BOLD CITIES.

BUILDING A DECISION-MAKING SUPPORTIVE TOOL THROUGH EXPLORATION OF BOLD METHODS TO ASSESS SUSTAINABILITY IN LANDSCAPE ARCHITECTURE PROJECTS.

Mentors:
Dr.ir. Alexander Koutamanis
Dr. Aksel Ersoy

Francesco Gualinetti - 4598970
Management in the Built Environment
TU Delft
The Netherlands
F.Gualinetti@student.tudelft.nl

- THIS PAGE WAS INTENTIONALLY LEFT BLANK -

COLOPHON

BOLD CITIES. BUILDING A DECISION-MAKING SUPPORTIVE TOOL THROUGH EXPLORATION OF BOLD METHODS TO ASSESS SUSTAINABILITY IN LANDSCAPE ARCHITECTURE PROJECTS.

FRANCESCO GUALINETTI

Student Number: 4598970
Email: fra.gualinetti93@gmail.com
Phone: +31 655570805
Address: Warmoezierstraat, 9A, 2613 VG, Delft

DELFT UNIVERSITY OF TECHNOLOGY

Faculty: Architecture, Urbanism and Building Sciences
Master Track: Management in the Built Environment
Graduation Lab: BOLD Cities
Lab Coordinator: Dr. Ir. Alexander Koutamanis

Address: Julianalaan 134, 2628 BL, Delft
PO box 5043, 2600 GA, Delft
Phone: +31 15 2789111
Website: www.bk.tudelft.nl

MENTORS

First Mentor: Dr. Ir. A. Koutamanis

Second Mentor: Dr. A. Ersoy

- July 2018 -

Preface

Today more than ever before, technology is part of our daily life. We need it to retrieve information, to solve complex problems and even to feel our opinion counts on social media platforms. If some might argue that technology is a creature taking our souls away, the aim of this report is to prove the opposite: technology is nothing more than a tool, and it does not per se include the concept of good or bad. It's in our human responsibility to use it in a productive and efficient way, so that it can contribute to the solution of problems hard to solve otherwise.

To a certain extent, this progress reminds me of the invention of photography in the 19th century. Before that innovative discovery, the only chance we had to depict a moment in time came with hours, days or even months of work. Even then, a good restitution of reality wasn't assured. With the first pictures instead, a couple of minutes of work became enough to impress reality on a piece of paper. Concurrently, paintings haven't disappeared at all, but they transformed: from a mere effort to depict things as they appear, they turned into being soul efforts to express the artist's inner emotions. Photography, on the other hand, became more and more used to represent a sharp picture of reality. The same can be said about technology in the built environment: we don't throw away the paintings, any style or emotion related to traditional ways of dealing with urbanism or architecture, but we strive to understand more objectively the urban reality, through a responsible use of IT-based systems. The combination of the two aspects, soft and hard skills, leads to a deeper understanding of the urban environment we live in.

Big open linked data and the internet of things are nothing more than technological tools that give us the opportunity to integrate IT technologies with Architecture, Urbanism and traditional management forms to understand, and consequently shape, the city of tomorrow. More than ever before, we need humans and machines to cooperate and to complement each other.

Whether we take this opportunity or not, only depends on us.

Francesco Gualinetti, July 2018

MANAGERIAL SUMMARY

Projects of re-use of underused infrastructures to design sustainable urban landscape architecture represent a great contribution to meet the need for sustainability cities are experiencing today. Urban administrators often strive for a successful realization of such projects, to give a social and economic power impulse to poorly performant neighbourhoods. In some cases, though, a balance between the three dimensions of sustainability (environmental, social and economic) is a hard matter to achieve. Indeed, in some occasions, the neighbourhood-boosting role takes over, leading to the establishment of mechanisms that might only partially work from a sustainable viewpoint. Big Open Linked Data (BOLD) methods are offering new opportunities to design decision-making models for urban planning and management. The combination of social media, census, sensors and traditional data gives a new perspective to solve modern urban challenges through a holistic and inclusive approach. Compared to the mere use of traditional sources, BOLD methods rely on a bigger-scale, more accurate, real-time, data set. In this research, BOLD potential is explored to estimate the extent to which it can help solving the described urban issue. Therefore, the research question can be addressed as follows: How can BOLD help city planners and managers determining the real-time and holistic impact on social, environmental and economic dynamics in projects of re-use of obsolete or underused infrastructures? How could these projects enhance sustainable benefits without neglecting the positive economic and social impact for the neighbourhood? An in-depth literature study on public parks and brownfield redevelopments can help setting criteria and variables related to sustainability. For each of these variables, it is established whether a BOLD approach could bring more satisfactory results on a selected case study, the High Line Park, in New York. The final product is a framework that serves as decision-making supportive tool, to assess through BOLD and traditional data combined the way these aspects of sustainability connect to each other in such projects. Finally, the framework is tested and adapted to a case study in Rotterdam, the Hofbogen viaduct redevelopment. This case study in the Netherlands is not only useful to test the validity of the framework built in a different context, but it serves the purpose of solving the main problem concerning this case study: social sustainability. Indeed, the framework is used to improve this aspect thorough the next phases of the redevelopment, defining a frame for both project and neighbourhood assessment and inclusive participatory model for all stakeholders involved.

I. TABLE OF CONTENTS

1. Introduction

The increasing need for sustainable projects in cities is partly solved through the concept of landscape architecture. This approach involves urban transformations that, when born from a brownfield redevelopment, are addressed as landscape ecological urbanism. Examples are given by the adaptive re-use of obsolete or underused infrastructures such as rail corridors, underutilized back alleys, urban streets, abandoned transport or utility corridors, considered as valid possibilities to design new public spaces (Wolch et al., 2014).

As some authors argue, this form of revitalization is a clear manifestation of a broader movement to promote sustainability worldwide (Newman et al., 2011). Others add that re-developing a piece of land or a structure that already exists should be seen as an opportunity to create "something pleasant where there once was nothing", by also avoiding phenomena like urban sprawl, decay and underuse of certain city areas (Mehdipour, Rashidi Nia, 2013). Steiner (2011) suggests that landscape ecological urbanism can gather ideas from landscape urbanism and urban ecology, to create new territories that reflect both cultural and natural processes. For all these reasons, such developments could represent a satisfactory answer to cities' needs for a holistic view on every aspect of sustainability.

Indeed, now more than ever before, cities are in need for projects able to meet these objectives, which are often promoted or imposed by organisms that stand above and beyond the municipal borders (Eurostat, 2015). Yet, the concept of eco-city has been endorsed since the seventies as part of the sustainable urban development agenda (Yigitcanlar et al., 2013). Almost a decade later, achieving a sustainable society has been extensively addressed by the United Nations World Commission on Environment and Development as "the ability that humanity should have to make developments that ensure meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). For the first time, environmental sustainability embraced deeper social and economic meanings. This dimension over time is juxtaposed to the dimension over space: sustainability is definable as the capacity of the Earth to maintain and support life and to persist as a system at different scales, from global to the local city-planning dimension (Jongman in Leitao & Ahern, 2002).

With more than 66% of the entire world population living in cities before 2050 (United Nations, 2014), it's even clearer that the need for more sustainable urban areas is becoming the key point of the global sustainable strategy for the future (Cucca, 2012). In other words, due to both their economic and social nature, cities have been identified as centres where sustainable modernization is more likely to occur (Lehman, 2010). Within city contexts, a sustainable urban development can involve various types of urbanisation models and processes. In theory, those could provide energy-efficient, environmental-friendly settlements, mobility patterns and social cohesion by focussing on divergent spatial scales, from metropolitan to neighbourhood levels. In practice, the recent years have seen the dramatic take up of the eco-city concept and an accelerated a translation of these ideas and visions in many tangible initiatives (Yigitcanlar, 2013).

