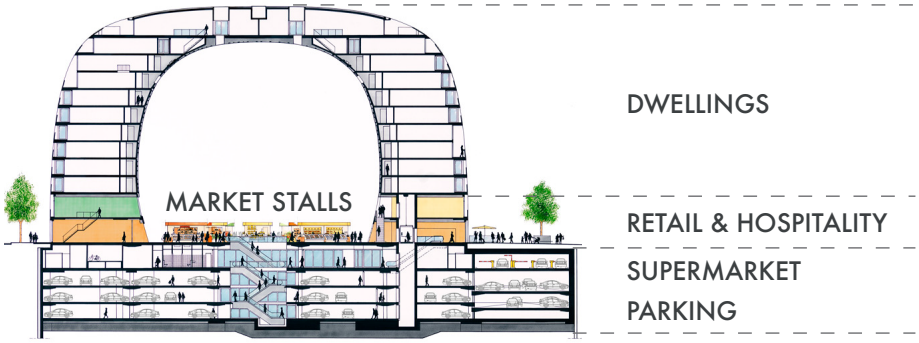


Figure 6: Section with the Markthal building programme (MVRDV (n.d.), edited by the author).

Target groups

Developer Provast aimed to mainly attract residents that lived in proximity of the Markthal (10 minutes by public transport or 15 minutes by car), who would be visiting the Markthal for their daily groceries. The developer planned to attract a diverse audience, both in terms of age and in terms of financial capacity. The programme of the market floor was based on the objectives to provide daily groceries for a diverse audience. Therefore, the market stalls included all types of fresh goods (meat, fish, fruit and vegetables) and based on the targeted audience, a differentiation was made between stalls in the higher and lower price segment (Schröder, 2018). The envisioned segmentation is presented in figure 7.

Figure 7: Planned segmentation on the ground floor (Markthal Rotterdam B.V., 2013).

3.2. Strategies to reach the urban regeneration objectives

Improvement of the public domain

As mentioned in the former paragraph, the municipality of Rotterdam played an active role in the urban regeneration process by using its preferential rights to acquire real estate objects in the area.
As a result of the dotcom-crisis in 2000, the value of the acquired real estate dropped and the proactive strategy of the municipality turned out to be unsustainable (Stanicic, 2018).
After discarding the strategy of using its preferential rights, the municipality switched towards a more risk-averse role by lobbying to stimulate market parties to redevelop the impoverished buildings in the area. One of the examples of this strategy, is the HUF-building at the Hoogstraat, which was redeveloped by Provast at the insistence of alderman Karakus (Schröder, 2018).

Catalytic function

The Markthal development was part of the bigger plan to regenerate the Laurenskwartier, which involved a large number of physical interventions, differing from small improvements in the public space to large construction projects.
Due to the dotcom crisis in 2000 the budget of the municipality to transform the urban area had shrunk. In order to continue the improvement of the area, the municipality decided to focus on several key projects in order to stimulate the further development of the urban area despite its reduced budget. Due to the aspiration for the project to function as a catalyst in the Laurenskwartier, the Markthal was chosen as one of these key projects (Stanicic, 2018).
In 2008 the feasibility of the Markthal development was threatened again due to the financial crisis caused by the fall of the Lehman Brothers. Repeatedly, the financial feasibility could be preserved due to the involvement of the municipality. The municipality agreed to pay a large part of their investment in the parking garage at an early stage. Furthermore, alderman Karakus developed a temporary leasehold construction, by which the developer could postpone the acquisition of the land towards the date of completion. These two interventions resulted in a healthier cash flow for the developer, and thereby secured the financial feasibility of the project (Schröder & De Wit, 2017).

3.3. Strategies to promote the image

Iconicity

The first sketches MVRDV made of the Markthal had arisen from the intention to integrate the functions of residential and retail in one concept. Based on the integration of functions and the insolation in relation to the buildings on the neighbouring plots, these sketches quickly evolved to the iconic arched shape. Later in the design process, the developer and architect decided to cover the arch above the market floor with the 11.000 m^2 artwork ‘Hoorn des Overvloeds’ by artist Arno Coenen (Top010, 2013). The combination of the iconic horseshoe shape and the colossal colourful artwork covering the market floor, as pictured in figure 8, has given rise to the iconicity of the design.

Figure 8: Iconic arched design and artwork (MVRDV, n.d.).

It was through this design that MVRDV and Provast had understood that their plan involved a very special and iconic design, which could benefit their chances to win the competition. In contrary to the other plans, Provast made an integrated design instead of a separation between a ‘regular’ market hall and residential tower (Schröder, 2018).

The municipality acknowledged the plan's potential and saw the opportunity to establish an improved image for the whole Laurenskwartier area by the construction of the iconic building. Based on the design of MVRDV and the offer for the land, Provast was eventually chosen by the municipality to develop the Markthal (Stanicic, 2018).

Urban image of Rotterdam

Rotterdam Partners played an active role in the generation of publicity for the Markthal development. During the development of the project, Rotterdam Partners collaborated closely with Provast and architect MVRDV. Already at the early stages of the development and during the construction phase, Rotterdam Partners was in close contact with a large number of journalists from around the world. Both journalists from lifestyle-related and architecture-related media were proactively approached in order to bring attention to the Markthal development. Besides the attraction of international press, Rotterdam Partners also collaborated with Provast to organize the official opening of the Markthal, by which they not only aimed to gain international publicity, but to also involve the residents of the city of Rotterdam (Heinen, 2018). As the photograph in figure 9 implies, the official opening of the Markthal attracted a large amount of visitors.

Figure 9: Large amount of visitors at the official opening of De Markthal (Architectenweb, 2017).

4. Outcomes

In this paragraph, an overview will be given of the outcomes that have been observed by the different stakeholders within the years after the completion of the Markthal.

4.1. The Markthal project

Building programme

The initial programme of the market floor consisted of many regular market stalls that offered fresh products, like bread, fish and meat. However, Klepierre experienced that the demand for the so-called 'blurring' segment, consisting of market stalls where visitors could both buy food-related products or sit and dine, turned out to be higher than anticipated (Kroes, 2018). Schröder (2018) and Stanicic (2018) noted that the large amount of tourists that are visiting the Markthal may have caused the decreasing demand for market stalls that offer daily groceries, which used to make up the largest part of the initial building programme. Therefore, the previous building programme of market stalls with fresh goods has partially changed to a programme of the 'blurring' segment.

Target groups

The target groups that were defined by Provast during the development of the Markthal were primarily focused on the residents of Rotterdam. The market research that was done in order to define the catchment areas had determined that approximately 77% of the total revenue would be gained through residents that live within 15 minutes from the Markthal (Markthal Rotterdam B.V., 2013).

However, this initially targeted audience does not comply with the actual visitor characteristics in the current situation (Kroes, 2018).
The Markthal turned out to be a popular spot for tourists. Although the market research by Provast expected residents outside Rotterdam and international tourists to deliver only 23% of the total revenue, the actual numbers turned out to be much higher. According to the most recently published market research that was conducted by Strabo, 47% of the Markthal's visitors were national and international tourists from outside the Rijnmond region (Van Tellingen, 2017).

4.2. Regeneration of the Laurenskwartier

Public domain

Due to the regeneration of several buildings in the area, the construction of the Markthal and the improvements that have been done in the public space, the Laurenskwartier seems to have evolved from a desolated neighbourhood (figure 10) towards a trendy and upcoming area (figure 11). The area has become a popular destination for both local and touristic visitors. The upgrade of the area also has a downside, as some of the initial residents of the Laurenskwartier have been affected by the nuisance caused by the large amount of visitors in the area and the audience of the nightlife venues (Stanicic, 2018).

Figure 10: Image of the Hoogstraat in 2008 (Rotterdam010, 2008).

Figure 11: Image of the Markthal (left) and the Hoogstraat in 2015 (Halkes, 2016).

Catalytic function

Whether the Markthal has worked as a catalyst by stimulating other developments in the area cannot be proven, due to the large amount of interventions that have taken place in the area alongside the construction of the Markthal. However, the results of the market research by Strabo have implied that the Markthal has attracted many visitors to the area. This increased amount of visitors seems to have had a positive effect on the entrepreneurs in the area. According to the market research of Strabo, the regular market on the Binnenrotte has gained more visitors since the completion of the Markthal (Van Tellingen, 2017).
Besides that, the entrepreneurs in the surrounding area seem to have benefited from the development of the Markthal (Stanicic, 2018), although this statement has not been underlined with quantitative research.
Furthermore, the prices of the dwellings in the Markthal and the prices of real estate in the Laurenskwartier have increased significantly in relation to the average price increase in Rotterdam (Schröder, 2018; Stanicic, 2018).

4.3. Image promotion

Iconicity

Since its completion, the Markthal has generated large attention from the press and based on its iconicity, the project was even nominated for the BNA's Best Building of the Year 2015 award (BNA, 2015). Moreover, the project is often mentioned as one of the must-sees in the city of Rotterdam and it is one of the most frequently shared images in Rotterdam on social media (Urbanus, 2014).

Kim Heinen (2018) from Rotterdam Partners believes that the combination of the internationally acknowledged architect Winy Maas from MVRDV, the building's unique typology and its striking image

have provided the Markthal the iconic value by which more visitors have been attracted to visit the city of Rotterdam.

Rotterdam urban image

The image of the city of Rotterdam has recently been strengthened by the development of the new and iconic central station, De Rotterdam and the Markthal. As complement to the urban icons like the Erasmusbridge and Euromast, the recently developed icons have underlined Rotterdam's nickname as city of architecture.

The image of the city of Rotterdam has gained a boost since the development of the Markthal and the Laurenskwartier has transformed into one of the trendiest areas within the city.
Because of the area's architectural highlights, including the Markthal, Kubuswoningen and Laurenskerk, the Laurenskwartier can now be found in any tourist guide or Rotterdam hotspot list. As the articles in figure 12 and 13 show, the Laurenskwartier provides an attractive image to represent the city of Rotterdam.

Although the project's popularity is shown by the number of publications including images of the Markthal, it yet remains unclear how the project's contribution to the urban image relates to the influence of the other icons within the city. Quantitative research on the number of publications in the press or on social media could provide more insights into the actual contribution of the Markthal development to the Rotterdam urban image.

Figure 12 & 13: Newspaper articles promoting the city of Rotterdam with images of the Markthal and Laurenskwartier (Rotterdam Partners, 2018a, 2018b).

5. Summary and conclusions

The case study of the Markthal has generated insights in the main stakeholders' objectives, the strategies that were followed and the outcomes that have been observed in the development of the project. In the following sections the match or mismatch between the objectives and outcomes will be described, an overview will be provided of the relevant features associated with the project and the application of the case study results in next chapter's impact assessment methodology blueprint will be addressed.

5.1. Relationship between the objectives and outcomes

Project objectives

The objectives that were associated with the commercial part of the Markthal primarily included the attraction of Rotterdam residents that would frequently visit the Markthal for their daily groceries. The building programme was adjusted to this targeted audience, consisting of mostly fresh goods in different price segments. The composition of the actual visitors significantly differs from the audience Provast envisioned, as almost half of the visitors were national or international tourists. The targeted audience that Provast had defined did however not comply with the target groups that Corio established for the sale of the Markthal. Because Klepierre could not disclose any clear percentages that indicated Corio's initially targeted visitors, it could not be determined to which extend the actual ratio of residents and tourists differs from their previous assumptions.

Due to the changing audience, several entrepreneurs had to close their business and made place for a more hospitality-focused programme, the so-called 'blurring' stalls.
Although the Markthal has been called an immense success due to the high number of annual visitors and its popularity among tourists, a mismatch could be observed between the initial objectives and the actual outcomes with regards to the commercial part of the project.

The dwellings in the Markthal have all been sold and rented out and they are currently benefiting from high price increases. Therefore, no mismatch could be identified for the residential part of the project.

The parking garage was planned to not only facilitate visitors and residents of the Markthal, but to also facilitate visitors of the shopping streets, library and train station in the surrounding area. This goal seems to be reached, but there currently is no quantitative research available to identify the different users of the parking space.

Regeneration objectives

The combination of new developments like the Markthal, the renovation of existing buildings and improvements in the public space have transformed the Laurenskwartier from an obsolete area towards a vibrant part of the Rotterdam city centre. The effects of this transition could not only be observed by the large amounts of visitors in the area, but also by the increasing revenue of the Binnenrotte market and other entrepreneurs in the area.

Whether the Markthal functioned as a catalyst for the other developments remains a question, because the Markthal development took place at the same time as many other renovation or development projects. However, based on market research it has been determined that the project did attract many visitors to the area, who may have had an effect on the market surrounding the building. However, there currently is no quantitative research that can prove the effect of the Markthal development on the revenue and visitor numbers of surrounding businesses.

The increasing popularity of the area has also shown a downside, as more nuisance was caused by the people visiting the bars and restaurants on the location. Although decreasing theft and nuisance incidents was one of the focus points of the municipality in the regeneration of the Laurenskwartier, these problems still need to be mitigated.

Image promotion objectives

The Markthal has become a famous building and it has helped to boost the image of both the Laurenskwartier area and the city of Rotterdam. The area is now being profiled as a neighbourhood with architectural highlights, including the Markthal, Kubuswoningen and Laurenskerk. Although the main stakeholders initially did expect that the building would become iconic, the effect seems to be even bigger than they had anticipated.

The high amount of attention from international press may have contributed to the large number of tourists that visit the Markthal every day. The goal to promote the image of the Markthal and thereby put Rotterdam back on the map seems to be accomplished, but this impression has not been confirmed by quantitative research yet.

5.2. Relevant features and indicators retrieved from the case study

The case study of the Markthal has not only been conducted to gain more insight into the main stakeholders' objectives, the applied strategies and the outcomes of the development. Besides that, this case study has been used to determine the relevant features and indicators that can be used as input for the project-specific elements in next chapter's impact assessment methodology. These features and indicators have been identified in order to answer the following research question: *Which types of effects are relevant for the evaluation of urban icons?*

The following subsections will provide an overview of the most relevant features and indicators related to the development of the Markthal.

Project-related features

The following project-related features and indicators could be identified in the case study:

Features	Indicators
Building programme	Dwellings
	Retail
	Food & beverage
	Market stalls
	Parking
Visitors	Number of visitors
	Origin of visitors
	Average spending of visitors
	Average time spent during a visit
Real estate value	Price per square meter

Table 1: Project-related features and indicators (own illustration).

Urban regeneration-related features

The following urban regeneration-related features and indicators could be identified in the case study:

Features	Indicators
Economic spin-offs	Annual revenue of nearby venues
	Annual visitor numbers of nearby venues
Perception of the public space	Visitors' quality perception of the public space
Nuisance	Noise complaints
Criminality	Number of theft incidents
	Number of pickpocketing incidents
Real estate developments	Number of development initiatives
	Numbers of dwellings added
	Number of square meters added
Demographic change	Number of households
	Average household income

Table 2: Urban regeneration-related features and indicators (own illustration).

Image-related features

The following image-related features and indicators could be identified in the case study:

Features	Indicators
Iconicity	People's acquaintance with the project
	Number of articles mentioning the Markthal
Contribution to Rotterdam urban image	Number of articles about Rotterdam that mention the Markthal
	Number of online shares about Rotterdam that include the Markthal
Tourism	Number of tourists visiting the Markthal

Table 3: Image-related features and indicators (own illustration).

5.3. Application in the next chapter

The outcomes of this case study will be used as input for the design of the next chapter's impact assessment methodology blueprint. The type of input that is generated by this case study is twofold: Firstly, the case study has shed a light on the relationship between the initial objectives and the actual outcomes. Secondly, the conversations with the main stakeholders have revealed which types of information they use to substantiate their observations. Moreover, the features identified in the case study help to determine the indicators for the impact assessment methodology blueprint

Insight in the relationship between objectives and outcomes

The Markthal case study has revealed that the success of real estate developments cannot easily be predicted. The outcomes may differ from the before-set objectives and the success on one field (i.e. the large amount of tourists that visit the project) may even negatively influence the success of another aspect (i.e. the initially targeted audience, consisting of the city's residents who would do their daily groceries at the Markthal).

Information sources to measure and explain the outcomes

This case study has been based on the observations of the main stakeholders, which has shed a light on the information that they use to substantiate their statements.

Some observed changes have been substantiated by available numbers, e.g. the increasing real estate values and number of visitors. However, many assumed spillover effects have yet been based on observations instead of quantitative research. In order to determine the actual contribution of the Markthal development to the revenue of surrounding businesses or its contribution to the urban image of Rotterdam, new research methodologies need to be established. The exploration of big data-based research methodologies can provide the opportunity to effectively measure these types of spillover effects.

During the interviews, the stakeholders have underlined the importance of communication with other relevant actors (residents, visitors, entrepreneurs) in order to not only understand which changes, but also why certain changes can be observed in the area. This information can help to determine which challenges still lie ahead.

Relevant features and indicators for project evaluation

The next chapter of this research encompasses a blueprint of the methodology by which the impact of urban icons can be effectively measured. Although the blueprint is designed to be generic, it does include a project evaluation framework that incorporates project-specific elements. This is due to the project-specific perspective of evaluation, as it is aimed to determine the success of a project, i.e. to which extend the initial goals were reached. Therefore, the indicators used within an evaluation framework should be project-specific, instead of generic.

Due to its iconicity and the broad range of interests involved in the project, the Markthal has been used as test case to determine the relevant features and indicators for the next chapter's impact assessment methodology. Based on the objectives, strategies and outcomes that were identified in the case study of the Markthal, the most relevant features and indicators associated with the project have been identified. These features and indicators will be used as input for the project evaluation framework in the next chapter.

IMPACT ASSESSMENT METHODOLOGY

1. Introduction

The current state of research with regards to the impact measurement of urban icons lacks the availability of a comprehensive assessment framework. A similar observation can be made in practice, in which evaluation is either not part of the building cycle or it is still being carried out by traditional, qualitative and time-consuming methodologies.

The following research question will be answered in the following paragraphs: *By which assessment methodology can the impact of urban icons be effectively measured and monitored?*

In this chapter, a blueprint is provided for a comprehensive impact assessment methodology. The blueprint is made up of three consecutive parts. The first part consists of the process-oriented strategy by which evaluation becomes an integral part of the urban regeneration cycle. The second part includes the design of a big data-based project evaluation methodology, by which the impact of urban icons can be quantitatively measured at a high spatiotemporal resolution. The third part prescribes the strategy by which data visualization and big data analytics can be applied to develop a data-driven approach to urban planning.

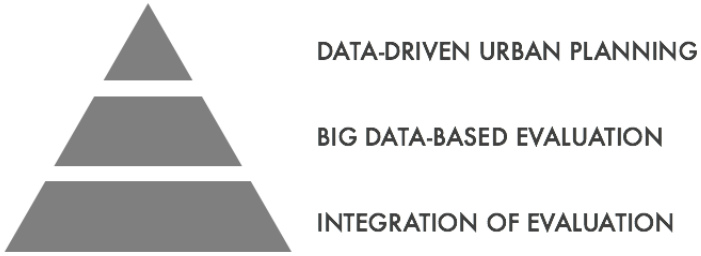


Figure 14: Impact assessment methodology blueprint structure (own illustration).

2. Integration of evaluation in the process cycle

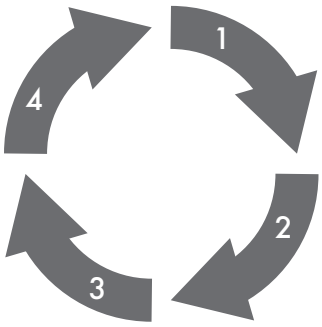
The first step to be taken in the design of an effective impact assessment methodology for urban icons, is to integrate the practice of evaluation in the building cycle. In the first section, a theoretical overview will be given of the elements that can contribute to the effectiveness of evaluation. In the second section, the design of the integration of evaluation in the building cycle will be presented.

2.1. Evaluation of urban regeneration projects

Multiple studies have investigated the impact assessment of urban regeneration projects and mega sport events. Based on the results that were presented in these studies, the following subsections will prescribe the way in which evaluation can be practiced most effectively.

Integration of evaluation in the urban regeneration cycle

The task of monitoring and evaluation is closely linked with policy development, both at a strategic level as in the design and implementation of specific projects. Roberts and Sykes (2005) stated that the practice of evaluation should be an integral part of the urban regeneration cycle. They designed an iterative evaluation cycle that consists of four consecutive steps:



1. To draw upon experiences of previous projects and programmes
2. To identify targets and incorporate them within an agreed schedule of action and implementation
3. To measure and monitor specific aspects of implementation
4. To evaluate the overall performance (effectiveness and efficiency) of a project or programme

Figure 15: Evaluation cycle (own illustration, information retrieved from Roberts and Sykes (2005)).

As this iterative cycle addresses, evaluation is not simply a task that is carried out after the completion of a project. In order to be effectively implemented, the practice of evaluation should be incorporated into each stage of the process.

Definition of clear objectives

As the evaluation cycle in the previous subsection addressed, the definition of clear objectives in the early stages of the project cycle influences the effectiveness of the evaluation that is being carried out afterwards.

This statement is underlined by Matheson (2010), who did research on the legacy of mega-events. She addressed that legacy planning is needed before the event takes place, instead of solely evaluating the legacies after the event. The importance of clear objectives is agreed upon by i Cid (1992), who named the strength of the before-set objectives as one of the major success factors that contributed to the economic impact of the Barcelona Olympic Games.

Taşan-Kok (2010) supports the need for clearly-defined objectives, as he names the ill-defined objectives and ambiguous political goals as one of the factors that interfere the effective impact assessment of large-scale property-led urban regeneration projects. Evans (2005) supports this statement, as he names the lack of pre-arranged measurement and evaluation criteria as one of the main points of criticism with regards to flagship-led regeneration projects.

Long-term and longitudinal monitoring

Evaluation of urban regeneration projects is often carried out at one single point in time and shortly after completion of the project. However, in that way some changes may not be visible yet and the further development of change cannot be clarified.

The focus of urban regeneration impact assessments is mainly on the operational stage and not on the construction stage, according to the study of Glasson and Wood (2009), who assessed the impact of 20 urban regeneration projects. In his study on the impact of major sport events, Smith (2009) did a similar observation, as he stated that the social leverage is often overestimated on the long term and underestimated during the build-up to the events.

In his framework for evaluating flagship-led urban regeneration projects, Evans (2005) advocates the use of a longer-term perspective on impact measurement in order to investigate the social and economic changes that emerge over time. Matheson (2010) shares this view, as she criticises the regular short-term approach to the evaluation of legacy caused by major sports-events. She states that a time period of 15 to 20 years is needed to measure the true legacy of an event, instead of the period of 2 years that is now common in legacy measurement.

The importance of a longitudinal approach to impact monitoring is proven by the research of Norris and Gkartzios (2011), who did a 20-year study on the intended and unintended impact of urban renewal projects. Their study showed that the observed effects of the applied strategy were significantly higher in the first years after completion in comparison to the latter years that the study was carried out.

Learning from evaluation

Roberts and Sykes (2005) implied that the practice of evaluation plays an essential role in the cycle of urban regeneration. Evaluation does not only provide insight in the performance of a previous project, but it also generates experience that can, and should, be applied in the strategy development of future projects.

According to Evans (2005), policy makers are currently unable to base their flagship-led regeneration strategies on evidence, due to the commonly short-term perspective on social and economic impacts. In her study on legacies of major sport events, Matheson (2010) underlines the need to generate evidence for future policy making and planning. However, she also claims that it remains difficult to prove a direct causal relationship between an event and its potential impact.

The importance of evaluation in order to provide evidence for future development strategies is proven by Smith (2009), who studied the relationship between major sport events and social sustainability. Socially sustainable regeneration is a rhetoric that is often used to justify investments in major sport events. However, Smith (2009) undermined this common justification and found out that major sport events usually have a negative influence on the social sustainability, because they often disrupt and disadvantage existing communities.

2.2. Design of the integration of evaluation in the building cycle

The former section included an overview of ways in which the task of evaluation could be performed most effectively. Based on these prescriptions, a design has been made of the implementation of evaluation in the building cycle. In the following subsections, the proposed implementation of evaluation will be discussed based on the four consecutive phases of the building cycle: the initiative phase, development phase, construction phase and use phase.

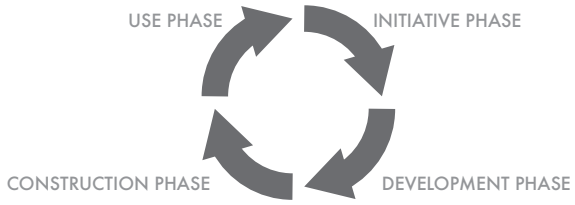


Figure 16: Building cycle (own illustration).

Initiative phase

During the initiative phase, the goals that are associated with the project should be established. Lessons learnt from previous projects should be taken into account when defining these goals.

Development phase

During the development phase, the previously determined goals should be transformed into clearly-defined objectives. Experience from previous projects should be included when determining the objectives and strategies for the project.

Besides that, a measurement strategy should be established during the development phase. By defining evaluation indicators up front and determining the time span by which effects are expected to be visible, the practice of evaluation becomes more effective.

Furthermore, measurements should be carried out to map the existing situation. In that way, a comparison can be made between the results of measurements before and after the intervention took place.

Construction phase

During the construction phase, measurements should be carried out as some changes may already be visible. Besides that, attention should be paid to the potential short-term impacts that can be caused by the construction works.

Use phase

After completion, the project should be monitored for a long time span (preferably continuously and for at least 15 years). In this way, both short-term and long-term effects can be identified.

A longitudinal process of measurement should be carried out, by which the progress of change can be determined. By comparing the growth/decline rates of a specific indicator, an acceleration or deceleration of change can be revealed.

The project should be evaluated based on the a priori set indicators and the time frame by which the change is expected to happen. By determining the match or mismatch between the objectives and outcomes, and by investigating which factors have caused the outcomes, the effectiveness and efficiency of the project can be determined. Furthermore, the evaluation will provide valuable lessons that can be implemented as experience in the strategy and policy development process of future projects.

Towards an experience-based process cycle

By integrating the practice of evaluation in each consecutive phase of the building cycle, an iterative process emerges in which evaluation is not only carried out effectively, but also provides experience that can be implemented in future projects. In this way, an experience-based process cycle can be established, which can contribute to the development of a more effective urban regeneration practice.

3. Big data-based project evaluation methodology

The second step to be taken in the establishment of an effective impact assessment methodology for urban icons includes the exploration of the opportunities of exploiting and joining different types of data sources in order to measure the relevant features that make up the impact of urban icons.

In the following sections, a big data-based project evaluation methodology will be presented. Due to the project-specific nature of project evaluation, which is focused on the objectives and outcomes of a specific development, the project evaluation methodology blueprint will be based on the relevant features and indicators that were retrieved from the case study of the Markthal.

In the first section, the different types of urban dynamics will be distinguished. After that, an overview will be given of the different types of applicable data sources. Finally, the design will be presented of a big-data based evaluation methodology blueprint by which the impact of urban icons can be measured.

3.1. Urban dynamics

Urban change processes can be distinguished based on the speed by which they emerge. Some changes may be visible over a time span of several years, while other changes can be observed real-time. The speed of urban change processes has implications for the type of data sources that are suitable to measure specific processes. Wegener, Gnad, and Vannahme (1986) distinguished slow, medium-speed and fast urban change processes. In the next subsections, the features that were extracted from the case study of the previous chapter will be classified as either slow, medium-speed or fast urban change processes.

▶ Slow urban change processes

Wegener et al. (1986) distinguished the processes of industrial, residential or transport construction as the slow processes of urban change. The response time of these construction processes, i.e. the process from initiative to completion, generally varies between 2 and 10 years. The response duration, i.e. the life-cycle of the stock, can exceed a period of 100 years.
The slow urban change processes that could be identified in the case study relate to the physical environment. Therefore, they consist of the real estate and infrastructure objects and developments in the area, including the Markthal building itself.

▶▶ Medium-speed urban change processes

Wegener et al. (1986) identified economic, social and technological changes as medium-speed urban change processes. The economic and technological changes have an estimated response time between 2 and 5 years and a response duration between 10 and 20 years. The response time and duration of demographic changes can vary significantly, as they are estimated between 0 and 70 years.

From the features that were extracted from the case study of the previous chapter, real estate value change, real estate development initiatives and demographic change can be classified as the relevant medium-speed urban change processes associated with the Markthal development.

▶▶▶ Fast urban change processes

Wegener et al. (1986) stated that mobility-related changes can be considered as fast processes. Both the labour, residential and daily mobility processes have an estimated response time below 1 year. Therefore, these changes can quickly emerge and dynamic data sources are needed to effectively observe these changes. The response duration of these processes can vary between 2 and 10 years.

The relevant fast urban change processes that were identified in the case study include the following features: visitors in the area, revenue of nearby venues, quality of the public space, nuisance, crime, image and tourism.

3.2. Applicable data sources

A wide variety of data sources can be applied to measure urban change processes.
Census data and surveys make up the traditional data sources that are applied in urban research (Thakuriah, Tilahun, & Zellner, 2016).
In addition to these traditional data sources, new measurement opportunities have emerged in the shape of big data analytics. Big data sheds a light on urban dynamics at much higher spatial and temporal resolutions than traditional data sources (Thakuriah et al., 2016). The different types of big data sources can be divided into three categories: directed, automated and volunteered data sources (Kitchin, 2014). The challenge of big data is to “extract value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery, and/or analysis” (Gantz & Reinsel, 2011, p. 6).

Traditional data sources

The traditional data sources that are regularly applied in quantitative urban research include census data and surveys (Thakuriah et al., 2016).
The extension to which administrative census data is gathered differs between countries. In the case of the Netherlands, large amounts of information are gathered by the CBS (Centraal Bureau voor Statistiek). The CBS provides municipalities extensive information about features as household characteristics, income, tourism and real estate value.
Surveys are an adequate data source to identify human activities, behaviour or perceptions. This data source may reveal interesting insights or explanations that could not be retrieved by the analysis of census data.

Although census and survey data can provide reliable information on a broad range of topics, the traditional data sources also have their limitations. Firstly, these traditional data sources do not

comply with the high spatiotemporal resolution that is needed to identify and observe fast urban change processes. Furthermore, the methodology associated with conducting survey-based research is expensive and time-consuming.
Due to the declining response rates of traditional surveys and increasing costs of administering the census data, the interest has been raised to look for alternative ways of supplementing the urban data structure (Thakuriah et al., 2016).