These discussions prove that a modern definition of sustainability doesn't only refer to environmental aspects, but it also involves a complex combination of social and economic dynamics. To this purpose, Dale and Newman (2009) have defined a sustainable urban project as a mean of reconciliation of these three important features: an *ecological imperative*, for the project should carry on the capacity of maintaining biodiversity; a *social imperative*, to ensure democratic processes of governance and meet the requirements of the users; an *economic imperative*, to ensure that basic needs are met. This concept recalls Elkington's (1997) triple bottom line (TBL) accounting framework: *Planet* (environmental aspect), *People* (social aspect) and *Profit* (economic aspect).

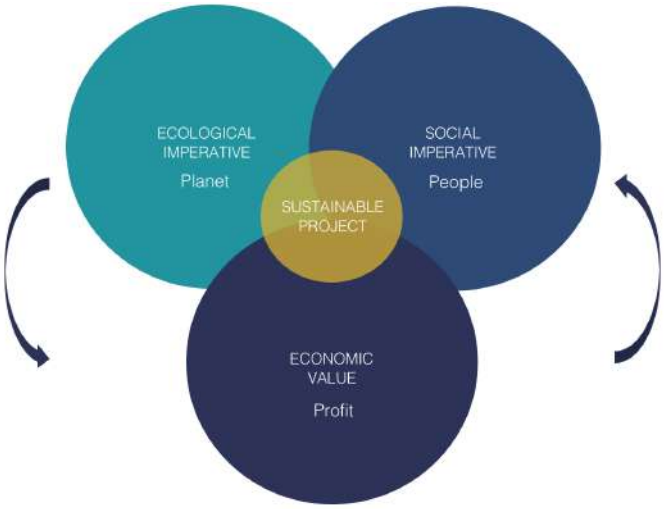


Fig. 1. Three imperatives for a sustainable project (Source: Elkington, 1997).

According to Steiner (2011), this model has a solid basis for a direct application in urbanism and city management, when designing sustainable landscape architecture projects. He suggests that landscape urbanists are very much interested in creating places that bring together people and nature in the same place, trying to build new urban ecologies that involve social, cultural and environmental dynamics. And this seems to be the direction many cities are striving for. City administrators should - and to a certain extent are - reconsidering their urban plans by integrating the idea of environmental benefits with social and economic advantages in urban projects. Therefore, landscape ecological urbanism projects of re-use of obsolete infrastructures could represent the matching point between the ecology needs cities have and a successful form of urbanism (Mostafavi & Doerty, 2010).

At this point, the role of a manager in the built environment is evident: ensuring that balanced sustainability dynamics are taking place through the realization of such projects, thanks to the deployment of solid and structured processes.

Following this theoretical introduction, the next section shows all relevant steps in this research.

In the first part, a study of re-use of obsolete infrastructures projects is introduced, through the identification of relevant features that make them a hybrid between public linear park and brownfield redevelopment. After this, some challenges interfering with an effective realization of projects that perform efficiently from an environmental, social and economic point of view are presented. To answer these complex dynamics, possibilities offered by Big Open Linked Data are identified. The scope of this research is identifying whether and in which ways this new approach could make it easier and more efficient to assess and enhance sustainability of such projects and bring an added value to urban management.

The main research question will be as follows: *How can big open linked data (BOLD) help city planners and managers determining the real-time and holistic impact and effects on social, environmental and economic dynamics of projects of re-use of obsolete infrastructures and how can it enhance these components?* Research question and related sub-questions will be re-introduced in chapter 1.4, after the explanation of the societal issue from a BOLD point of view.

Therefore, BOLD relevance is explained, with a particular attention to how it could be useful, and to how specific limitations represent a restraint for this study. Then, in the method section, an explorative approach is deployed: BOLD methods found in literature are tested in their validity on the High Line Park project in New York, which has been chosen as a valid example of a project in operation. The explorative research on the High Line Park is necessary to discover if BOLD methods can add value to the overall assessment. This is done by comparing such BOLD methods to traditional ways of assessing sustainability issues on the project.

The results of this analysis will be summarized and collected in a final decision-making supportive tool useful for managers and urban actors to assess sustainability with the help of BOLD. The framework will then be applied in its social sustainability part to a case study, the Hofbogen viaduct case, which is in its design phase. The aim is to prove or disprove the utility of the framework in aligning stakeholders, enhancing public participation and stakeholder involvement through Big Data and integrated traditional methods. Adaptation and further analysis of BOLD as a tool to manage urban issues will follow this application. The reason behind the choice of focussing on social sustainability, comes from the understanding that social dynamics in cities are amongst the most complex parameters to assess with traditional methods and at the same time, the potential of BOLD can partly be a solution to this problem.

1.2. The study of re-use of obsolete infrastructures: a categorization

In this report, projects of re-development of obsolete or underused infrastructures will be considered as units that combine features from both brownfield developments and urban parks. This classification will help developing a more accurate assessment of the studied project, especially in relation to the choice of parameters from literature.

Brownfields development characteristics

Some authors underline how a re-use of brownfield sites could be an ideal solution to answer environmental, social and economic sustainability issues. Mehdipour (2013) makes an interesting connection between the three imperatives of sustainability and development of brownfield sites, identifying some criteria that make brownfield developments sustainable (fig.2). With this table, we encounter the first alignment process of environmental, social and economic displays in an urban project: this consideration will be useful for the future chapters of this research, when the explanation of how these dynamics influence each other will be dealt with more in depth.

Fig. 2. The major benefits of brownfield redevelopment. (Source: Mehdipour and Rashidi Nia, 2013)

Urban park characteristics

Projects of re-use of obsolete infrastructures can also be classified by considering specific characteristics of urban linear parks. Indeed, due to their original function usually related to transportation of goods from or to major industrial sites, urban underused infrastructures usually stretch for a longer length than width, across multiple blocks or even neighbourhoods. This aspect will be particularly important, especially for the assessment of environmental and social dynamics.

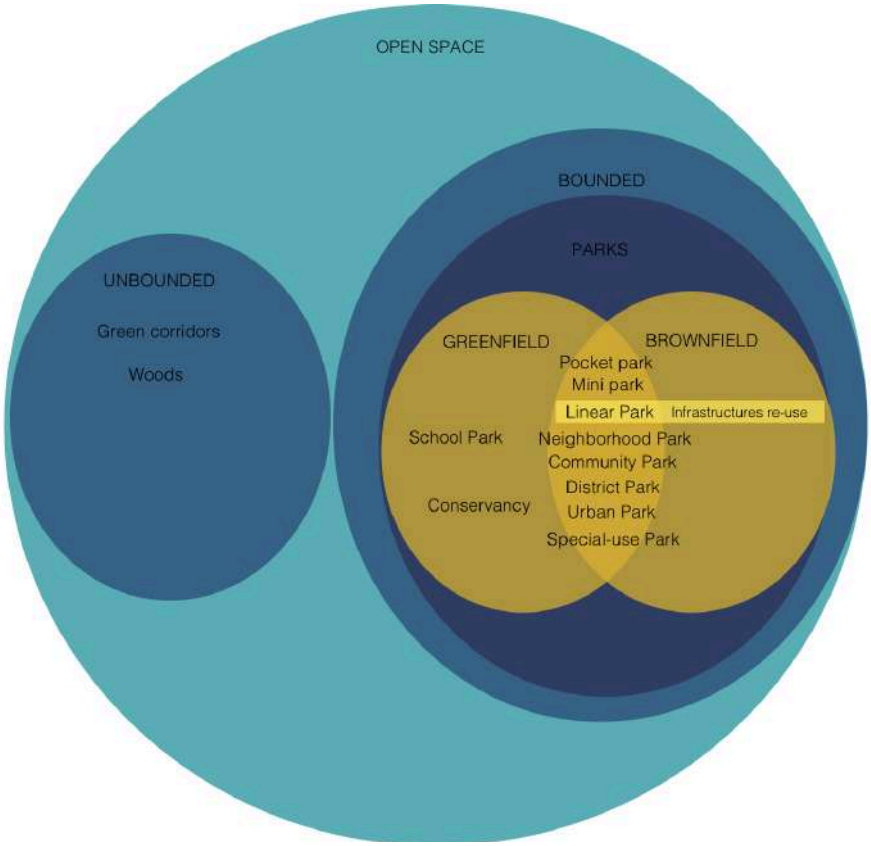


Fig. 3. Re-use of obsolete and underused infrastructure categorization in the context of urban parks (Source: own illustration).