New big data sources have provided the potential to capture data on complex urban phenomena which have either not been measured previously, or which have been measured at resolutions that are too aggregated to be meaningful (Thakuriah et al., 2016). The following three categories of big data sources can be distinguished: directed data, automated data and volunteered data (Kitchin, 2014).

Directed data sources

The first category of big data sources refers to directed data. Directed data are generated by a human operator in traditional forms of surveillance, e.g. passport control or fingerprint scanning (Kitchin, 2014). Directed data are generally gathered in offices or laboratories and stored automatically in suitable formats (Skourletopoulos, Mastorakis, Mavromoustakis, Dobre, & Pallis, 2018).

Automated data sources

The second big data category consists of automated data, which are retrieved from an automatic function of a device, like the log of mobile phone usage or a check-out desk (Kitchin, 2014). Skourletopoulos et al. (2018) divided automated data further into the following five subcategories: automated surveillance (e.g. surveillance cameras), digital devices (e.g. mobile phones, smart watches, etc.), sensed data (e.g. pedestrian sensors, noise sensors, etc.), scanned data (e.g. retail transactions) or interaction data (e.g. OV-chip cards, Wi-Fi logins).

Volunteered data sources

The third big data category includes volunteered data, which refers to data provided by the user itself. Skourletopoulos et al. (2018) distinguished four subcategories of volunteered data, including: transactions (e.g. E-commerce), social media (e.g. Twitter or Instagram), surveillance (e.g. health apps or fitness apps) and crowd sourcing (crowd sourcing platforms).

3.3. Design of a big data-based project evaluation methodology

The most relevant features and indicators to be implemented in the evaluation of an iconic building have been retrieved from the previous chapter's case study of the Markthal. In the following subsections, a project evaluation blueprint will be proposed, based on the different big data-based measurement methodologies that can be applied to evaluate the impact of urban icons.

The table on the following page provides an overview of the relevant features and indicators that were retrieved from the case study, clustered based on the speed of the urban change processes:

Urban change speed	Features	Indicators
▶ Slow urban change processes	Building programme	Dwellings
		Retail
		Food & beverage
		Market stalls
		Parking
▶▶ Medium-speed urban change processes	Real estate value	Price per square meter
	Real estate developments	Number of development initiatives
		Number of dwellings added
		Number of square meters added
	Demographic change	Number of households
		Average household income
▶▶▶ Fast urban change processes	Visitors	Number of visitors
		Visitor characteristics
		Time spent during a visit
	Economic spin-offs	Annual revenue of nearby venues
		Annual visitor numbers of nearby venues
	Quality of the public space	Visitors' perception of public space quality
		Activities performed at public space
	Nuisance	Noise complaints
	Crime	Number of theft incidents
		Number of pickpocketing incidents
	Image	Publicity the building
		Contribution to urban image
	Tourism	Popular routes
		Visitor characteristics
		Visitors' perception
		Accommodation characteristics

Table 4: Overview of features and indicators retrieved from the case study (own illustration).

▶ Building programme

The realization of a specific building programme has been identified as one of the municipality's objectives associated with the development of the Markthal.

The building programme can be considered as a feature related to the slow urban change process of construction. Therefore, traditional static data sources like floor plans and measurement reports will provide sufficient information on this feature.

▶▶ Real estate value

The change of real estate value, regarding both the apartments within the Markthal and the dwellings in the surrounding area, has been named by several stakeholders as one of the outcomes that can be observed after the completion of the project.

Information about the changing real estate value and the number of transactions within a specific timeframe can be obtained by consulting the Kadaster. In the Kadaster, transactions are registered and the latest sale price is mentioned. Besides that, a registry is kept of the WOZ value (Valuation of Real Estate Act value) of each property.

Changing real estate value can be considered as a medium-speed urban change process. Therefore, the temporal resolution of the Kadaster data will provide sufficient information in order to analyse the process of real estate value change.
In addition to the traditional Kadaster records on real estate value, large amounts of information on real estate properties is offered on online platforms, e.g. Funda or Pararius. By retrieving

information from these web pages, recent information regarding the requested price for different types of real estate objects can be found.

Real estate developments

The municipality aimed to create a catalyst for further developments in the Laurenskwartier area by the development of the Markthal.

Information regarding real estate developments can be obtained from the registry of building permits and the Kadaster. Because real estate developments are considered as relatively slow urban change processes, the temporal resolution of these data sources is sufficient for the analysis of this feature.

Demographic change

During the interviews with the stakeholders involved in the development of the Markthal, demographic changes within the Laurenskwartier were named as one of the possible outcomes of the project. The residential developments in the area did not only increase the number of households, but the improved image of the area has also seemed to attract different target groups.

Demographic information is extensively provided in the traditional census records, e.g. in the annual records and analyses made by the CBS. Because demographic changes are considered as medium-speed urban change processes, the temporal resolution of census data is sufficient enough to observe the developments of demographic change within an area.
Private organisations can acquire the latest analyses on ZIP-code level, while governmental bodies have access to more detailed information on a personal level.

Visitors

The attraction of visitors to the Markthal and the surrounding area is considered to be an essential objective of multiple stakeholders involved in the project.

Understanding more about the users of the space, e.g. who they are, what they do and when they are at the location, can provide valuable insights regarding the audience that the Markthal attracts.

Traditional measurement methodology

The owner of the Markthal has installed static sensors in order to measure how many people enter and exit the market floor. This methodology provides quantitative results considering the visitor numbers of the project, but it does not provide further information about the people visiting the Markthal. Owner Klepierre commissioned Strabo to conduct additional market research. By surveying the visitors of the Markthal, Strabo was able to retrieve information about customers' origins, motives to visit the Markthal and their spending behaviour. Although conducting surveys can generate interesting results, it can be considered to be a time-consuming and labour-intensive methodology. Furthermore, the spatiotemporal resolution of survey-based research is relatively low, which makes it impossible to capture fast urban change processes.

Tracking mobile phone data

Mobile phones can provide detailed information on people's movement behaviour due to the implemented GPS and Bluetooth technology. Pentland (2014) showed that the analysis of such data can reveal personal information by the discovery of movement patterns, e.g. where someone lives or where someone works. This methodology can provide interesting insights on the demographic composition of the people visiting a location.

Retrieving information from social media platforms

Data retrieved from social media platforms can generate useful information with regards to the users' characteristics and the personal connections that people have. By analysing Flickr users' spatial activity, Offenhuber and Ratti (2014) were able to identify the home town of the people that had shared photographs on the social media platform. Crandall and Snavely (2012) stated that the analysis of geotagged photographs can reveal possible connections between people.

Proposed measurement methodology

The analysis of the spatial activity of mobile phone users, based on GPS or Bluetooth technology, provides a detailed and reliable source to retrieve visitor characteristics, such as people's home town and workplace.
The data of social media platforms is openly available and can also be used to generate visitor characteristics based on their online activity. This provides an easily accessible data source by which more information about a location's visitors can be retrieved in addition to the sensors that solely count the number of visitors at a specific time.

▶▶▶ Economic spin-offs

Economic spin-offs make up one of the urban regeneration-related features that were identified in the case study. The impact in the shape of economic spin-offs was not only mentioned as an objective of the municipality, i.e. the catalytic function that the Markthal should have in the Laurenskwartier area, but it was also mentioned by multiple stakeholders as actual outcome of the project, because they had taken notice that entrepreneurs of nearby venues had experienced increasing visitor numbers and revenue since the opening of the Markthal.

These statements were however based on unquantifiable sources and there is no effective methodology yet to measure the exact economic spin-offs that have taken place. In order to accurately measure the economic spin-offs, insight should be given in the number of visitors in a specified area and the spending behaviour of these visitors.

Traditional measurement methodology

Insight in customer behaviour is traditionally retrieved by the conduction of surveys. This methodology was applied by Lovelace, Birkin, Cross, and Clarke (2016) in their study to measure retail flows of shopping centres and by Strabo in their market research on the customers of the Markthal (Van Tellingen, 2017). Although surveys generate detailed customer information, including information on visitors' origins and spending behaviour, the survey methodology has a low temporal resolution and does not provide a continuous stream of data (Lovelace et al., 2016).

Measuring the number of visitors

Static sensors could be applied in order to measure the exact number of visitors in an area. Static sensors are usually installed in fixed places and capable to measure various types of parameters, e.g. human activity (Skourletopoulos et al., 2018). Similar sensors have been installed at the entrances of the Markthal, by which the total number of visitors entering and exiting the retail floor are measured (Van Tellingen, 2017).

Some types of venues, e.g. museums or other public functions, measure the number of visitors and provide this information in their annual reports. When an organisation is classified as a (cultural) ANBI organisation, which many cultural facilities as museums or theatres are classified as, it is obliged to publish this information online (Belastingdienst, n.d.). The annual reports containing this information can be consulted in order to find any remarkable changes in visitor numbers since the completion of an iconic building located nearby.

The number of people visiting nearby venues can also be tracked from automated check-in systems. Such systems can be found at different types of locations, e.g. public transport hubs

(OV chip cards), libraries (library cards) or educational facilities (campus cards). The check-ins by visitors of these locations are automatically registered, which provides the opportunity to retrieve information regarding the venues' visitor numbers within a specific time span.

Measuring customers' spending behaviour

The percentage of electronic payments in the Netherlands has been increasing for years and reached 55% of all payments in 2017 (DNB, 2017). Banks collect transaction data, which provide detailed information on the financial transactions made by each customer at a specific location and time. Recently, the interest in transaction data has emerged, because it provides useful insights for both commercial companies and urban researchers (Thakuriah et al., 2016). Examples are known of banks that have begun to sell anonymized transaction data to retailers, thereby providing interesting insights in the financial performance of their competitors (Van't Spijker, 2014).

Proposed measurement methodology

The economic spin-offs generated by urban icons can be effectively measured by a combination of static sensors and the analysis of transaction data. With these measurements, insight can be given in the exact amount of visitors and their spending behaviour. This methodology provides both a higher temporal resolution and more reliable data in comparison to the traditional survey methodology.
Furthermore, more information can be retrieved from nearby locations that track their visitor numbers or apply automated check-in systems. This information might also reveal spin-offs in the shape of increasing visitor numbers at nearby locations.
The information on visitor numbers and financial transactions can be benchmarked against measurements on different moments in time, in order to observe the potential change of visitor numbers and/or revenue since the development of an urban icon.

▶▶▶ Quality of the public space

The improvement of the public space quality has been identified as one of the key goals of the municipality which were associated with the regeneration of the Laurenskwartier and the development of the Markthal.

Although the quality of the public space seems to have improved due to the multiple interventions made in the area, there are no quantifiable measurements that can underline this impression. In order to effectively measure the quality of public space, the activity and perception of visitors that use the public space should be measured on different moments in time. This information might provide interesting insights regarding the factors that lead to the potential improvement of the quality of the public space.

Traditional measurement methodology

The quality of public space can be measured by a wide range of indicators. In the Public Space Index (PSI), Mehta (2014) advocates that the quality of public space can be distinguished into two dimensions: the use of the public space and the perception of the public space. The measurement methodology proposed by Mehta (2014) involves observations to determine the activities performed at the location and a survey to identify the users' perception of the public space.
This methodology provides useful insights in the quality and usage of public spaces. However, the measurement methodology is time-consuming due to the observations and surveys needed. Besides that, the measurements can only be taken at specific moments in time, resulting in a low temporal resolution.

Revealing visitors' perception

In order to measure the users' perception of public space quality at a higher volume and spatiotemporal resolution, multiple researchers have prescribed the analysis of data retrieved

from social media platforms. Zeile, Resch, Exner, and Sagl (2015) mentioned the potential of a trans-disciplinary algorithm to detect human emotions at a specific location based on tweets. A similar approach was conducted by Campagna, Floris, Massa, Girsheva, and Ivanov (2015), who used spatial, temporal and textual analysis of tweets to generate insights in the interests and perception of touristic visitors. Shi, Zhao, and Chen (2017) also applied a sentiment analysis of social media posts to understand visitors' perceptions of touristic locations in relation to the level of crowding.
As these studies imply, conducting a sentiment analysis of posts on social media can offer interesting insights in the perception of visitors at a specific location. Especially regarding locations that are associated with high levels of activity on social media platforms, e.g. touristic locations, information of a large volume and spatiotemporal resolution can be obtained.

Identifying the use of space

The identification of activities performed at a location can be done by using public cameras. This approach is advocated by Tay, Jebb, and Woo (2017), who mentioned the use of video material could be used to quantify psychological states, as human emotions and behaviours. The data obtained by public cameras could also be applied to identify activities, based on the type of movements that are recorded.

Physical activity can also be measured by using apps that track running and walking routes (Thakuriah et al., 2016). These apps, e.g. Strava or Runkeeper, trace the paths that their users follow and measure the speed of their movements by using the wearable sensors integrated in mobile phones.

Sensing human emotions

A different way to detect human emotions, and thereby people's perception of a specific location, is the use of wearable sensors. Zeile et al. (2015) used this methodology to identify stress points in the urban area. The researchers used a mobile application to measure the participants' body reactions while moving through a city. The results from the measurements included the participants' levels of stress in relation to the GPS data of their route. Surveys were conducted afterwards to identify the cause of the participants' higher stress levels at specific locations.

Proposed measurement methodology

In order to measure the quality of public space, insight should be gained into the activities performed at a location and the perception of its visitors. The activities performed at a location can be identified by the analysis of video material obtained by public cameras. More insight in the visitors' perception of a location can be gained by the spatial, temporal and textual analysis of posts on social media platforms. With these two methodologies, the quality of public space can be measured in a more effective way than the traditional observation-based and survey-based methodology.
The application of wearable sensors to identify human emotions and activities can provide an interesting opportunity to gain more insight in the users' perception and use of specific locations within a city. This methodology could be applied by the development of a mobile application that measures users' body reactions and location or by conducting an experiment with pre-selected participants.

▶▶▶ Nuisance

During the discussion of the impact of the Markthal development, nuisance was mentioned as unexpected factor that increased since the completion of the project.

Although the number of complaints by neighbours of the Laurenskwartier were increased according to the stakeholders of the project, there is still little information available on the sources, specific locations and times at which the high noise levels were reached.

Traditional measurement methodology

Information about noise levels is traditionally gathered by indicative calculations and the collection of noise complaints. However, the indicative calculations that are used to make the so-called 'sound maps' (*in Dutch: geluidskaarten*) are based on average numbers instead of measurements. These static documents do not take into account changing conditions, e.g. the higher amount of traffic during rush hours or the higher amount of nightly visitors during the weekend.
The collection of noise complaints only provides insight into excessive cases of noise pollution that were registered, but does not provide real-time information on the noise levels at specific locations.
Therefore, a new approach is needed in order to measure the noise levels and to understand when and by which source the nuisance is generated.

Application of noise sensors

Noise sensors could be applied for real-time measurements of noise levels. In this way, information on noise levels at specific locations can be collected in a higher volume and temporal resolution. Skourletopoulos et al. (2018) advocated the use of static sensors, which are installed in fixed places, in order to gain insight into the physical context of a location, including the noise levels in that area. The use of static noise sensors was also mentioned in the study by Tay et al. (2017), who prescribed the potential to not simply determine noise levels, but to identify human behaviour and emotions through the data obtained by such sensors. A similar approach was used in the Stratumseind Living Lab project, in which noise sensors were applied to identify noise pollution caused by the visitors of the entertainment district in the Dutch city of Eindhoven (Smart Data City, 2014).
Xu et al. (2018) and Segura-Garcia, Felici-Castell, Perez-Solano, Cobos, and Navarro (2015) advocated a methodology that does not involve static sensors, but that employs noise sensors that are incorporated in mobile devices. By this methodology, noise levels at a specific time and location can be recorded by citizens using their mobile phones. The data collected with those wearable sensors can be used for the development of a noise map.

Proposed measurement methodology

In order to measure the noise levels in the area surrounding an urban icon, static noise sensors can be installed for real-time measurements. The sensors can provide useful insights in the noise levels during construction and the change of noise levels caused by traffic or visitors since the completion of the project. The noise levels can be compared with different types of context factors in order to find potential correlations, e.g. the time of the day, amount of visitors or traffic in the area and possible events in the surrounding area.

▶▶▶ Crime

Reducing the crime rates was considered as one of the goals of the municipality in the urban regeneration of the Laurenskwartier. Especially the number of theft and pickpocketing incidents in the shopping area were perceived to be problematic before the development of the Markthal.

By effectively mapping and analysing the criminal incidents that have taken place in the area, possible patterns of criminal activity could be identified and future crime rates could be predicted.

Traditional measurement methodology

Criminal records are being collected by police departments and are traditionally mapped into the so-called 'hot-spot maps', in which the distribution of crime is analysed and visualised across the dimensions of space and time (Gerber, 2014). Based on previous research, a number of predictive census variables have been defined. These variables, e.g. a high proportion of ethnic minority residents or high unemployment rates, have shown a strong regression with the crime rates in an area and are therefore used by police departments to identify areas with higher crime risks (Williams, Burnap, & Sloan, 2017). The potential of

revealing potential correlations between crime rates and such context variables to improve urban crime-related policies has been underlined by Thakuriah et al. (2016).

Kernel density estimation

Future crime rates can be predicted by using the Kernel Density Estimation (KDE) approach. This approach fits a two-dimensional spatial probability density function to historical crime records on a hot-spot map. Because crimes often take place in the vicinity of past crimes, this methodology provides the opportunity to predict future crime rates at a specific location. The analysis of past crime records can also take into account potential correlations between crimes and the proximity to physical locations, e.g. local roads or police stations, in order to predict future crimes at locations of which limited information about past crimes is available (Gerber, 2014).

Application of social media to predict crime patterns

The effectiveness of predicting future crime rates at specific locations can be enhanced by using information obtained from social media platforms. Williams et al. (2017) investigated the potential of analysing tweets to predict crime rates within a large city. They found out that Twitter can provide an alternative information source, instead of the census-based predictive variables, to predict future crime rates. However, this methodology turned out to be more effective in low-crime areas, because residents of high-crime areas were less likely to post about criminal activities on social media. Gerber (2014) studied the potential of applying social media as additional source in the prediction of crime rates. The prediction of future crime rates by using data obtained from social media in addition to the Kernel Density Estimation methodology turned out to be more effective for 19 out of 25 crime types, in comparison to the traditional KDE approach.

Proposed measurement methodology

The visualisation and analysis of crime records on hot-spot maps can provide insight into the spatial and temporal distribution of criminal activity within a city. By conducting the KDE-approach and an additional analysis of social media posts, potential patterns of criminal activity can be revealed and potential correlations between crime rates and context factors can be identified. These patterns and correlations can contribute to the prediction of future crime rates at specific locations.

▶▶▶ Image

The image of the Markthal and its contribution to the urban image of Rotterdam have been considered to be important objectives associated with the iconic project.

Although it can be observed that the Markthal turned out to be a popular image based on the large media attention, it still remains unclear how large its relative contribution to the Rotterdam urban image is, in comparison to other landmarks such as De Rotterdam and the Erasmus bridge. An effective measurement methodology is therefore needed, which can provide a quantitative indication of the size of the project's contribution to the Rotterdam urban image.

Traditional measurement methodology

One of the most famous methodologies to understand how the image of cities is perceived was developed by Lynch (1960), who asked people to draw so-called 'mental maps'; drawings consisting of the main elements that they associated with the image of a city. Through the analysis of these 'mental maps', Lynch (1960) discovered that the mental maps generally included 5 typologies that contribute to the readability of a city. Landmarks, which are similar to iconic buildings, make up one of these typologies.
The 'mental maps' methodology is already decades old, but it is still perceived to be relevant for understanding the image of cities. In a recent study Hospers (2009) advocated the applicability of the 'mental maps' methodology to improve the urban marketing practice.

Despite the acknowledgement of the methodology's relevance, it employs a time-consuming and labour-intensive process. Besides that, it remains difficult to observe changes in the perceived urban image over time. Therefore, a more dynamic approach would increase the effectiveness and efficiency of determining a city's image and the contribution of a specific project to that urban image.

Online photo analysis

The large amounts of photographs shared on social media platforms have generated the opportunity to determine the most popular landmarks and the general image of a city through online photo analysis. Several studies have employed this methodology by using data retrieved from online photo-sharing platform Flickr. Crandall et al. (2009) did an analysis based on the meta data (geotags) and content (image and tags) from a large volume of Flickr photographs. Based on the analysis, they were able to identify the world's most shared landmarks. Chen, Battestini, Gelfand, and Setlur (2009) applied a similar approach, by identifying the most-shared locations within a city through the analysis of Flickr meta data and the use of a clustering mechanism. In that way, a city's digital 'mental map' was established, based on the large amount of photos that were shared on the Flickr platform. Crandall and Snavely (2012) were also able to develop 'mental maps' based on data collected from Flickr. Besides that, they indicated that the data provides the ability to identify connections between users or to track the paths by which they have moved through a city.
Hu et al. (2015) applied a similar analysis of Flickr meta data and photographs to identify the different Areas Of Interest (AOI) within a city. By making a comparison between the results on different points in time, they were able to determine the temporal evolution of the AOIs' popularity. Furthermore, they conducted a semantic analysis of the textual information related to the photographs, in order to find out why the specific locations were perceived to be interesting.

Proposed measurement methodology

As the previously discussed studies have shown, the analysis of photographs posted on social media platform can be applied in order to determine the contribution of a project to the image of a city. By analysing the online photographs' content and meta data, a city's mental map can be established. Furthermore, a project's contribution to the urban image can be compared with other landmarks in the city. By comparing the analyses and mental maps through time, the evolution of a project's relative contribution to the urban image can be observed. This may provide interesting insights when comparing a situation before and after the development of an urban icon, as it may reveal the influence of a recent project on other landmarks' relative contribution to the urban image.

▶▶▶ Tourism

Based on the case study of the Markthal, tourism has proven to be one of the relevant features associated with the project. The attraction of tourists to the city of Rotterdam was the main objective that Rotterdam Partners aimed to achieve by their involvement in the project. Furthermore, the amount of touristic visitors turned out to be much higher than the main stakeholders had initially anticipated. The large attention among tourists increased the success of the project in terms of popularity and annual visitor numbers, but it negatively influenced the success of the initial concept, which was based on the sale of fresh goods for daily groceries.

There currently is no measurement methodology that can provide clear insights in the behaviour and perception of tourists visiting a city. The establishment of a methodology that can quantify these aspects is therefore needed.

Traditional measurement methodology

As Offenhuber and Ratti (2014) stated, it is hard to quantify tourism, because tourists leave minimal tangible traces of their stay. The traditional census records on tourism include mostly

static data, consisting of e.g. the amount of tourists visiting a country per year or the annual amount of hotel nights booked in a city.
In order to gain insight into the dynamic aspects associated with tourism, e.g. tourist behaviour and perceptions, surveys are traditionally conducted. However, as explained in previous sections, this methodology is considered to be time-consuming, expensive and it does not provide the required spatiotemporal resolution.

Tracing digital footprints

Many tourists use social media platforms, like photo sharing platform Flickr, to share the highlights of their trip with their friends. As previously discussed in the section on measuring the image of a project, the meta data and content of the posts shared by Flickr users can generate valuable information. Besides retrieving an overview of the most-shared locations and objects, the data from social media platforms can also be used to trace tourists' movements through a city. Van der Drift (2015) chronologically ordered the posts by touristic Flickr users in order to trace the paths that they had taken within a city. Offenhuber and Ratti (2014) applied a similar approach as they extracted the so-called 'desire lines', the most walked routes, within a city. Besides that, they were able to retrieve spatiotemporal characteristics from the visitor behaviour, as they could reveal patterns in the popularity of places at different seasons or days a week.

Revealing visitors' perception

Besides revealing patterns of tourist activity, social media platforms also offer the opportunity to extract information on tourists' perceptions of specific locations. As discussed in the section on perception of public space, Campagna et al. (2015) and Shi et al. (2017) showed that conducting textual analyses of social media posts can help to understand the perception of touristic visitors. This opportunity was confirmed by Offenhuber and Ratti (2014), who stated that the analysis of photo tags can reveal clues about people's perception of their environment and the semantics of their perspective on urban space.

Extracting visitor characteristics

The analysis of the profiles and activity of social media users can also reveal the characteristics of the visitors at a specific location. For example, Offenhuber and Ratti (2014) were able to identify the origins of the people that shared photographs on different touristic hotspots, based on the spatial activity of Flickr users.

Accommodation characteristics

The massive popularity of online tourist accommodation platforms has made platforms like Airbnb an inseparable part of the touristic sector. The collection of data retrieved from the Airbnb platform can be used to analyse the spatiotemporal characteristics of the locations, usage and pricing of Airbnb accommodations. For example, Quattrone, Proserpio, Quercia, Capra, and Musolesi (2016) did research on the socio-economic conditions in areas with many Airbnb accommodations in London. They were able to find a correlation between the amount of Airbnb listings and the distance to the city centre. Furthermore, they found a change in the location, the average income of the locations' residents and the home ownership of the Airbnb listings during the 4 year-timespan of their research.

Proposed measurement methodology

Data retrieved from social media platforms can be used to trace the most popular routes among tourists, to understand their perception of the places they visit and to extract the main characteristics of the people visiting a place. Besides that, the analysis of Airbnb data should become an essential part of the research on the usage and locations of tourist accommodations. Comparisons between the analysis results of Airbnb accommodations and

traditional hotel accommodations may provide useful insights about the developments in the touristic sector.

Overview

The previous subsections have given an indication of the applicable data sources and methodologies to perform more effective measurements of the spillover effects of commercial iconic buildings.

The following table provides an overview of the different features, indicators and applicable data sources that were mentioned in the previous subsections:

	Aspects		Data sources			
	Features	Indicators	Traditional	Directed	Automated	Volunteered
▶	Building programme	m^2 per function	Floor plans	-	-	-
			Measurement report	-	-	-
▶▶	Real estate value	Price per square meter	Kadaster	-	-	Online platforms
	Real estate developments	Number of developments	Kadaster	Building permit registry	-	-
	Demographic change	Household characteristics	CBS	-	-	-
▶▶▶	Visitors	Number of visitors	Counting	-	Static sensors	-
		Origin of visitors	Survey	-	GPS/Bluetooth	Social media
		Time spent during a visit	Survey	-	Static sensors GPS/Bluetooth	-
	Economic spin-offs	Annual revenue of nearby venues	Survey	-	Transaction data	-
		Annual visitor numbers of nearby venues	Survey	-	Static sensors	-
			Annual reports	-	Check-ins (OV chip card, etc.)	-
	Quality of the public space	Visitors' perception	Survey	-	-	Social media Mobile body reaction sensors
		Activities performed	Observations	-	Cameras	Mobile GPS, acceleration sensors
	Nuisance	Noise pollution	Indicative calculations	Noise complaints	Static noise sensors	Mobile noise sensors
	Crime	Number of theft incidents	-	Criminal records	-	Social media
		Number of pickpocketing incidents	-	Criminal records	-	Social media
	Image	Publicity the building	Mental map survey	-	-	Social media
		Contribution to urban image	Mental map survey	-	-	Social media
	Tourism	Popular routes	Survey	-	-	Social media
		Visitor characteristics	Survey	-	-	Social media
		Visitors' perception	Survey	-	-	Social media
		Accommodation characteristics	CBS	-	-	Online platforms

Table 5: Overview of features, indicators and applicable data sources (own illustration).

Several remarks can be made on the features and applicable data sources that were presented in this section.

Firstly, many features can be measured by traditional data sources, e.g. by conducting surveys and making observations. However, these methodologies are considered to be time-consuming and

labour-intensive. Besides that, these methodologies do not provide the spatial and temporal resolution that is needed in order to map the dynamic features that are classified as fast urban change processes.

Moreover, the use of data retrieved from social media platforms has proven to be an applicable source to measure multiple qualitative features regarding the visitors' characteristics or perceptions. The analysis of social media data appears to be a suitable substitution for the inefficient survey-based measurement methodology, which used to be the only suitable traditional methodology to measure these types of qualitative features.

Furthermore, the use of static sensors provides interesting opportunities to accurately measure the number of people at a specific place. However, these sensors cannot provide any qualitative information with regards to the characteristics of the people that are traced by the sensors. Social media is associated with opposing limitations, as it can provide qualitative information about visitors' characteristics and perceptions, but due to the limited amount of users it cannot provide accurate information about the number of people at a specific location at a specific time.
The exploration of joining these data sources may result in a comprehensive collection of both qualitative and quantitative information regarding the number of visitors and their characteristics.

Finally, a central link can be identified between the indicators associated with multiple features that represent fast urban change processes: the users of a space. These indicators, e.g. the amount of visitors at a location, their spending behaviour or their perception of the urban space quality, are all focused on retrieving information about the people that are present at a specific location and time. Many questions can be answered when information is available about who they are, what they are doing, how they are feeling and what they are spending.

4. Towards data-driven urban planning

Urban planners have historically been educated and trained to work in data poor environments. However, many of the data sets that urban planners will work with in the future will include big data (Thakuriah et al., 2016). The rise of the rich data landscape has emerged the need for tools that can assist urban planners to analyse such large data sets and apply that information in the practice of urban planning. Methods like data information visualization and predictive analytics can help to understand cities and their future development (Pettit et al., 2015).

The implementation of tools for data visualization and big data analytics can enhance the effectiveness of the urban planning practice, by establishing a shift towards data-driven urban planning. In the following sections, the opportunities of establishing a data-driven urban planning practice by integrating methods of data visualization and big data analytics in the field of urban planning will be discussed.

4.1. Data visualization

Proper data visualization will enhance the applicability of information in urban planning. If data visualization is not applied properly, the information will provide little to no assistance in decision-making processes (Skourletopoulos et al., 2018). If data visualization is applied properly, it does not only help urban planners to understand urban change processes, but it can also assist them to communicate this with other stakeholders (Thakuriah et al., 2016).

Examples of data visualization

Urban dashboards can be considered as examples of data visualization tools (Skourletopoulos et al., 2018). An urban dashboard provides the ability to visualize urban changes, by mapping specific features on a spatial and temporal scale.
Furthermore, the previously discussed 'hot-spot maps', in which criminal incidents are mapped in time and space (Gerber, 2014), are also known examples of data visualization tools.

Proposed implementation method

The urban planning practice could be supported by the development of an interactive urban dashboard, in order to gain more insight in the spillover effects of urban icons.