Sarhan (2016) remarks how parks and open spaces in cities are able to improve physical and psychological health of communities and make urban environments more attractive places to live and work in. If certainly the main scope of a park should be creating a pleasant environment for its community, sometimes, when parks are also a mean to enhance or boost a specific city area, this aspect is neglected in favour of other dynamics: brownfield redevelopments are often considered good chances to boost the economic role of a neighbourhood.

The choice of discussing the impact of projects of re-use of obsolete infrastructures, comes mainly from two reasons. Firstly, they represent an interesting effort to bring sustainability to a post-industrial city environment. Secondly, these projects are often important connectors between sustainable features, neighbourhood identity and willingness to attract capital.

1.3. De-industrialisation and globalization: Opportunities and threats.

The process of de-industrialisation that has seen a shift from Fordism to post-Fordism during the eighties, has left a discrete amount of underused or dismissed urban areas (Tallon, 2010). Following this transition, cities have re-defined their industrial role and embraced new opportunities in the tertiary field. This transition is evident in the shift from city government to city governance, from welfare state to neo-liberalism initiative. As a matter of fact, while during Fordism initiatives were often following a top-down scheme, in the post-Fordism, public funds and public-sector initiatives have demonstrated their lacking power. Hence, city administrators have been striving to catch partnership opportunities to stimulate developments and projects to make cities more competitive on a global scene (Tallon, 2015), without being limited to the scarcer availability of public funds. Unlike parks built in the previous decades, new generation's parks like the High Line in New York are almost totally dependent on private financing for their creation and survival, which sometimes leads to follow the will of subsidiary bodies outside the state boundaries (Joassart-Marcelli et al., 2011). In a such liberal-oriented society, where this reliance on private funds and initiatives is taking place, sustainable urban dynamics risk to be neglected.

Market-oriented cities need to fix resiliency frames and incorporate ecological concerns in a new way. While issues of climate change and environmental protection are often addressed, such concerns are shadowed by an over reliance on market entrepreneurialism and an implicit faith in the "green" development will provide the necessary trickle-down effects for overcoming environmental and economic problems facing the city (Angotti in Lang and Rothenberg, 2017). But only well-designed and well-managed projects will bring the desired effect of a consistent contribution of resiliency in the development of the built environment.

According to Tretter (2014) this can be a hard goal to achieve, as it's often too difficult to combine needs cities have for both sustainability and economic growth. This is especially true in neighbourhoods strongly affected by a demission of industrial sites, where post-Fordist reconversion has been altering industrial neighbourhoods into tertiary-oriented residential areas, attracting the so-called new "creative class" (Tallon, 2015). This aspect, if mitigated, should be seen as an opportunity for the image value of a neighbourhood, being one of the key elements in the built environment (MacMillan, 2007). The function of the image value though, often done through city branding, should link up with quality of life and therefore the issue of sustainability (Chang & Marafa, 2014). Many brownfield development projects aimed at improving urban spaces, list sustainable development as a stated goal. It is a key question, however, whether the benefits of these redevelopment projects are equitably shared with the original members of the community or with residents of adjacent neighbourhoods (Dale et al., 2009).

All in all, it seems essential to find new ways to assess these increasingly complex urban dynamics, where challenging relationships between variables are far more important than single-compartment measures. It becomes essential to grasp this complexity to still deliver quality built environments. To solve modern issues, we also need to embrace modern solutions: in the following chapter, a BOLD approach towards facing these issues is explained.

1.4. A BOLD approach to the societal challenge

The relatively new concept of smart city, defined as a mechanism seeking to address public issues via ICT-based solutions (Beretta 2017), and the idea of a network of Big Open Linked Data hidden in this new form of urbanity, can help answering the societal challenge from a different perspective. BOLD could offer a holistic, inclusive and complete approach to study contemporary urban issues. In an urban environment, big amounts of data are constantly produced as traces of human activities in cities: the power of this continuous flow of data, coming from multiple sources, gives the chance to interpret the city as a constantly changing and modifying organism. Let's think for a moment about the difference between a fix and a changing situation: if we looked at a picture, we would get a rather still impression of a frozen moment in time. Indeed, the single fragment is not able to communicate the spatial or temporal relationships beyond and outside the timeframe we captured. Yet, if we looked at a video about the same situation, then we would listen to descriptions coming from different people, we could certainly get a better chance to understand what is happening in the portrayed situation. Likewise, traditional methods alone are often limited to the description of a static instant, in time and space. If used in combination with other sources instead, we would get closer to its complexity. Some researchers have already highlighted that the analysis and integration of social media data in planning support systems has great potential to provide meaningful insights on urban dynamics otherwise impossible to gain simply by using static governmental records (Bocconi et al., 2015). Cities are primarily about complex relationships between people, thus having a quite unpredictable behaviour (Bettencourt, 2013). What we need is deploying modern information and communication technologies, able to open new possibilities and opportunities for the application of engineering solutions to flexibly manage urban environments.

Traditional literature's authors explicitly point out some pitfalls of traditional methods to assess urban dynamics and deliberately suggest that further study and applications are required. Techniques like the LPA[1] and MSA[2], for instance, can describe a steady scenario and help managers define a Landscape Performance Distribution Map (LPDM) (Jie et al., 2014). This construct allows to understand the balance between social, economic and environmental performance of a park, but it depicts a fixed position in time, often before a project initiation, to express desirable achievements. Ming-Han Li (2014) recognises that, even though there is actual evidence of attempts to measure landscape architecture performances, very little has been done to effectively collect data from on-going projects. Indeed, the scoring process of these rating systems is based on prediction rather than actual measurements. BOLD could help filling the research gap by providing a continuous measurement over time.

Under the BOLD lens, cities are first and foremost large social networks, where space, time and infrastructure play a fundamental role in enabling social interactions to form and persist (Bettencourt, 2013). A combined use of all kind of big data generated by sensors technologies, social media or classic census data, seems to be beneficial to help local government and businesses to plan, monitor and innovate with substantial negative effect reductions.

Assessing whether Big Open Linked Data will give substantial help in solving the societal issue, is part of the challenge of this research. The research question, from a BOLD perspective, thus becomes:

How can BOLD help city planners and managers determining the real-time and holistic impact and effects on social, environmental and economic dynamics of projects of re-use of obsolete infrastructures and how can they enhance these components?

[1] LPA: the measure of efficiency and effectiveness with which landscape solutions fulfill their intended purpose and contribute toward sustainability.
[2] MSA: Multi Scenario Analysis. It's used to depict several feasible statuses to achieve a series of social, ecological and economic goals.