This dashboard should provide the ability to visualize the spatial and temporal development of different features. For example, a dashboard could show the mobility patterns of the visitors at the Markthal location. In these patterns, distinctions can be made between the origin of the visitors (local visitors or tourists) and the way they are moving (pedestrian, bicyclist or car driver). This visualization can provide more insight into the way that a space is used and by whom it is being used.

Furthermore, the interactive dashboard should include the ability to plot graphs to determine the changes of a specific feature through time. For example, graphs can be plotted to show how many visitors are at a specific location at a specific time. These graphs can show on which hours the location is usually crowded and on which hours less visitors are usually present.

Moreover, the interactive dashboard should provide the possibility to carry out regression analyses. By this function, insight can be given in the potential correlations between the different features. For example, regression analyses can be performed in order to determine the factors that contribute to the number of visitors at a specific location at a specific time. Potential variables that influence this may include the weather conditions, time, a sales period or the occurrence of events in the neighbourhood.

4.2. Big data analytics

A distinction can be made between three types of big data analytics: descriptive, predictive and prescriptive analytics. Descriptive analytics is focused on measuring the past. Predictive analytics is associated with the practice of forecasting the future, based on the analysis of continuous historical development patterns. The third type of big data analytics, prescriptive analytics, is associated with the process of predicting the potential effects on the basis of different scenarios (Velkoski & Carpenter, 2015).

Descriptive analytics

Descriptive analytics can be considered as the first phase of analytics, as it focuses on providing a description of the past by answering the following question: what has happened? (Velkoski & Carpenter, 2015)

Proposed implementation method

The method of descriptive analytics can be implemented by establishing the big data-based evaluation approach that was prescribed in the previous paragraph. Furthermore, the development of urban dashboards, which has been discussed in the previous section, can also be considered as a tool to practically implement descriptive analytics.

Predictive analytics

Predictive analytics is based on forecasting and providing an estimation for the probability of a future result. By using techniques as data mining and machine learning, patterns in existing urban change processes can be determined and the future continuation of these processes can be predicted (Skourletopoulos et al., 2018).

The implementation of predictive analytics allows cities to move from decision-making based on reactive strategies to policy development based on informed, holistic insight and proactive interventions (Appel et al., 2014).

Identification of predictor variables

In most urban phenomena one variable can be considered as the outcome of a set of cause-and-effect interactions between different predictor variables (Thakuriah et al., 2016). In order to identify these predictor variables, multiple researchers have advocated the importance of incorporating context factors in big data analytics.

Pentland (2014) and Lécué et al. (2014) stated that context factors, e.g. weather conditions, or other exogenous sources of information, e.g. car accidents or concert events, should be considered as relevant factors that may influence the outcome variables.
Moreover, Gerber (2014) determined that demographic and spatial characteristics were relevant variables in the identification of crime patterns and in the prediction of future crime rates at a specific location.

The relevance of integrating big data with other types of data has been underlined by Thakuriah et al. (2016), who stated that the integration with survey, census or GPS data can lead to a better understanding of the dynamic nervous systems of cities. By this comprehensive approach, exploiting a wide range of data sources and variables, relevant predictor variables can be determined and correlations between variables can be identified.

Examples of predictive analytics

A known example of predictive analytics in the built environment includes the analysis of GPS trajectory data to trace and predict people's movement patterns. Pentland (2014) established the 'reality mining' approach, which predicts individuals' future movements based on the data retrieved from GPS and Bluetooth signals from their mobile phones. This methodology provides the potential to predict the future dispersion of illnesses and the emergence of traffic jams. Skourletopoulos et al. (2018) underlined the potential of trajectory data analysis, by stating that trajectory patterns can be derived to predict the occupancy or quality of transportation infrastructure services.

Another example of predictive analytics is related to the prediction of crime rates. The Memphis police department was able to predict future crime, which resulted in a 30% decrease of crime rates within the city (Thakuriah et al., 2016).

Moreover, Appel et al. (2014) applied predictive analytics to identify the indicators that contributed to the cause of vacant property. By this methodology, they were able to determine locations that were likely to become obsolete, which provided the ability to establish a proactive approach to prevent the emergence of distressed neighbourhoods.

Proposed implementation method

The application of predictive analytics can provide urban planners a tool to understand continuous urban processes and to predict the future development of these processes. As methodology for the measurement of spillover effects of urban icons, predictive analytics can be applied to gain more insight into the visitors of a location.

Data mining experiments can be performed on large data sets in order to identify patterns of variables that influence the amount of visitors, visitor characteristics or the visitor behaviour at a specific location. These variables may include weather conditions, time, sales periods or events in the neighbourhood. When these patterns have been identified, a prediction can be made of the amount of people that visit a location at a specific time, the characteristics of these people or the activities they will perform.

The comprehensiveness of the used data set influences the effectiveness of the data mining technique and the ability to predict the future development of a process. The added value of big data analytics lies in the comprehensiveness of the data set, as it provides the ability to find unexpected patterns between a large number of variables. Therefore, the experiments should not remain limited to the expected correlations, but they should include a wide range of variables in order to be able to identify unexpected influential variables.

Prescriptive analytics

Prescriptive analytics is associated with forecasting the impact of future actions before they are taken (Skourletopoulos et al., 2018). The approach of prescriptive analytics is based on generating synthetic information and performing large scale simulations by using this synthetic information (Hsu, 2014).

In contrary to predictive analytics, which is related to the prediction of future developments based on continuous patterns, prescriptive analytics deals with future developments based on a disruption of these patterns. This disruption can consist of a physical intervention, e.g. the development of an urban icon, or a change in policy.

Prescriptive analytics can be used by urban planners and policy makers to evaluate the potential effects of different scenarios and to forecast the future effects of their decisions.

Examples of prescriptive analytics

The application of prescriptive analytics in urban planning and management is currently still at its infancy.
An example is known, in which Hsu (2014) has described the use of prescriptive analytics in a disaster resilience study. In the study, realistic simulation models were developed based on synthetic information. Synthetic information is a term that is used for data that is generated from multiple unstructured sources. In the study on disaster resilience synthetic information was used regarding the population, technological devices assigned to the population, a collection of activity sequences, activity locations and a transportation network. With this information, a model was developed to determine where people are located and which activities they perform at a specific moment in time.
Multiple simulations were carried out based on the occurrence of fictional disasters. Based on the synthetic information implemented in the model, the effects of the fictional disasters were simulated.

Proposed implementation method

By the practice of data mining correlations between variables can be determined, which can provide input for the establishment of synthetic information. This synthetic information will represent the characteristics of a specific context, e.g. the residents that live within an area, the visitors at a specific location and the activities they perform.

When this synthetic information is established, simulations can be carried out of different scenarios, e.g. the development of a potential urban icon. Based on the synthetic information and the identified patterns between variables, the spillover effects of an urban icon can be predicted. For example, these simulations may imply the potential real estate value change, the amount of visitors attracted to an area, the building's influence to the urban image and the demographic changes within a neighbourhood.

Despite the potential to predict the outcomes of future scenarios, the methodology of prescriptive analytics still needs to be developed further in order to be applicable in the urban planning practice.

5. Summary and conclusions

In this chapter, an impact assessment methodology blueprint has been designed in order to answer the following research question: *By which assessment methodology can the impact of urban icons be effectively measured and monitored?*

As answer to the research question, an overview will be provided of the proposed impact assessment methodology. Furthermore, the effectiveness of the three steps that were prescribed in the methodology will be determined.

5.1. Proposed methodology

The impact assessment methodology blueprint which has been prescribed in the former chapter can be divided into three consecutive steps: the integration of evaluation in the building cycle, the establishment of a big data-based evaluation methodology and the move towards a data-driven urban planning practice.

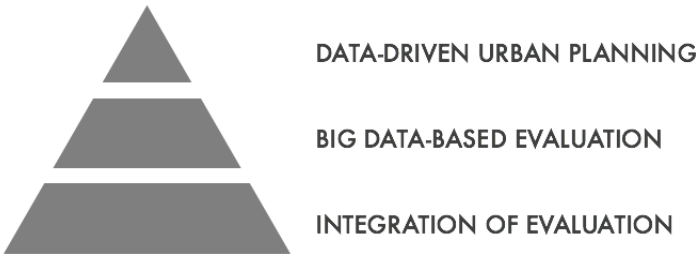


Figure 17: Impact assessment methodology blueprint structure (own illustration).

Integration of evaluation in the building cycle

In order to effectively evaluate iconic developments, the practice of evaluation should become an integral part of the building process cycle. The integration of evaluation is fulfilled by the definition of clear objectives, long-term and longitudinal measurements and the applications of lessons learnt in the strategy development for future projects.

Establishment of a big data-based evaluation methodology

The application of big data sources to measure the impact of urban icons can improve the effectiveness of the evaluation process. The high spatiotemporal resolution of big data sources makes it possible to capture dynamic urban change processes that cannot be measured by using traditional static data sources. Moreover, big data sources provide a more efficient measurement methodology in comparison to the expensive and labour-intensive traditional data collection methods.

Move towards a data-driven urban planning practice

The final step in the establishment of an effective impact assessment methodology includes the application of data visualization and big data analytics in order to develop a data-driven urban planning practice. Data visualization can be used as a tool to assist urban planners in the understanding of urban change processes and the communication with other stakeholders. Big data analytics, by techniques as data mining and the development of synthetic information, can be applied on comprehensive big data sets in order to distinguish patterns that are associated with urban processes. Based on these patterns, predictions can be made of the future development of urban change processes or the effects caused by different development scenarios.

5.2. Review of the proposed methodology

The prescribed impact assessment methodology has been developed in response to the gaps in the current state of research and practice with regards to measuring the spillover effects of urban icons.

Shortcomings of current state of research and practice

In the current state of research there is a shortcoming of a comprehensive impact assessment methodology, by which the spillover effects of urban icons can be quantitatively and longitudinally measured. Furthermore, due to its spatiotemporal resolution, traditional data sources are not able

to capture fast urban change processes. Moreover, the application of traditional data sources requires labour-intensive and expensive data collection methods.

The application of big data sources and big data analytics can enhance the effectiveness of measuring the spillover effects of urban icons, as it provides the opportunity to comprehensively, quantitatively and longitudinally measure the spillover effects of urban icons.
Besides that, big data has generated the opportunity to capture fast urban change processes due to its high spatiotemporal resolution.
Finally, the application of big data requires less labour-intensive and expensive data collection methods.

Opportunities provided by the impact assessment methodology blueprint

The three steps of the prescribed impact assessment methodology have been designed in response to the gaps in the current state of research and practice. Due to their consecutive nature, the higher steps provide a more holistic answer to the shortcomings in the current state of research and practice.

The following table provides a 1-5 scale ranking to indicate how each step addresses the gaps in the current state of research and practice:

	Current situation	Step 1	Step 2	Step 3
Longitudinal focus				
Quantitative measurement				
Spatiotemporal resolution				
Applicability to multiple cases				
Comprehensiveness of indicators				
Ability to predict continuous processes				
Ability to predict effects of scenarios				

Table 6: Ranking of impact assessment methodology steps (own illustration).

The first step of the impact assessment methodology includes the integration of evaluation in the building cycle. Due to the integral and long-term perspective, this step provides the ability to evaluate projects with a longitudinal focus.

The second step encompasses a big data-based project evaluation methodology, in which the use of big data sources is prescribed to measure the spillover effects of urban icons. The added value of this step is related to the ability to quantitatively measure a wide range of features and indicators on a high spatiotemporal resolution.

The third step advocates the shift towards a data-driven urban planning practice. The measures prescribed in this step provide the potential to predict the future development of continuous urban change processes and to establish a methodology to predict the outcomes of interventions made in the built environment.

Effectiveness of the impact assessment methodology blueprint

The impact assessment methodology that has been presented in this chapter was aimed to increase the effectiveness of the measurement of spillover effects of urban icons.

The table on the following page provides a 1-5 scale ranking of the effectiveness of the prescribed steps:

	Current situation	Step 1	Step 2	Step 3
Effectiveness				

Table 7: Effectiveness of the impact assessment methodology steps (own illustration).

The first step of the impact assessment methodology provides an increased effectiveness, due to the integral implementation of evaluation in the building cycle. Because the objectives associated with a project are clearly defined and the effects can be measured on a long term, more effective results will be provided by the impact assessment of urban icons.

The second step prescribes the use of big data sources to measure the spillover effects of urban icons. The big data-based project evaluation methodology will provide quantitative results for a wide range of indicators on a high spatiotemporal resolution. Therefore, the effectiveness of the methodology will be increased further in comparison to the former step of the blueprint.

The third step entails an increased effectiveness due to the comprehensive nature of the methodology and its applicability in the urban planning practice.
The development of data visualization tools enhances the ability of urban planners to integrate the results from big data-based measurements in their strategies and decisions.
Furthermore, the application of big data analytics provides the potential to identify complex patterns between variables that influence an urban change process, and thereby predict the future development of these urban change processes.
Besides that, the results retrieved from this methodology can be used to inform future investment decisions.
Based on these opportunities provided by the prescribed methodology, the third step entails a higher effectiveness than the former two steps.

IMPLEMENTATION FEASIBILITY STUDY

1. Introduction

In the former chapter an impact assessment methodology blueprint has been presented, which has the potential to increase the effectiveness of measuring the spillover effects of urban icons. By implementing the prescribed methodology, municipalities will be able to justify their previous investments and to apply the lessons learnt from previous projects in the strategy development and decision-making processes of future projects.

Despite the opportunities that this methodology provides, multiple factors can be identified that may affect the feasibility of implementing the prescribed blueprint in practice. In order to identify these factors and their influence on the implementation feasibility, the following research question will be addressed in this chapter: *What is the feasibility of implementing the impact assessment methodology blueprint in practice?*

The next paragraphs will provide an overview of the different practical implications and their influence on the implementation feasibility. Based on the structure that was presented by Offenhuber and Ratti (2014), a distinction will be made between the methodological, technological and societal implementation feasibility.

2. Methodological implementation feasibility

In this paragraph, an overview will be given of the different implications and their influence on the methodological implementation feasibility of the prescribed impact assessment methodology blueprint.

2.1. Methodological implications

Traditional and big data-based research methods

The potential of big data analytics has generated the opportunity to shift towards a data-driven urban planning profession. Although the application of new data sources and measurement methodologies may improve the effectiveness of the urban planning practice, it also provides a limitation in comparison to the traditional methodology. Data-driven research is less focused on the 'why' and 'how' questions with regards to urban processes or on the disclosure of complex cause-and-effect relationships (Thakuriah et al., 2016).

The term 'big data hubris' refers to the assumption that big data can be a substitute for traditional data collection and analysis (Lazer, Kennedy, King, & Vespignani, 2014). This assumption can be considered to be a misconception, as big data analysis can reveal correlations between variables, but cannot disclose any causal relationships between different phenomena. The interpretation of correlations as causal relationships can lead to wrong conclusions.

A famous example of this correlation-causality misunderstanding is described by List and Gneezy (2014). A statistical study once showed that there was a correlation between the amount of deaths by drowning and the amount of ice creams sold. When solely looking at these two variables, one can misunderstand a causal link between these variables and say that by eating ice cream one increases the risk of dying by drowning. However, an important third variable was missing: during summertime people eat more ice cream and more people go swimming, thus the amount of people who died by drowning is higher during that season.