Research sub-questions are:

a) How is sustainability assessed in projects of re-use of obsolete infrastructures?
b) How do these components of sustainability relate to and influence each other?
c) Can a BOLD approach deliver better outcomes when assessing environmental sustainability?
d) Can a BOLD approach deliver better outcomes when assessing social sustainability?
e) Can a BOLD approach deliver better outcomes when assessing economic sustainability?
f) In which ways is it possible to define a managerial tool to assess sustainability of such projects?
g) In which ways the study of an on-going project through BOLD tools can serve as example to learn from when designing a new development of this kind?
h) Is the decision-making supportive tool for a "present situation assessment" translatable into a supportive tool for "future development responsible planning"?
I) Do data possess enough (temporal and spatial) resolution to represent the studied phenomenon?
j) Are there biases (of cultural and technological nature) that might influence the conclusions that could be drawn by such data?
k) How does the world depicted by social media compare with common or consolidate knowledge (e.g. from census or municipal databases or interviews)?

1.5. Unfolding BOLD

But what is really big open linked data? BOLD can be seen as an integration of multiple data sources (Fig. 4), going from the more traditional registration and surveys data to the recent system of sentiment analysis on social media. What researchers have underlined, and practice has confirmed, is that information is now available for analysis in raw form, escaping the confines of structured databases and enhancing researchers' abilities to identify correlations of new and unexpected uses for existing information (Tene & Polonetsky, 2013). From this first definition, it can be noted that BOLD includes an extraordinary wide range of practices, whose combination and confrontation could possibly lead to a complete study of the defined variables.

BOLD includes:

a) *Registration and survey data*: These data belong to the more traditional way of collecting information in cities (e.g. census data, interviews). Quite expensive to collect, their major issue is not being integrated and dynamic. Too often, results on data collection are not updated, as it might take too long to collect, process and analyse such information (Rotterdam Centre for BOLD cities, 2017).

b) *Sensor data*: sensor data represent the portion of data coming from traditional sensors' sources (e.g. temperature, pressure, light) or from new devices like smartphones that contain embedded sensors such as microphones, cameras, accelerometers, gyroscopes, and GPS which can be used to sense a variety of data from the environment (Li-Minn Ang & Kah Phooi Seng, 2016). This information represents the middle step between the integration of traditional methods of data collection and future scenarios opened by social media data.

c) Social media data: social media data is the product of social media usage in the built environment. They are classified as raw data, meaning that they come to the analyst without any kind of intermediate filtration, thus they are rather unbiased. Social media data have been appointed as an opportunity for the future of urban studies.

More on the relevance and importance of social media data will be assessed in the social sustainability chapter (chapter 2.4).

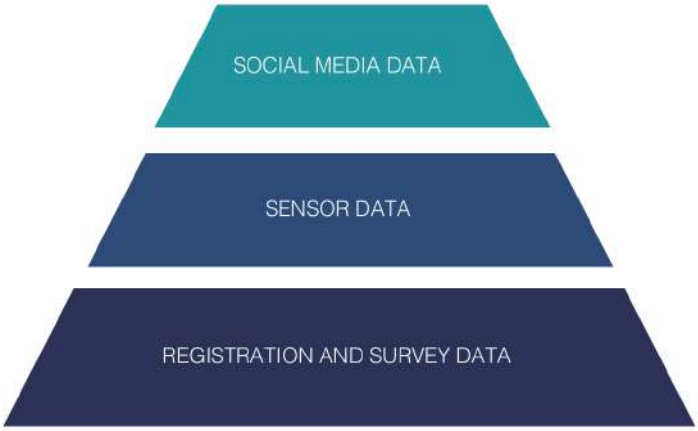


Fig. 4. Types of BOLD (Source: Rotterdam Centre for BOLD cities)

If the availability of BOLD tools makes us believe in a better outcome when assessing urban dynamics, it cannot be neglected that this method comes with some drawbacks. In the next chapter, these limitations are briefly discussed.

1.6. Limitations of BOLD approach

In the following, a short literature study concerning some limitations of the BOLD approach are explained and discussed. Together with the cost of data collection and cyber security concerns, some major issues will be addressed to define which limitation a big data method will encounter.

Big-sized phenomena

One of the most criticized aspects of any BOLD approach comes from the fact that the use of big data is unable to identify small-number phenomena, focusing more on big correlations between wider dynamics (Glaeser et al., 2015). Indeed, data collection is usually based on large samples, reflecting general behaviours or trends observable from a "panoramic" view on the city. From an urban study perspective, this drawback might be quite significant when it comes to decisions that have to be taken on a small-scaled project.

Correlation and Causality

Glaeser et al. (2015) underlines another important aspect of BOLD analysis: it defines correlation between phenomena and not causality. In certain circumstances, two phenomena might look like they are influencing each other, but it is not possible through a BOLD analysis alone, to establish that one is the consequence or cause of the other. Practically speaking, it's up to the analyst to decipher this potential causality between two outcomes in an urban study. The possibly to confront the outcomes of a big data analysis with more traditional sources makes it easier not to draw confusing or misinterpreted relationships between phenomena that might have nothing to do with each other.

Echo-chamber effect

The Echo-chamber effect is extensively described as a major drawback of big data in Rabari & Storper (2013) and it refers to a vicious circle coming for the use of a single BOLD source that is taken for granted, or that it's impossible to counterprove with other sources. This could be a misleading factor if data are coming from a single source, which makes finding multiple sources important, in order to analyse the issue from more than a single perspective.

Privacy

The fact that more and more personal data are collected is bringing up the privacy issue concerning big data. Multiple parties have access to more and more personal and private data, which makes privacy difficult to handle (Tene & Polonetsky, 2013). On one side, data availability makes it easier for decision-makers to take more fact-driven decisions, on the other it is important to safeguard the interest of citizens by safeguarding individual privacy. Data create enormous value for the world economy, driving innovation, productivity, efficiency, and growth. In order to craft a balance between beneficial uses of data and individual concerns, policymakers must address some of the most fundamental concepts of privacy law, including the definition of "personally identifiable information," the role of individual control, and the principles of data

minimization and purpose limitation (Tene & Polonetsky, 2013). Tene & Polonetsky (2013) identify data sharing amongst multiple parties as one of the major menaces in regard to privacy concerns: this aspect is amplified in a governance scenario, where data need to be handled by multiple parties at different times in order to deliver the desired outcome.

This brief analysis of BOLD limitations and drawbacks is useful to realize that such methods have to be handled with care. Despite those factors – which surely have to be considered and further analysed by decision-makers and governmental authorities - it's strongly believed that the potential of BOLD applications in an urban context can by far belittle those drawbacks.

2. The Research Method

The research method includes an explorative approach to discover whether a use of BOLD, combined with more traditional methods, can deliver a better outcome in assessing and/or improving sustainability of landscape architecture from re-use of obsolete infrastructures. The results of a method exploration on the High Line Park in New York will be resumed and framed in a final decision-making supportive tool to assess other projects of this kind and learn from what the High Line application has shown. The whole explorative process will be useful at the end for a practical testing application on a project in the Netherlands, giving the opportunity to try out the efficiency of the BOLD frame in another context and in another phase of realization (design phase). This passage will be particularly useful to assess limitations of such theoretical framework, but also to discover its further potential when applied to another scenario.

Even though the explorative study will be conducted on the overall sustainability of a project, the main focus of this research will be specifically on social sustainability. The reason of this will be extensively explained in the social sustainability related section (chapter 2.4): essentially, it comes from the realization that social dynamics are the most multifaceted, unclear and unpredictable phenomena in a city, thus requiring new assessment methods to be managed, or at least, better understood. To this purpose, Yi et al. (2014) argue that while environmental sustainability is often well documented, many studies and researches lack quantifying social benefits.