This example indicates the need of theoretical framing to drive quantitative empirical research, which has been advocated by Thakuriah et al. (2016). This statement has been supported by Offenhuber and Ratti (2014), who distinguished two methods that combine quantitative and qualitative research in order to gain understanding of complex urban processes.
In the first method, qualitative analysis is used to inform quantitative queries. By this method, a theory or hypothesis is established based on qualitative research. In order to provide empirical evidence to affirm the hypothesis, quantitative research can be carried out.
In the second method, quantitative data mining is used to inform qualitative enquiries. By revealing complex patterns in large data sets, correlations between variables can be exposed. These

correlations can be used as input for qualitative research, which is aimed to explain and understand the existence of these correlations.

As these examples and methods demonstrate, the potential of big data analytics is embedded into the combination with traditional research methodologies. Therefore, big data-based research should not be perceived as a substitution, but as an addition to traditional research methods.

Implications for the urban planning profession

The big data era has generated a paradigm shift in the urban planning process (Thakuriah et al., 2016). The emergence of new concepts, such as smart cities, has led to the advocacy that the state of urban planning should be re-examined and explored in order to determine how data can lead to a new understanding of the city (Offenhuber & Ratti, 2014).

Urban planners have historically been educated and trained to work in data poor environments, but urban planners are now expected to be working with many big data sets in the future. In contrary to traditional urban data sources, the processes of data collection and analysis run parallel in the case of unstructured big data. Therefore, the boundary between the tasks of traditional data analysts and urban planners has become blurred, resulting in the need for urban researchers to acquire data analytic skills or to work closely with data scientists (Thakuriah et al., 2016). Gupta, Pfeffer, Verrest, and Ros-Tonen (2015) implied that government employees often lack the time and expertise to set up, maintain and operate these geo-technologies.

Thakuriah et al. (2016) distinguished four types of professionals that work for organizations in the field of urban data. These types included data scientists, ICT developers, analysts trained in urban planning and managers who lead data-centric projects in cities or communities. The latter two types can be perceived as similar to the traditional urban planners and managers. In contrary, the former two types of professionals are relatively new in the field of urban planning and research, which implies that big data analytics will have to be integrated in the urban planning profession.

Short term investments and long term benefits

The development of geo-technologies is costly and requires specific skills (Gupta et al., 2015). Therefore, the transition towards a data-driven approach to urban planning requires a high amount of resources, both in terms of money, time and people.
Because the incorporation of big data analytics in the urban planning practice is still at its infancy, it remains uncertain on which term the increased effectiveness of the research and planning methodology will become visible.

Municipal organisations operate by using public money, which means that they have to justify their investments directly to the city's political body. The Dutch city councils operate in 4-year terms and determine annual budgets, which has led to a rather short-term approach with regards to the municipal investments.

The expert panel confirmed that municipalities often consider the level of costs to be a roadblock for the implementation of a requested measurement programme. However, the panel members also underlined that the required investments are relatively small compared to the multi-million budgets that are associated with iconic developments (Arends, Dorsman, Dudok, Epskamp, & Van Rhee, 2018).

2.2. Methodological implementation feasibility

Willingness to make the required investments

The implementation of the proposed impact assessment methodology requires investments to finance the hardware, software and people that are needed to conduct the measurements and analyse the results. In order to be able to implement the prescribed methodology, the politicians and managers that are in a position to make the required investments need to support and recognize the potential of the impact assessment methodology.

Due to both financial and political reasons, it currently remains unlikely that municipalities would be willing to make the investments to implement the prescribed impact assessment methodology in practice.

The implementation of the impact assessment methodology blueprint will require high short term investments. However, it remains uncertain to which extend and on which term the methodology will eventually pay itself off in increased effectiveness. Due to this uncertainty and the long term perspective regarding the potential benefits, it can be considered questionable whether the responsible politicians and managers would be willing to make the required high investments.

Furthermore, the methodology blueprint provides municipalities a tool to justify their former investments and to help them substantiate future investment decisions. However, as long as municipalities are not held accountable for any potentially bad investments and no public commotion has emerged, there is no incentive for the responsible politicians or managers to invest in a methodology that will support the justification of their previous investments or investment decisions.

Willingness to change the traditional way of working

The proposed methodology implies that a shift in culture should occur with regards to the current state of urban planning. In order to implement the prescribed methodology, a new urban research and planning approach should be established, in which big data analytics and the traditional research and planning methods are combined in a complementary way.

The researchers that are acquainted with big data analytics should work together with urban planners that still work according to the traditional approach. Together, they should establish a synergetic approach through the integration of both traditional and big data-based research methods in the urban planning practice.

According to the expert panel, the organisation of the municipality of Rotterdam is currently divided into a group of ‘early adopters’, who see the potential of the application of big data analytics in urban planning, and a large group of civil servants that do not share this perception and who do not intend to adapt their traditional way of working, which often remains to be based on personal experience and intuition instead of objective measurements (Arends et al., 2018).

In order to successfully implement the impact assessment methodology blueprint, consensus with regards to the potential of the proposed methodology should be reached on all levels of the municipal organisation. Based on the current level of resistance among the municipal organisation, it remains questionable whether the required culture shift could actually be initiated and pushed through in practice.

The prescribed methodology can be either implemented top down or bottom up. A top down implementation would require the management level to see the potential of the prescribed methodology and to initiate an organisational culture shift. A bottom up implementation would require the the ‘early adopters’ to persuade their colleagues of the opportunities and benefits that are associated with the proposed culture shift. In that way, the civil servants on the lower and middle levels of the municipal organisation can initiate the culture shift themselves.

3. Technological implementation feasibility

This paragraph will address the different technological implications and their influence on the implementation feasibility of the presented impact assessment methodology blueprint.

3.1. Technological implications

Data availability and ownership

Traditionally, the data used for urban planning and management was mainly collected by governmental organisations. However, an increasing amount of data is currently being gathered by private companies, such as mobile operators, social network platforms and electronic payment

companies (Thakuriah et al., 2016). The data these private organisations offer can provide urban planners and researchers interesting insights with regards to people's daily movements and activities within a city. As a result of this potential, a new business model has emerged among private organisations, that can now benefit from the sale of their data.
In some markets, the acquisition of data from corporations has even become essential in order to conduct accurate market research. For example, if municipalities do not obtain data from companies like Uber, who are not required to share travel information, they will miss a large segment of the transportation market (Thakuriah et al., 2016). The same applies for information from platforms like Airbnb, which currently makes up a large share of the travel industry.
In order to keep providing the urban services that meet the citizens' demands, urban planners need to establish partnerships with private organisations to obtain the data that is required to offer their services (Thakuriah et al., 2016).

Despite the new opportunities that have arisen due to the increasing amount of available data obtained from private sources, concerns have emerged on the resulting so-called corporatisation of urban governance. Kitchin (2014) stated that urban governance is being overtly shaped by the corporate interests of the organisations that sell their data to cities. Furthermore, cities become increasingly dependent on the data of private organisations, which can result in monopoly positions for these corporations (Kitchin, 2014). The increasing dependency of cities on the data from private organisations has raised the concern that it may negatively influence the urban governance and it may weaken the negotiating position of cities with regards to future data sales.

Data veracity

Data veracity is one of the features that is inseparably linked to the quality of big data, alongside the other 4 V's of volume, velocity, variety and value. Data veracity refers to two aspects: data consistency and data trustworthiness (Demchenko, Grosso, De Laat, & Membrey, 2013).

Data consistency is related to the certainty or statistical reliability of a data source (Demchenko et al., 2013). An issue with data consistency has been encountered with regards to data obtained from crowd-sourcing applications or social media platforms. These users of these data sources do not represent the overall population (Thakuriah et al., 2016), which might lead to biased information based on the divergent demographic composition.
The method of data triangulation can be used in order to warrant the consistency of a typical data source. Data triangulation is a strategy in which multiple methods of data collection are used in order to strengthen the reliability of the data collected (Robson & McCartan, 2016). A similar approach was advocated by Lovelace et al. (2016), who compared the quality of three big data sources in their research on retail flows. By conducting cross-verification, they were able to reveal a high level of similarity between the travel information obtained from mobile phone records and geo-located surveys. The information obtained from geotagged tweets showed high deviations from the information obtained by the two other data sources.

The data trustworthiness is related to the origin of data and the collection and processing methods that were used to obtain the data (Demchenko et al., 2013). Issues regarding data trustworthiness can be associated with the technique of 'web scraping', which is a frequently applied method to collect large amounts of information from websites (TechTerms, 2018).
This technique has been used to extract information from online accommodation platform Airbnb, which has been used by secondary parties to provide detailed market information.
An issue with the data trustworthiness of scraped information was encountered in 2017, when the information presented by one of these secondary web scrapers was as input for market research on the number of Airbnb rentals within the city of Amsterdam. After the publication of the market research, Airbnb stated that the numbers that were used in the research were inaccurate (Remie, 2017). This incident raises the question whether data collected by the technique of web scraping provides trustworthy information that can be used in urban research and planning. Because the web pages that are scraped are constantly changing, the information that was previously extracted disappears. In that way, the extracted information cannot be traced back and it becomes impossible to identify any potential errors in the historical data that was obtained by using a web scraper.

3.2. Technological implementation feasibility

Dependency on corporations

The formation of partnerships with private organisations is essential for municipalities in order to obtain information about specific markets or types of indicators. However, in this way municipalities establish a dependency on corporations, which may result in corporations obtaining monopoly positions. This dependency can generate a weak negotiating power for municipalities, which can potentially result in future financial disadvantages with regards to the acquisition of data.

Although the dependency on corporations does not provide a potential obstruction for the implementation of the impact assessment methodology, it does provide a threat to the future effectiveness and efficiency of the methodology, as the effectiveness of the methodology depends on the availability of corporate data and the efficiency may be harmed due to potential cost increases. Municipalities should carefully take these threats into account when establishing partnerships with corporations to obtain data.

Ascertaining data reliability and accuracy

The availability of new data sources, e.g. social media and crowdsourcing-platforms, and collection methods, e.g. web scraping, have provided new opportunities to obtain useful information with regards to a wide range of topics. However, these data sources and collection methods provide threats to the ability to the reliability and accuracy of the obtained data.

In order to ascertain the data reliability and accuracy, municipalities should only apply data collection methods that remain accountable and historically traceable. Furthermore, they should apply triangulation methods in order to verify the data obtained by specific sources. The results of these triangulations may imply that specific data sources provide inaccurate biased results, which would limit the extent to which the impact assessment methodology blueprint can be implemented in practice.

4. Societal implementation feasibility

The following sections will address the different societal implications and their influence to the implementation feasibility of the impact assessment methodology blueprint.

4.1. Societal implications

Privacy and data protection

European Consumer Commissioner Meglena Kuneva (2009) once stated: “Personal data is the new oil of the internet and the new currency of the digital world”. Based on the amount of information personal data provides, it is considered to be immensely valuable (Greenwood et al., 2014). According to Koonin and Holland (2014) we will be able to improve our scientific understanding of cities by using tools of big data. However, the high value of big data comes with privacy concerns that can have a serious impact on the regulatory environment, data economy and future innovation (Tene & Polonetsky, 2011).

Personal data provides valuable information about people’s movements and interactions, which can be either used to offer personalized services or to be exploited by people with bad intentions (Greenwood et al., 2014). Therefore, urban planners should consider the trade-off between providing personalized services and privacy concerns (Thakuriah et al., 2016).

The strategies to address privacy concerns can be broken down in three dimensions: privacy-enhancing technology, the legal framework for data protection and raising awareness of the privacy implications of people’s activities (Thakuriah et al., 2016).

Privacy-enhancing technology

Big data analytics requires personalized, location-based information, which makes it sensitive to misuse. In order to protect the data privacy, effective encryption methodologies should be developed (Skourletopoulos et al., 2018). Several technological encryption solutions are available, including the anonymization of GPS data or the use of synthetic data as a substitute for administrative data (Thakuriah et al., 2016). In order to generate privacy-preserving data visualizations, the use of parallel coordinates can be applied (Koonin & Holland, 2014).

Despite the range of applicable encryption solutions, it remains extremely hard to ensure true anonymization (Greenwood et al., 2014), as even anonymized data can often be re-identified and attributed to specific individuals (Tene & Polonetsky, 2011).

In order to mitigate the weaknesses of encryption and anonymization technology, Greenwood et al. (2014) proposed to combine technological and legal privacy-enhancing measures in the establishment of a 'trust network'. This solution will be elaborated further in the next subsection.

Legal framework for data protection

The right to privacy is a fundamental right, which advocates that "everyone has the right to protection of personal data" and that "data must be processed fairly for specified purposes and on the basis of consent of the person concerned" (Europen Union Agency for Fundamental Rights (FRA), n.d.).

The rapid development of big data technology can be hardly withstood by the current legal framework to protect privacy, as the emergence of new data sources and mining techniques generate privacy concerns that cannot always be tackled by the existing privacy and data protection laws.

On May 25th 2018, the European privacy and data protection legislation was reformed. The reform includes the obligation for public administrations to appoint a Data Protection Officer (DPO) (European Commission, n.d.-a) and the requirement to conduct a Data Protection Impact Assessment (DPIA) for cases in which data processing is likely to result in a high risk to the rights and freedoms of individuals (European Commission, n.d.-b).

According to Greenwood et al. (2014), the threat of legal action is important to safeguard privacy rights, but it does not provide a sufficient measure. Therefore, they proposed the establishment of a 'trust network', which consists of a combination of networked computers and legal rules defining and governing expectations regarding data. In the trust network, users can control their data themselves as they are able grant permission to share certain types of data with specific organisations or for specific purposes.

Raising awareness of privacy implications

Many people consider big data to be deeply suspicious, as they see big data as an invasion to their privacy (Skourletopoulos et al., 2018). Despite the growing concerns about privacy, an increasing willingness of people to share personal information can be observed (Thakuriah et al., 2016). As these trends imply, people's perception of privacy does not always align with their actual level of privacy. This implication was underlined by Tene and Polonetsky (2011), who stated that the feeling of control encourages users to share more data. For example, privacy policies give people the impression that their data is protected, while they are actually used as a liability disclaimer for businesses in order to be able to collect data from their users.

Greenwood et al. (2014) stated that users should be authorized to manage and control their own data. Therefore, they proposed concepts as the 'trust network' and 'living informed consent', in which they advocate that users should become entitled to know what data is being collected about them and that individuals should be able to grant or withdraw permission to share their data with specific entities.
In that way, people's perception of privacy and data protection will not be based on false assumptions, but people will actually become in control of their own data.

Ethical considerations

The application of big data analytics is inseparably linked with several ethical issues. According to Thakuriah et al. (2016), the ethical issues surrounding big data are not well understood and recognized yet.

There currently is little transparency and oversight in big data research, as big data operations often collect personal information without the consent, or even without informing, the people that are monitored (Thakuriah et al., 2016). For example, in 2015 the municipality of Amsterdam conducted research to get more insight in the networks of problematic youth by using information retrieved from social media. The persons whose data was collected were not informed about the procedure, which raised ethical concerns and turned out to be in opposition to the privacy and data protection legislation (Van Lonkhuyzen & Stokmans, 2018).

Besides that, big data may raise serious ethical questions, because it can result in ethnic profiling. Examples are known of research on crime patterns, in which individuals that had previously committed crimes were profiled by the analysis of data regarding their race, ethnicity and neighbourhood (Thakuriah et al., 2016). Although the outcomes of these analyses may provide information that can be used to prevent future crimes, the profiling techniques show a concerning resemblance to ethnic profiling.

Furthermore, the hypotheses that are based on big data analytics can sometimes have far-reaching consequences for the people that are involved. Examples are known of companies that lowered people's credit card limits, as a result of the inferences that were established by algorithms based on geotagged social media data. Thakuriah et al. (2016) advocated that new legislation is required to govern how these assumptions are used.

4.2. Societal implementation feasibility

Privacy concerns

Municipalities should guard privacy and data protection by the application of suitable technological measures to ensure that personal information is not misused. Moreover, they should act according to the new privacy and data protection legislation. Furthermore, people should be made aware of the privacy implications of their online activities.

These required measures imply that the use of specific data or data sources may invade people's privacy, which can result in a limitation of the amount of information that can be applied in the prescribed impact assessment methodology.

Recognition of ethical issues

The application of big data analytics in urban research and planning can be associated with the occurrence of ethical issues. In order to prevent the outbreak of any negative commotion about ethical concerns, municipalities should carefully consider the ethical principles when applying big data analytics in their operations.

There may be ethical reasons to exclude the application of specific data sources or to limit the purposes for which certain types of information is used. Therefore, the effectiveness of the impact assessment methodology might be limited as a result of ethical considerations.

Ethical concerns can get easily mixed up with privacy concerns, but they refer to different types of issues that municipalities have to take into account. For example, municipalities may act according to the privacy legislation, but still neglect any relevant ethical principles.

5. Summary and conclusions

In order to identify the different practical implications and their influence on the implementation feasibility, the following research question has been addressed in this chapter: *What is the feasibility of implementing the impact assessment methodology blueprint in practice?*

The implementation feasibility is influenced by different methodological, technological and societal implications. The next sections will address the implications that may cause an obstruction to the implementation feasibility and the implications that provide threats that might affect the effectiveness of the implementation of the prescribed methodology.

5.1. Potential obstructions to the implementation feasibility

The implementation of the proposed impact assessment methodology implies a radical culture shift, which requires both high investments and consensus on all levels of the municipal organisation. These methodological implications can potentially provide a roadblock to the implementation of the proposed methodology.

In the current context, it can be considered unlikely that the high investments that are required for the implementation of the methodology will be made by the responsible politicians and managers. Due to the uncertainty about the benefits of the methodology and the term on which these benefits would emerge, the risk of investing in the prescribed methodology may currently be considered to be too high. Moreover, there currently appears to be no urgent need for politicians or managers to more accurately justify their previous investment decisions or substantiate their investment decisions. Although high municipal investments are often questioned by the public, the level of negative commotion is too low to provide an incentive to invest in the implementation of the prescribed impact assessment methodology.

Furthermore, a significant division can be observed between civil servants that advocate the benefits of implementing big data analytics in the urban research and planning profession and the group of civil servants that prefer to keep operating in a more traditional way, in which personal experience and intuition are used to support the development of strategies. Due to the current level of resistance among urban planners, it remains questionable whether the civil servants that prefer the traditional way of working can be persuaded and if the required culture shift will be able to be implemented. A top down initiated culture shift may be needed in order to implement the prescribed methodology within a municipality.

5.2. Threats to the effectiveness and implementation feasibility

Besides the potential roadblocks that affect the implementation feasibility, several implications have been identified that may threaten the effectiveness and implementation feasibility of the prescribed impact assessment methodology.

Municipalities should not overlook the potential inaccuracies and forms of bias that can occur when using unstructured big data sources. Therefore, critical methods of triangulation should be applied in order to determine the reliability and accuracy of these data sources. The results of these triangulations may limit the amount of applicable data sources.

Furthermore, potential privacy or ethical concerns should be carefully taken into account. Municipalities should proactively investigate the privacy-related and ethical implications that can be associated with a proposed research or planning methodology. Privacy or ethical concerns may affect the amount of applicable data and data sources or they may limit the purposes for which the obtained information can be used.

CONCLUSIONS

In this chapter, the conclusions of this research will be presented by answering the research questions and hypothesis. The first paragraph will provide the answers to the sub questions and main research question. In the second paragraph, the answer to the hypothesis will be provided.

1. Answers to the research questions

1.1. Sub question 1 – Theoretical background

In the theoretical background chapter, an exploration was made of the current state of research with regards to the spillover effects of urban icons. Based on this exploration, the following research question has been answered in this chapter: *What are the gaps in the current state of research on the spillover effects of urban icons?*

Based on the literature study that was conducted to establish the theoretical background, it has been determined that most studies on the spillover effects of urban icons applied a qualitative research strategy, focused on one type of intended impact and were carried out at one moment in time.

Therefore, the current state of research on the spillover effects of urban icons lacks the availability of an effective, and thus quantitative, comprehensive and longitudinal approach by which the impact of urban icons can be effectively measured.

1.2. Sub question 2 – Case study

In the case study chapter, a thorough analysis was made of the iconic Markthal development. By examining the objectives, strategies and outcomes that were associated with the project, the relevant features associated with the Markthal development were identified. By the definition of these features, an answer could be provided to the following research question: *Which types of effects are relevant for the evaluation of urban icons?*

The relevant features by which the project could be evaluated were retrieved from the objectives and observed outcomes with regards to the Markthal development, the urban regeneration of the Laurenskwartier area and the Rotterdam urban image. This resulted in the following list of features, which indicate the relevant types of effects to evaluate urban icons:

Feature category	**Features**
Project-related features	Building programme
	Visitors
Urban regeneration-related features	Real estate value
	Economic spin-offs
	Perception of the public space
	Nuisance
	Crime
	Real estate developments
	Demographic change
Image-related features	Image
	Tourism

Table 8: Overview of relevant features for evaluation of urban icons, based on the Markthal development (own illustration).

The presented list of features has been used to determine the project-specific features and indicators that are part of the big data-based project evaluation methodology blueprint that is presented in the next chapter.

1.3. Sub question 3 – Impact assessment methodology

In the impact assessment methodology chapter, a blueprint was designed in order to answer the following research question: *By which methodology can the impact of urban icons be effectively measured and monitored?*

The prescribed impact assessment methodology blueprint is structured by three consecutive steps. The first step includes the integration of evaluation in the building process cycle. By this step, the practice of evaluation can be carried out more effectively. The second step consists of the application of big data sources and measurement methodologies in order to more effectively measure the different types of spillover effects of urban icons. The final step is associated with the establishment of a data-driven urban planning practice, by the implementation of data visualization and big data analytics tools to support the urban planning practice.

By implementing the prescribed methodology, the impact of urban icons can be measured effectively, based on the associated quantitative strategy, the high spatiotemporal resolution and the longitudinal focus. The results of these measurements can be applied by municipalities to justify previous investments and to support the decision-making process for potential future investments.

1.4. Sub question 4 – Implementation feasibility study

In the implementation feasibility study chapter, an exploration has been made of the different practical implications and their influence on the feasibility to implement the prescribed impact assessment methodology blueprint in practice. This exploration was made to provide an answer to the following research question: *What is the feasibility of implementing the impact assessment methodology blueprint in practice?*

In order to determine the implementation feasibility, a distinction was made between the methodological, technological and societal implications that may affect the implementation feasibility.
The methodological implications, which are related to the willingness to make the required investments and the willingness to make a culture shift in the urban planning practice, provide potential obstructions to the implementation feasibility.
The technological and societal implications provide several threats to the implementation feasibility and effectiveness of the prescribed methodology. Concerns regarding data reliability, privacy or ethical issues may result in the limitation of the amount of applicable data sources and data collection methods.

Based on the methodological implications, the implementation feasibility can be considered to be low in the current political and organisational context. A top down or bottom up initiated culture shift will be required in order to implement the impact assessment methodology in practice.

1.5. Main research question

The research that has been presented in this thesis was conducted in order to answer the following main research question: *How can the spillover effects of urban icons be effectively measured?*

In order to effectively measure the spillover effects of urban icons, municipalities should initiate a culture shift towards an approach in which research and urban planning are inseparably linked. Furthermore, municipalities should invest in the establishment of a methodology in which evaluation becomes an integral part of the building process cycle, big data sources are applied to effectively measure the impact of urban icons and a data-driven urban planning practice is established.

In that way, a methodology can be established to effectively measure the spillover effects of urban icons. The results of these measurements can provide useful insights that can be applied by municipalities to justify previous investments and to inform and substantiate future investment decisions.

2. Answer to the hypothesis

The exploration of the opportunities to apply big data to measure the spillover effects has played a central role in this research. Therefore, the following hypothesis has been defined: *By the application of a big data-based*

approach, a comprehensive and feasible assessment methodology to effectively measure the impact of urban icons can be established.

In order to affirm or disprove the hypothesis, a reflection will be made on the comprehensiveness and feasibility of the big data-based impact assessment methodology that was presented in this research. Based on these reflections, an answer to the hypothesis will be provided.

2.1. Comprehensiveness of the big data-based methodology

The effectiveness of the ability to measure the types of spillover effects used to be limited by the spatiotemporal resolution of traditional data sources. Due to this limitation, spillover effects that represent fast urban change processes could not yet be captured. However, by the application of big data sources the ability has been provided to capture dynamic urban change processes at a high spatiotemporal resolution. Therefore, a comprehensive impact assessment methodology blueprint could be designed, by which the whole range of potential spillover effects of urban icons can be measured.

2.2. Feasibility of the big data-based methodology

Several methodological implications have provided a potential obstruction to the practical implementation feasibility of the big data-based impact assessment methodology that was presented in this research. In the current context, there is too little incentive for municipal managers to make the required investments to establish a methodology by which they can justify their investments. Moreover, due to the experimental nature of the prescribed methodology, it remains uncertain when and to which extent the high required investments will pay off in increased effectiveness of the urban planning practice. Furthermore, it remains questionable whether the required culture shift in the urban planning practice can be made, due to the current level of resistance among urban planners.

2.3. Answer to the hypothesis

Despite the opportunities of the comprehensive big data-based methodology that was presented in this research, the hypothesis has been disproven due to the low implementation feasibility of the prescribed big data-based methodology in the current context.

In order to be able to affirm the hypothesis in the future, several changes should occur in the current political, technological and organisational context.

In order to implement the impact assessment methodology through a top down approach, changes in the current political and technological context should occur.
Firstly, the need for accountability and the justification of investment decisions should increase in order to provide politicians the incentive to start implementing the big data-based impact assessment methodology. Moreover, the further development of the technology that is associated with the big data-based methodology will decrease the uncertainty with regards to the potential benefits, which will result in a lower risk level and makes it more likely that municipalities would be willing to make the required investments to implement the prescribed methodology.

In order to implement the impact assessment methodology through a bottom up approach, a change should be made in the current organisational context.
More widespread support of the prescribed methodology should emerge within the municipal organisation, in order to make the required culture shift feasible. This change may generate a bottom up initiated culture shift.

LIMITATIONS

In this chapter, the limitations of this research will be discussed. The following paragraphs will address the theoretical perspective of this research, the generalizability of the presented impact assessment methodology and the inability to prove causality.

1. Theoretical perspective

This research encompasses an explorative study in which an impact assessment methodology blueprint is designed to measure the spillover effects of urban icons. This design has been established from a theoretical perspective, as it has been based on examples of existing measurement methodologies retrieved from literature.

This research does not include the practical implementation of the presented impact assessment methodology. By the practical implementation of the prescribed methodology, the actual spillover effects of urban icons can be measured and potential correlations between different variables can be determined. Furthermore, the practical implementation may result in the encounter with potential obstacles associated with the application of the prescribed methodology.

2. Generalizability of the impact assessment methodology

The impact assessment methodology that has been presented in this research was designed as a blueprint that provides municipalities the ability to measure the spillover effects of urban icons. The principles of the blueprint's three consecutive steps, i.e. the integration of evaluation in the process cycle, the application of a big data-based evaluation methodology and the establishment of a data-driven urban planning practice, are generic and applicable to multiple cases.

Despite the generic principles of the impact assessment methodology, the content of the second step in the blueprint, i.e. the big data-based evaluation methodology, has been based on a list of project-specific features and indicators that were retrieved from the Markthal case study. These features and indicators are thus not generic, but specified according to the case of the Markthal.
The reason why these features and indicators were retrieved from the case study is linked to the project-specific perspective of evaluation. Evaluation refers to the assessment of the effectiveness of a project, in which the actual output is compared with the initial output objectives. Therefore, the features and indicators that are applied in project evaluation cannot be generic, but should be based on the specific objectives of the project that is being evaluated.

Although the principles of the three steps in the impact assessment methodology are generalizable, the content of the impact assessment methodology is not fully generic. Therefore, the applied indicators and measurement methodologies should always be adjusted to the project-specific objectives in the practical implementation of the prescribed impact assessment methodology.

3. Inability to prove causality

Researchers are generally eager to establish causal explanations, in order to understand and explain the occurrence of complex urban phenomena. Proving causality can be considered to be the highest possible result in the research on the spillover effects of urban icons. If we were able to prove which effects have been generated and by which factors these effects were caused, we would become able to predict the effects of future iconic developments. However, it yet remains impossible to provide a causal explanation for the complex urban phenomena that are associated with the development of urban icons by the application of the impact assessment methodology that has been presented in this research.

Schutt (2011) distinguished five criteria that are essential in order to establish a cause-and-effect relationship between variables. These criteria include *empirical association* (determining correlations between variables), *appropriate time order* (a chronological order of cause and effect), *nonspuriousness* (the exclusion of other influential variables), *mechanism* (the existence of a cause-and-effect mechanism) and *context* (the inclusion of influential context factors).

Quantitative measurements can be applied in order to assess the criteria of empirical association, appropriate time order and context. If the measurements are conducted on a comprehensive data set (which includes all potential influential variables) with an adequate spatiotemporal resolution, the required correlations, time order and context factors can be determined.

Qualitative studies can be applied to determine the mechanism criterion. By this research strategy, a theory can be established that provides an explanation for the relationship between different variables.

The nonspuriousness criterion provides the bottleneck due to which it remains impossible to establish a causal explanation for the spillover effects of urban icons. In social research, experiments are traditionally applied to determine causal relationships between different variables. In these experiments, a comparison is made between two nearly identical situations, in which only one variable is divergent. In that way, the potential influence of other variables can be excluded.
However, due to the lack of identical situations in the built environment and the inability to rerun existing situations, it remains impossible to conduct such experiments in the research on complex urban phenomena. In that way, the influence of other variables cannot be fully excluded and causality can thus not be proven.

Although the presented impact assessment methodology does not provide the ability to prove causal relationships, it does have the ability to determine relevant correlations or patterns that clarify the links between variables. These results results can be applied to inform and substantiate future investment decisions and strategies, and thereby increase the effectiveness of the urban planning practice.

RECOMMENDATIONS

The following paragraphs provide the recommendations for practice and further research, which have emerged throughout this research process.

1. Recommendations for practice

1.1. Reflecting on the modus operandi

In this big data era, during which many corporations are yet known to work with evidence-based decision-making and to apply a data-driven business strategy, it can be considered to be remarkable that municipalities are still basing their multi-million investments in the development of urban icons on ambiguous assumptions and personal intuition.
Therefore, municipalities should start to critically reflect on their modus operandi and question themselves whether their current way of operating can still be considered to be sustainable and future-proof.