Sustainability assessment

Concerning the sustainability assessment, the study will be divided into three sub-sections:

1) Environmental sustainability assessment
2) Social Sustainability assessment
3) Economic Sustainability assessment

Even though the valuation will be done separately, a special regard will always be on the consideration of critical relationships between these three systems of sustainability. This comes with the realization that a wide-ranging approach is more relevant and necessary than a fragmented assessment.

Concerning the relationship between types of sustainability, Ming-Han Li (2014) describes this correlation in detail by clustering landscape performance benefits in the classical triangular scheme that balances the three components. This is also referred as Landscape Performance Composition Scale (fig. 5) (Ming-Han Li & Luo Yi, 2014). The analysis of these relationships brings to three hypotheses:

a) Certain social benefits will compromise various environmental benefits.

Amongst other environmental benefits, water, part of carbon energy, and part of other benefits contribute to generate several social benefits, such as flood protection, walkability, increasing users' satisfaction, fostering play, increasing public's eco-awareness, and producing food. Nevertheless, other social benefits like increasing recreational / social activities might lead to increase in carbon emissions and compact soil. As a result, plants and wildlife health could be seriously compromised.

b) Certain economic benefits will negatively impact the natural environment and therefore sacrifice a number of environmental benefits.

Amongst the environmental benefits, material re-use and recycle or waste reduction would help reduce construction costs, while energy saving would help reducing bills, operation and maintenance costs. Additionally, air quality improvement, storm water management, water conservation, flood protection would have a positive impact on wider economic effects (e.g. increasing property values). On the other hand, several economic benefits will also increase local traffic, boost infrastructure construction, and exacerbate human disturbance.

c) The relationship between social benefits and economic benefits is more converging than conflicting.

The result of the analysis of the relationship between social and economic benefits shows that they are closely associated. For example, economic benefits such as creating new jobs or saving construction costs normally would increase residents' satisfaction. Similarly, social benefits such as providing increasing recreational social opportunities, often results in creating new jobs and raising property values.

(Ming-Han Li & Luo Yi, 2014)

This study shows that even though a Landscape Performance Distribution Map can help assessing a project, still it's not enough to give an inclusive perspective on problems that are made by complex relationships between parameters. The focus of these fixed frameworks is often only on the project dimension, not on the

assessing of its relationship with the surrounding. The “empowerment of the neighbourhood” will be one of the expected outcomes of this BOLD explorative research.

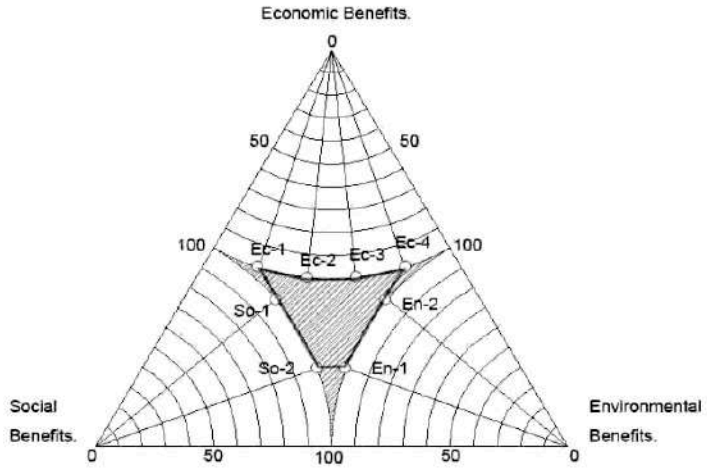


Fig. 5. Landscape performance distribution map (Source: Xu Jie et al., 2014)

A BOLD approach in defining sustainability aims at providing a more flexible and dynamic tool. To test whether BOLD methods are available for each specific aspect of environmental, social and economic sustainability an *input*, *availability, adaptability, output* model will be deployed for the study of each variable.

This model will be utilized more in depth in the social sustainability part, where availability of BOLD will be tested more extensively. In general terms, the approach works as follows:

1) *Input*: variables to assess each sustainability parameter are defined from the literature study. How does this variable perform on the project and what are the pitfalls of a traditional assessment?

2) *Availability:* research for suitable BOLD methods that can contribute solving the identified limitations under a new perspective, thus trying to fill the literature gap. When analysing data to assess urban phenomena, typical questions should be:

> a) do data possess enough (temporal and spatial) resolution to represent the studied phenomenon?
> b) are there biases (of cultural and technological nature) that might influence the conclusions that could be drawn by such data?
> c) How does the world depicted by social media compare with common or consolidate knowledge (e.g. from census or municipal databases or interviews)? (Bocconi et al., 2015).

2) *Adaptability*: explore how a theoretical variable performs on the case study and point out relevant limitations or issues.

4) *Output*: determine the added value of BOLD in solving the specific project issues related to the defined variables.

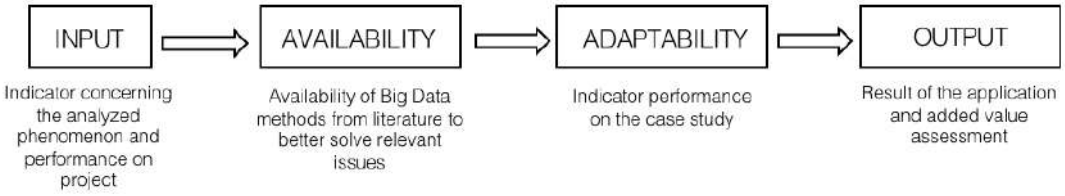


Fig. 6. Input, availability, adaptability, output model. (Source: own drawing)

This in-depth study, along with the study of the other two forms of sustainability, will allow the construction of a decision-making supportive tool, as resumed in fig. 7.

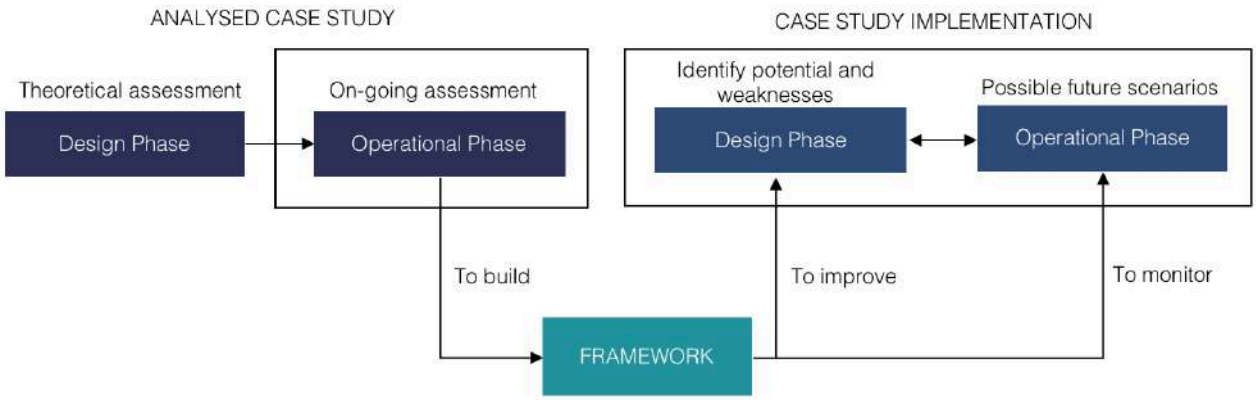


Fig. 7. Research purpose design. (Source: own drawing)

As shown in fig. 7, the evaluation will be built on the on-going assessment of High Line Park case study, to assess issues that can be visible in a 10-year operating case study. This study will grant the collection of valuable information to deliver better results in future projects.