Although the impact assessment methodology that has been prescribed in this research requires high investments, it does provide the opportunity to establish a more effective urban planning practice on the long term.
In order to make an informed decision about implementing the prescribed methodology, municipalities should carefully consider the trade-off between the associated short term investments and the long term benefits.

1.2. Closing the gap between research and urban planning

Municipal organisations include large research departments, which continuously collect and analyse large amounts of information about a wide variety of subjects. Despite this large research capacity, the findings of municipal research departments often remain to be neglected by urban planners during the strategy development and decision-making processes that are associated with urban regeneration projects or iconic developments.

In order to enhance the substantiation and justification of investment decisions, municipalities should aim to close the gap between research and urban planning by stimulating these departments to collaborate more closely. In that way, urban planners can make better-informed strategies and decisions.

1.3. Taking the first step

Although the implementation feasibility of the complete prescribed impact assessment methodology remains questionable, this does not imply that municipalities cannot make a change towards a more effective way of operating.

Every process of change begins with a first step. Therefore, municipalities should consider to start taking the first step by integrating the practice of evaluation in the process cycle. By defining clear objectives and conducting measurements of the current situation, relevant information can be collected which can be used as a benchmark in the ex post evaluation of specific projects. As discussed in the expert panel, the municipality of Rotterdam could consider to start the implementation of this methodology in the case of Feyenoord City, by measuring the existing situation in the surrounding neighbourhoods.

2. Recommendations for further research

2.1. Revealing correlations and discovering relevant indicators

By the application of big data analytics, new correlations between variables can be revealed. In contrary to traditional regression analyses, which are generally based on expected correlations that have emerged from theory, researchers should use data mining techniques on big data sets with a wide variety of variables and a high spatiotemporal resolution. The added value of this comprehensive methodology is its potential to identify patterns with unexpected correlations between variables. These patterns may include a combination of first order indicators, e.g. the revenue of nearby venues, static context factors, e.g. demographic neighbourhood characteristics, and dynamic context factors, e.g. time, weather conditions or the occurrence of temporary events.

2.2. Verifying modern data sources

Although some studies have yet addressed the potential bias that can be associated with data collected by social media or crowd-sourcing platforms, it remains uncertain how accurate and reliable the data collected by these types of modern sources can be considered.

In order to get more insight into the applicability of data obtained by these types of sources, data sources should be verified by means of triangulation methods. Moreover, researchers should aim to determine to which extent data sources with a specific demographic composition, e.g. social media platforms, can be applied in research without providing biased results.

2.3. Capturing physical appearance in big data analytics

Big data analytics has provided the opportunity to reveal previously invisible patterns between a wide range of quantifiable variables. Although this has provided municipalities the potential to effectively measure the impact of urban icons, it still lacks the inclusion of one relevant variable: the physical appearance.

In order to gain more understanding of why people perceive a building to be iconic, beautiful or recognizable, researchers should develop a methodology to capture the characteristics of a building's physical appearance in an analytic model. The further development of machine learning image recognition techniques may provide the solution to this current shortcoming.

REFLECTION

In this chapter, I will provide a reflection on this graduation research and the process of conducting this research. This reflection will be made based on the research topic, research methods, dissemination, ethical considerations and process.

1. Research topic

In the following sections, I will discuss the relation between the graduation topic, the BOLD Cities graduation laboratory and the chair of Urban Development Management.

1.1. Position within the BOLD Cities graduation laboratory

This graduation research is part of the BOLD Cities graduation laboratory. The graduation laboratory is linked to the Centre for BOLD Cities, which is a collaboration between Delft University of Technology, Leiden University and Erasmus University Rotterdam.

According to the introduction of the MBE Graduation Subjects, the BOLD Cities graduation laboratory "focuses on bringing together the perspectives of big data, [...] urban area development and governance into clear demonstrations that explain the potential of the emerging approaches" (2017).

With this graduation research, I aimed to explore the opportunities of implementing a big data-based impact assessment methodology. With this methodology, the spillover effects of urban icons can be effectively measured, which can be used by municipalities to evaluate the effects of investments and to support the substantiation of future investment decisions.

I addressed both the opportunities and challenges that are related to the implementation of the big data-based impact assessment methodology. By designing the methodology blueprint, I explored the opportunities that the emerging urban data landscape offers. By conducting a feasibility study, I explored the challenges that are linked to the application of big data analytics in urban research and measurement.

1.2. Position within the Urban Development Management chair

This research is linked to Urban Development Management chair, which is part of the MSc track Management in the Built Environment. The chair focuses on the management of the many stakeholders involved in the development of urban areas to reach a high quality outcome (TU Delft, n.d.).

Urban icons, the subject of my research, are projects that often entail high investments, the involvement of many stakeholders, including active involvement of municipalities, and ambitious goals with regards to the envisioned spillover effects. The envisioned impact of urban icons is linked to a larger scale than the building itself, as icons are often developed with the aim to generate spillover effects, e.g. by contributing to the image of a city or by functioning a catalyst in the development of the urban area around it.

By the design of the big data-based impact assessment methodology that has been prescribed in this research, the spillover effects of these urban icons can effectively be measured. The results of these measurements can be used to evaluate former investment decisions and can be applied to support the decision-making process for potential future urban icons.

2. Research methods

In the following sections, I will discuss the different research methods that have been applied to conduct this research.

2.1. Explorative interviews

In the early stages of this research process, I have conducted explorative interviews with several civil servants of the municipality of Rotterdam. By discussing topics as the development of urban icons, the evaluation of investments and the application of big data analytics, I was able to gain more understanding of the current ways of working within the municipalities and the potential room for improvement.

Although I have not included the results of these interviews in my research thesis, these interviews did help me to determine the societal relevance of my research topic and to further guide my research process.

2.2. Literature study

The literature study that has been applied makes up the primary source of information for this research.

The theoretical background has been written based on an exploration of the current state of research with regards to urban icons. The literature study conducted for this part of the research was focused on the different approaches that were applied to measure the spillover effects of urban icons. Based on this exploration, I was able to identify the gaps in the current state of research, which could be filled with the methodology I would design in the latter parts of the research.

In order to design the impact assessment methodology blueprint, I conducted a literature study on both the traditional measurement methodologies and the potential big data-based measurement methodologies that could be applied for the features and indicators that are associated with the impact of urban icons. Based on this literature study, I have designed an impact assessment methodology blueprint, in which the applicable data sources and measurement methodologies are linked to the relevant features and indicators.

In the final part of this research, the implementation feasibility study, I have conducted a literature study to identify the methodological, technological and societal implications for the implementation feasibility. Based on the findings of this literature study, I could identify the influence of these implications and the risks that could obstruct the implementation of the prescribed methodology.

For most topics, a sufficient amount of information could be obtained from the literature study. However, the current state of research with regards to the topic of prescriptive analytics has appeared to be still at its infancy. Therefore, the prescribed methodology to apply prescriptive analytics has remained rather abstract.

2.3. Interviews

As part of the case study, multiple semi-structured interviews were conducted with the main stakeholders involved in the Markthal development. During these interviews, interesting insights were obtained with regards to the stakeholders' objectives, strategies and the outcomes that they had observed.

The interviews provided useful information, which could not have been obtained from other sources. Instead of simple factual data, the interviews also helped to gain more understanding in the relationship between the before-set objectives and the outcomes after the completion of the project.

I have attempted to provide an objective representation of the information that was presented by the different stakeholders. However, I did observe a discrepancy between the level of detail and critical reflection in the information given by the different interviewees. This made it challenging to not become biased, although some stakeholders disclosed significantly more information than others.

2.4. Expert panel

At the final stages of this research, I organized an expert panel with five civil servants, including both researchers and urban planners, of the municipality of Rotterdam. During the expert panel, I discussed the methodological implementation feasibility my impact assessment methodology blueprint. The panel

provided useful insights regarding the potential roadblocks and risks that were associated with the implementation feasibility of the prescribed methodology.

3. Dissemination

In this paragraph, the dissemination of this research will be addressed by determining its societal and scientific relevance.

3.1. Societal relevance

Developments of urban icons are often initiated and financially supported by municipalities as a strategy to boost their urban image or to generate a catalytic effect in the regeneration of an urban area. Despite the high ambitions and investments that are involved in these projects, municipalities rarely conduct an ex post evaluation to measure the effects that have been generated by these projects.

Due to the lack of such evaluations, municipalities are not able to develop an evidence-based policy or strategy with regards to the support of potentially iconic developments. Therefore, municipalities' future investment decisions with regards to urban icons will remain to be mainly based on assumptions instead of proven goal-means relationships.

By the design of an impact assessment methodology blueprint, I have established a methodology by which the spillover effects of urban icons can effectively be measured. In that way, municipalities can learn from the experience in former projects, which can be applied in the strategy development process of future projects.

3.2. Scientific relevance

Despite the high level of academic attention to the topic of urban icons and the associated spillover effects, the current state of research still does not encompass the availability of a comprehensive impact assessment methodology.

In most studies, a qualitative research strategy was applied to observe the spillover effects of urban icons. Furthermore, most of these studies were focused on one impact type, instead of the wide range of potential effects. Moreover, the current state of research lacks a longitudinal approach to effectively measure the impact of urban icons, as most studies only conducted measurements at one point in time.

The impact assessment methodology blueprint that was presented in this research prescribes an all-encompassing measurement approach, by which the comprehensive range of spillover effects of urban icons can quantitatively and longitudinally be measured.

4. Ethical concerns

In this paragraph, the ethical concerns that were encountered during the research and the ethical concerns with regards to the application of the results in practice will be discussed.

4.1. Ethical concerns regarding the research

In order to identify potential ethical dilemmas associated with this research, I filled in the TU Delft Research Ethics Checklist. Based on this checklist, no ethical concerns could be identified.

4.2. Ethical concerns regarding the application in practice

As previously discussed in the implementation feasibility study, the implementation of the prescribed impact assessment methodology could encounter several ethical concerns.

Firstly, the analysis of context factors as race or ethnicity could lead to ethnic profiling. Secondly, personal data retrieved from social media can be applied in research without informing or asking consent from the individuals involved. Finally, the hypotheses that are made based on algorithms can have far-reaching results, e.g. the alteration of people's credit card limits.

Municipalities should proactively question and mitigate the ethical concerns that are related to the urban research and planning methodologies they intend to apply. In this way, municipalities will act in accordance to the ethical principles and the outbreak of any negative public commotion is prevented.

5. Research process

In this paragraph, I will reflect on my research process by addressing my process during the first semester, during the second semester and the personal goals that I have determined at the early stages of this research.

5.1. Towards the P2

The first semester of the graduation process took off with a flying start, as the choice for a graduation laboratory had to be made within the first week. The process of determining a specific topic and research approach was associated with a high level of uncertainty, because it still remained unclear to which direction this research would eventually lead. It was challenging to cope with both the tight structure of this faculty's graduation programme and the explorative nature of the process towards establishing a research proposal.

At the end of the semester, I presented my research proposal during the P2 presentation. At that point, I had determined the topic's relevance, conducted a literature study and developed a solid research proposal that could be carried out in the next semester.

5.2. Towards the P4

By passing the P2, I had gotten the false idea that my research proposal was feasible and ready to be carried out. However, a long process of exploration followed in order to make the research structure and methods more explicit. I experienced this process to be rather stressful, because the direction my research would move towards remained to be ambiguous while the clock was ticking.

Around the P3 presentation, the pieces of the puzzle started to fall into place. The upcoming deadline stimulated me to make decisions and to start writing. The more I was writing, the more it became clear which direction my research would lead and which tasks were left to be done. I experienced the remaining period towards the P4 presentation to be less stressful and more productive. Therefore, I was able to move toward the end of this process with a positive feeling.

5.3. Personal study goals

In the personal study goals that I wrote down in my P1 report, I stated that I intended to not walk the beaten paths, but to challenge myself by combining a personal fascination – the effects of urban icons - with the rather new methodology of applying big data analytics in urban research and planning. In that way, I found a way to walk a path that was not only new for me, but that has also remained to be relatively new for the field of management in the built environment.

By choosing the subject of urban icons, my research topic stayed closely linked to my personal interests and fascinations. This helped me throughout the research process, because it gave me the ability to use my personal experiences and imagination in order to stay motivated and to provide direction in my research process.

When I chose to explore the potential of applying big data analytics to measure the spillover effects of urban icons, I was aware of the challenge that lied ahead for me. Big data was a topic that I had little knowledge about and the potential of applying big data analytics still appeared to be rather ambiguous to me. This previous ignorance of the potential of big data both worked in a stimulating and discouraging way throughout my research process. My curiosity challenged me to explore the

opportunities of big data further and further, which eventually led to the more abstract topics of predictive and prescriptive analytics. However, my previous lack of knowledge on the subject also made me worry about my ability to reach the level of depth and quality that I intended to reach with this research.

Despite the challenges I have had to face, I can say I am glad with the path I have walked throughout this research process. This research did not only make me gain knowledge about my research topic, but it also helped me to further develop the skills that were needed to conduct this research.

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2. Images

Cover image: Own illustration.

Photograph: Own photograph.

Figure 1: Own illustration.

Figure 2: Provast. (n.d.). De Markthal, Rotterdam. Retrieved from https://provast.nl/projecten/markthal-rotterdam/

Figure 3: Own illustration, information retrieved from Schröder, H., & De Wit, R. (2017). *Bloedstollend Vastgoedverhaal: Markthal Rotterdam*. Den Haag: Hans Schröder.

Figure 4: Markthal Rotterdam B.V. (2013). Marktkansen - Brochure.

Figure 5: Rotterdam010. (2008). Afbraak aan de Hoogstraat. Retrieved from http://oud.rotterdam010.nl/106-Overzicht-2007/06/X-Hoogstraat-03-04-2008-01.html

Figure 6: Edited by author, image by MVRDV. (n.d.). MVRDV-designed Markthal housing + market hall opens in Rotterdam. Retrieved from https://www.designboom.com/architecture/mvrdv-markthal-rotterdam-opens-10-01-2014/

Figure 7: Markthal Rotterdam B.V. (2013). Marktkansen - Brochure.

Figure 8: MVRDV. (n.d.). MVRDV-designed Markthal housing + market hall opens in Rotterdam. Retrieved from https://www.designboom.com/architecture/mvrdv-markthal-rotterdam-opens-10-01-2014/

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Figure 12: Rotterdam Partners. (2018a). Metro UK. *Media Coverage 2018*. Retrieved from https://issuu.com/rotterdampartners/docs/metro_uk_-_april_2018

Figure 13: Rotterdam Partners. (2018b). A Vivre Architectures. *Media Coverage 2018*. Retrieved from https://issuu.com/rotterdampartners/docs/a_vivre_architectures

Table 1: Own illustration.

Table 2: Own illustration.

Table 3: Own illustration.

Figure 14: Own illustration.

Figure 15: Own illustration, information retrieved from Roberts, P., & Sykes, H. (2005). *Urban regeneration : a handbook*. London :: Sage.

Figure 16: Own illustration.

Table 4: Own illustration.

Table 5: Own illustration.

Figure 17: Own illustration.

Table 6: Own illustration.

Table 7: Own illustration.

Table 8: Own illustration.