2.1. Case studies collection

Four realized case studies have been selected to identify the recurrent features in re-use of obsolete infrastructure to design landscape architecture. In particular, the most relevant and inclusive examples are: High Line Park (New York City, NY), Promenade Plantée (Paris, France), Bloomingdale Trail (Chicago, IL, USA), Seoul High Line (Seoul, South Korea). All these examples, despite being realized in different environments and with different features, come from the re-use of underused railway lines and have really similar characteristics: they all present an above-ground structure that stretches along the neighbourhood.

Realised Project	Location	Year of completion	Type of structure	Initiator	Environmental ambitions	Social ambitions	Economic ambitions	Designer(s)	Ownership	Lenght	Pedestrian path	Cycle path
High Line Park	New York, USA	2009	Only structure	Bottom-up	yes	yes	yes	James Corner Field Operations; Diller Scofidio + Renfro Piet Oudolf	City of New York	2,33 km	yes	no
Promenade Plantée	Paris, France	1993	Structure with shops underneath arches	Top-down	yes	yes	no	Jacques Vergely (lanscape designer) and Philippe Mattieux (Architect)	Municipality of Paris	4,7 km	yes	no
Bloomingdale Trail	Chicago, USA	2015	Only structure	Bottom-up	yes	yes	yes	Collins engineers Inc.; MVVA; Frances Whitehead	Municipality of Chicago	3,2 km	yes	yes
Seoul Skygarden	Seoul, South Korea	2017	Only structure	Top-down	yes	yes	yes	MVRDV; Ben Cuipers	Seoul Metropolitan Government	1 km	yes	no

Potential project	Location	Year of dismission	Type of structure	Ownership	Lenght
Rotterdam Hofplein	Rotterdam, The Netherlands	2010	Structure with shops underneath arches	Hofbogen BV Pro Rail	2 km

Tab. 8. Case study collection for realized projects and potential development. (Source: own table)

Table 8., shows a comparison amongst four realized and relevant projects of re-use of obsolete infrastructures worldwide. In the following section, it is explained through a first analysis of this comparison the reason for the main case study choice. All four are elevated structures, influencing the relationship of the project with the surrounding neighbourhood. Indeed, in most cases, such infrastructures had been realized for practical reasons as above-ground commercial railway lines. Another important aspect concerns the project initiator: both the High Line Park and Chicago Bloomingdale trail have been initiated by neighbourhood associations or cooperatives: “Friends of the High Line” in the first case and “Friends of the Bloomingdale Trail” in the second. It is noticeable here, how the High Line Effect had spread and influenced the realization of other similar projects. Almost all cases of such developments have been initiated to also

accomplish an economic boosting role for the neighbourhood, to attract investments and capital. Paris' promenade Plantée, being realized in the early nineties follows a slightly different concept: the project had the luck of being already in a high-end area in the city centre of one of the most visited cities in the world. That's the reason why, despite its similarities with the Hofbogen in Rotterdam concerning the structure with activities under the arches (the case study that will be used for the application of the theoretical study), it hasn't been appointed as ground for the BOLD analysis. The context, governance dynamics, the bottom-up initial approach, are all more important aspects that make a comparison between the High Line and the Hofbogen project.

2.2. The High Line Park

As stated before, this research will be developed as an exploratory case study analysis, done though an objective setting of the research on one relevant case study.

Exploratory research, as intended by Yin (1994), refers to a study where the researcher uses one or more case studies, interviews, experiments, surveys, archival analysis or history to study a specific phenomenon. Specifically, according to Yin (1994) the case study should be the prevailing and preferred method when the research question: a) investigates *why* and *how* certain phenomena are happening; b) does not require control over the behavioural events observed; b) focuses on contemporary events. Even though some researchers have been critical to processes that make use of a single case study - due to its limitations in generalizing the results (Tellis, 1997 in Zainal, 2007) - Yin (1994) doesn't see this specific choice as an issue for a successful research outcome. Indeed, even a single case study can often be used to pursue an exploratory purpose as long as the choice of parameters and the setting of the research are objective. What matters most is that the goal of the researcher should be to pose competing explanations for the same set of events and to indicate how these situations might apply to other situations (Yin, 1994).

The reasons why the High Line Park has been appointed as relevant case study for this research are:

a) It represents one of the most exemplary and complex cases of re-use of obsolete infrastructure to design landscape architecture in the world. Surely, this project appears as one of the most controversial and successful re-use of obsolete and underused infrastructure in the western world. Understanding the dynamics that make it so, will help identifying relevant issues for a study of other projects worldwide.

b) The project has opened its first walkable part in 2009, making it a long-enough timeframe to assess the urban dynamics that has been generating over time; these dynamics will give a solid ground to test BOLD methods on a representative and genuine on-going urban transformation.

c) Economic, social, environmental values are coming together in a complex way in the High Line: this offers an opportunity for new methods to catch this complexity and define solutions which could be used by other similarly complex projects.

d) Since its opening in 2009, it has become an economic asset for the city and the surrounding community, but its role in terms of social and environmental sustainability remains unclear. Indeed, some researchers have criticized it for being promoted by NYC governance primarily for boosting economic growth and competitiveness (Lang & Rothenberg, 2017).

After having assessed the reasons for the choice of using the High Line as relevant case study, in the following section, the relevant project features are addressed.

The High Line Park: environmental, social or economic benefit?

From a sustainability point of view, it shouldn't be forgotten that according to the Environmental Science and Technology Department of New York City, the High Line is a great example of such concept: its location is promoted as easily accessible, which makes it socially acceptable, and the park is encouraging more development in that area, which is good for the economy (Environmental Science and Technology of NYC, n.d.). Also, the association "The Friends of the High Line" argues that the park was at least partly aimed at sustainability: different elements of the High Line have been carefully designed and refined to conserve energy and resources (Friends of The High Line, n.d.).

Quite interestingly, the High Line preservation was started by a local cooperative that stood for the community values, but it was later incorporated in the growth machine belonging to the project of requalification of the industrial waterfront. The initiative was indeed guided by Robert Hammond and Joshua David, two residents of Chelsea with some connections to city financial and political elites. The park was intended to be, from the beginning, an important piece of a bigger real estate operation.

Fig. 9. Visitors walking on the narrow High Line Park path between 26th and 28th Street after the re-use transformation. (Source: TimeOut, n.d.)

Fig.10. The High Line trait between 26ht and 28th Street, before its transformation. The decay of the structure is reflected in a less attractive neighbourhood compared to the situation after the transformation. (Source: Joel Sternfield).

Fig. 11. The High Line Park in the West Chelsea context. (Source: Petr Perinka, 2012)

Fig. 12. Timeline with the High Line Park history. (Source: own drawing)

2.3. The Environmental sustainability assessment

Criteria for environmental sustainability of parks are taken from Dizdaroglu and Yigitcanlar (2012) and Sarhan (2016). These have been integrated with the concepts of environmental sustainability of brownfield developments explained in Mehdipour and Rashidi Nia (2013). Results from those researches have been considered in defining the input variables or assessment criteria.

Three main categories of sustainability criteria have been appointed: *hydrology*, *ecology* and *pollution*. In the following, the BOLD contribution to the assessment of these variables is explained, considering the added value it can bring when assessing urban dynamics. Table 13., shows the results of the BOLD exploration process to assess environmental sustainability.

ASPECT	INPUT CRITERIA	VARIABLES	TRADITIONAL ASSESSMENT	BOLD AVAILABILITY	ADDED VALUE	OUTPUT
ENVIRONMENTAL SUSTAINABILITY	HYDROLOGY	Evapo-transpiration level	Traditional fixed sensors	smartphone application	none	Urban sensors and mobile phone applications give the highest contribution in assessing environmental sustainability
		Water runoff level				
	ECOLOGY	Biodiversity protection level	-	-	-	
		Heat island effect level	Traditional fixed sensors	SenseWeb app + GIS mapping	partial	
	POLLUTION	Air pollution level	Traditional fixed sensors	SenseWeb app + GIS; car sensors; social sensitization	yes	
		Soil pollution level	Traditional fixed sensors	-	-	

Tab. 13. Input, availability and output model for Environmental Sustainability (Source: own table)

Hydrology

Evapo-transpiration increase, and water runoff reduction have been effectively measured on the High Line with traditional sensor techniques, and the results have shown that the park performs as a green roof, bringing a substantial contribution to water runoff (Friends of the High Line, n.d.). More punctual and capillary measurements could be obtained with systems that overcome the mere use of traditional sensor technologies: targeted applications in mobile phones are opening new ways to shared and inclusive measurement methods.

In farm management, smartphone applications allow water flow measurement tasks to be done much easier and at a lower cost, as these methods don't require a permanent station installation. To this purpose, Pongnumkul et al. (2015), designed and developed an Android application for measuring open-channel flow. The application estimates water level, surface velocity, and discharge rate by analysing a short video recorded by a smartphone of the water flow between two control points with a known distance. To estimate the water level, the algorithm relied on a separation line of image segments with and without optical flow using a sequence of images. This technique is applicable as pixels in the dry parts of the image generally remain unchanged over time, while pixels on the water are subject to constant change. The surface velocity estimation was implemented by a modified method of the standard Particle Image Velocimetry (PIV) method. The preliminary results reveal that the accuracy of the water level, surface velocity, and runoff data obtained via their smartphone application is about 5% of data obtained from a commercial radar sensor.

Even though these applications might seem interesting and innovative, especially in terms of needing low monetary investments to work, on a project like the High Line they might not work as expected. As a matter of facts, an efficient way to involve citizens in such measurements needs to be found first. Sponsoring the usage of the app could be done through social initiatives on spot where citizens are sensitized on the issue and the measurement could be seen as a "social game" for citizen involvement. Secondly, these measurements won't be precise and accurate enough to have a full scientific assessment. The result of this assessment is that, overall, traditional methods that deploy fixed sensors are thus preferable to assess this component.

Ecology

Biodiversity and vegetation protection level is assured on the High Line Park through a responsible selection and maintenance of all the species that has been planted (Friends of the High Line, n.d.). For this reason, reduction of heat island effect has shown positive consequences on the park's roof surface: the park has been proven to have positive effects on the punctual reduction of the neighbourhood heat wave (Friends of the High Line, n.d.). Biodiversity protection level assessment is highly based on traditional categorization of species that will be or have been planted on the roof of the park. Traditional measurements involve monitoring temperature through fixed sensors, and then reporting heat measurements on a GIS system to visually show the obtained results. These sensors can give accurate and reliable results to monitor the heat island effect reduction, but technologies deployed might be expensive. As stated before, smartphone applications have

been opening new ways of measuring temperatures in a punctual way and by different users. Indeed, temperature sensors in users' smartphones can collect data in different locations of a park or even the park neighbourhood. This information is collected then in a network system, called "SenseWeb", which allows these data to fill an interlinked GIS platform where the visual product is a heat map of the area. This approach is extensively explained in the paper written by Resch et al. (2008). The SenseWeb project is a system that leverages sensor information in GIS applications. In this Wikipedia-like sensor platform, users can include their own sensors in the system and enhance the community effect. All the sensors can participate to a network aiming at collecting data from different spatial and temporal positions on the urban project. Oracle's system is then a middleware between this web service and a continuously updated database layer. Data come from "sensed people", though their mobile phones or cameras and, according to Resch et al., this can partially replace city-wide sensor networks, by creating a more precise system.

Similar to what has been observed for previous criteria, citizens need to be involved in such measurements through social initiatives of sensitization. If this is not taken into account, then the participatory level on to these initiatives might be lower than expected. If some of the users are willing to collect data on these aspects of the project, then results will be visible on the shared wiki platform online to monitor the heat island effect in different areas of the park and the neighbourhood. Despite these possibilities offered by such new development, it has been already proven that involving citizens in such measurements through their phones can produce little results (Farmazon, 2018). Traditional methods involving fixed sensors are also in this case more efficient for a relevant ecology assessment.

Pollution

The High Line Park has reportedly reduced the environmental and soil pollution in West Chelsea (Friends of the High Line, n.d.). An immediately visible indirect effect of reduction of pollutant levels comes with the nature of a re-development of brownfields areas: as stated before, brownfield developments reduce urban sprawl, by improving soil quality through reclamation processes. Soil pollution reduction is one of the first achievement attainable with traditional methods even before starting a brownfield re-development project. Despite traditional techniques appear to be quite firm in assessing the micro-scale phenomena, what seems harder to grasp is the relationship between possible pollutant factors, by catching their dynamics in the built environment beyond the project borders. Indeed, an immediate pollutant level reduction on the park surface area, might be in contrast with the augmented number of visitors by car that the facility will bring.

The main question then is: what happens in the surrounding? Measuring effects and consequences of such complicated dynamics might be challenging, but positive results can be reached by increasing awareness of people by sensitizing them on the issue and improving green infrastructure connection to reach the project in a more environmental-friendly way.

Environmental measurements thus become included and integrated with social initiatives, where citizens can feel, perceive and be aware of pollutant concentration in city neighbourhoods, and they are possibly stimulated in using public transportation, and come to the park with more sustainable forms of transportation. This transition entails the step from a mere "pollution assessment" of a project, to the vision of the project as influencer, or catalyst for positive change, which effects indirectly contribute to an increase in environmental sustainability of the project itself.

Some initiatives have already shown that merging environmental issue assessment with social inclusion is possible. The company Aclima is experimenting street-level environmental sensing "in order to bring people together around a new understanding of our environment and to empower policymakers and citizens alike to play an active role in improving it" (Aclima, 2017).

"In addition to mapping air quality in the surrounding regions near the heart of LA, Aclima also partnered with artist and Los Angeles-local, Nick Hanna, to visualize air quality in real-time, using "*Trikewriter*". The technology project uses a human-powered tricycle and integrated sensors to produce water visualizations of local air data on pavement. The tricycle's Aclima sensors measure local temperature, humidity, carbon dioxide concentration, and other parameters. The result of the data collection is a series of water visualizations that participants can view as they take part in the event. Hanna's "Trikewriter" makes the invisible be visible, using recycled, potable water. […]"

(Aclima, 2017)

For sure, Aclima initiative represents a good way of inducing environmental responsibility in citizens, making them more aware and responsible. Following this direction, environmental and social sustainability of a project are not seen as separated anymore: one helps the other evolve towards building a sense of belonging and involvement.

Recently (2017) Google has partnered with Aclima to include pollution measurements sensors on Google cars, so that pollutant concertation can be measured with extreme precision. This turns out to be particularly important if we consider that in cities, due to topographical, physical or optical irregularities, pollutant

concentration can differ considerably even on opposite sides of the street, and in different hours of the day (Resch et al., 2009).

On the High Line Park these initiatives could surely contribute to a better understanding on how the projects is contributing to sustainability in Chelsea. A Google car with sensor could sensibly monitor each part of the project that stretches for almost 2,5 km. Shared and spread sensing becomes particularly important to assess levels of pollutions in projects that cross multiple blocks.

Conclusions: the relationship between sustainability variables

Even though ways that go beyond traditional methods to assess environmental sustainability are available, most of them don't add a substantial value to traditional techniques concerning hydrology and ecology assessments. Concerning pollutant level concentration, shared sensing might play a big role in offering a new perspective in assessing changeable urban dynamics with capillary precision. Overall, environmental measurements still concern more the micro-sustainability of a project, where specific parameters can still be assessed by traditional sensor-based techniques.

The hardest task for managers is understanding how these dynamics could be included in a system that works coherently and takes into consideration all the possibilities offered by these BOLD applications. This passage will be discussed in in the next phases, with the presentation of the final inclusive decision-making tool

Quantitative sensing is certainly accurate for a satisfactory environmental condition assessment alone. A more complex issue arises when needing to assess social sustainability variables and confronting them to the environmental issues. Indeed, social dynamics are more qualitative, and their functioning doesn't strictly depend on rational cause effect relationships. Here is where BOLD comes to place with its power to deploy correlation between events and situations.

2.4. The social sustainability assessment method

As stated above, the social component of sustainability is what makes a potential use of BOLD innovative and valuable. Being the concept of "social" less technical compared to the environmental measurement aspect, input variables will have a less strict identification and definition. The social sustainability assessment is the product of a complex study of relationships between variables, as it will be extensively demonstrated on the case study. This part will be structured following the *input, availability, adaptability, output* model more in depth compared to the previous assessment, as this requires much more space for explanation and experimentation on phenomena observable on the High Line Park. In the next chapter, the importance of geo-located social media data for this part of the assessment is explained.

2.4.1. Geo-located social media data as a source

Traditional methods to assess park visitation, usership analysis and behaviour of visitors on park facilities largely rely on observation and surveys to assess number of visits over geography, time, socio-cultural groups or activities performed by park users (Hamstead et al., 2018). Most of the time, though, the result of these social studies appears to be rather sectorial, segmented and unchanging over time. Revealing its potential as mean to deliver a broader and more dynamic picture of the urban reality, BOLD can assess the complexity of social behaviours in cities. Specifically, one aspect of BOLD is responsible to provide effective solutions for the assessment of the social sustainability issue: Geo-located social media data. Geo-located social media data has born as a fusion between traditional GIS techniques of geo-localization and social media activity in our cities. This combination overcomes the traditional limitation of mere GIS techniques, by associating to the spatial-temporal dimension a text, tag, video, picture, emotion. Thus, researchers can not only determine *when* a park is used, and *what* people use on it, but also the *how* they use it (Hamstead et al., 2018). In this sense, social media allows the study of phenomena that are happening temporally and spatially: social media posts, from an urban point of view, are becoming an informatic trace of natural activities and behaviours in the city. Yet, social media activity is the reflection of humans' behaviours in the modern society, opening new perspective to assess behaviours of citizens through the traces they leave.

This phenomenon is what Antoniou et al. (2010) have defined as "neo-geography", but it could also be defined as "neo urban-sociology", where wide-scaled social interactions amongst people allow a complex study of human behaviours in cities. Hamstead et al. (2018) recognize the power of these new means to achieve important results in studying urban parks, the drivers of their use, as well as the social and public health benefits they provide.

The positive contribution that using Social media data gives, should outbalance by far the drawbacks, as explained in chapter 1.6. As a negative remark to this approach though, Bendler et al. (2015) argue that, in general, people tend to use recommendation platforms only when extremely satisfied or extremely angry

about a situation, and data sorting requires a big investment in terms of resources and human capital. Nevertheless, the feelings they can capture in relationship to the urban environment give an extraordinary opportunity to step forward in studying urban mechanisms.

Amongst all social media platforms, big data produced by Twitter, Flickr, Foursquare, Google Photos, Facebook have revealed their potential to the scope of this research. Those platforms are allowing the development of new branches of social and geographic study, what we define digital social sciences (Hamstead, 2018).

			SOCIAL MEDIA SOURCE					OTHER SOURCE				
			Twitter	Foursquare	Flickr	Picasa	Facebook	Google Maps	NYC 2016 Census	NYC DPR	NYPD	Google Forms widget
VARIABLE	Public participation in planning and development	Park project planning	Tweet content									
		Park programs planning	Pre-determined Hashtag content				Pre-determined Tag content					
	Usership and satisfaction	User satisfaction	Tweet content; Density of Tweets					Spatial features of urban area				
		Usership study		Venues check-ins	Pictures shared by user's profile	Pictures shared by user's profile		Spatial features of urban area				
		Social diversity	Contacts networks	Venues check-ins				Spatial features of urban area				
		Equitable access	TUD (Twitter users per day)		FUD (Flickr users per day)			Spatial features of urban area	Neighborhood social composition	Park characteristics		
	Safety	Potential hazardous conditions control						Spatial features of urban area				Interactive spreadsheet
		Crime prevention	Tweet content								Crime reports for different light settings	

Tab. 14. Social media relevance in this research, in relationship with and other sources for social sustainability assessment (Source: own table).

2.5. The Social sustainability assessment

For a park to be sustainable, it needs to keep the ability to serve its community at optimum levels. It is essential that a park has a clear purpose to serve on site, be safe from crime and hazardous conditions, be accessible by all, usable by all, and satisfactory to its users' needs and interests (Sarhan et al., 2016).

Variables for the social sustainability assessment are defined through an analysis of Sarhan et al. (2016) and categorized as shown in table 15.

ASPECT	INPUT CRITERIA	VARIABLES	TRADITIONAL ASSESSMENT	BOLD AVAILABILITY	ADDED VALUE	OUTPUT
	PUBLIC PARTICIPATION IN PLANNING AND DEVELOPMENT	Public participation in park project planning	Interviews, meetings are often conducted on limited samples, not consistent and exclude parts of the users	Twitter	yes	BOLD can: a) go beyond the mere park physical dimention, by also assessing the relationship between the project and the surrounding neighborhood. b) contribute with a holistic and inclusive view on dynamics c) capture complex relationships between urban phenomena d) empower in new ways stakeholders traditionally excluded e) make the park act as a catalyst for whole neighborhood improvements, beyond the park's borders
		Public participation in park programs planning	Interviews, meetings are often conducted on limited samples, not consistent and exclude parts of the users	Twitter; Google Maps	yes	
	USERSHIP AND SATISFACTION	User satisfaction	Interviews, meetings are often conducted on limited samples, not consistent and exclude parts of the users	Twitter; Google Maps	yes	
		Usership study	Interviews, meetings are often conducted on limited samples, not consistent and exclude parts of the users	Foursquare; Flickr; Google Photos; Google Maps	yes	
		Social diversity	Interviews (mostly on HLP, but also at neighborhood level) don't picture the complex relationships between people	Twitter; Foursquare; Google Maps	yes	
		Equitable access	Interviews, meetings are often conducted on limited samples, not consistent and exclude parts of the users. Not able to catch compe spatial relationships with people's behaviours	Twitter; Flickr; Google Maps; NYC DPR	yes	
	SAFETY	Potential hazardous conditions control	Planned daily control and efficient maintenance is done exclusively on the High Line Park	Google Forms Widget + Google maps	partial	
		Crime prevention	Constant and efficient patrol activity is done exclusively on the High Line Park	Twitter; light settings changes	yes	

Tab. 15. Input, availability and output model for Social Sustainability. (Source: own table)

A. Public participation in planning and development

Planning a park is an ongoing process that evolves with the development of needs and interests of the community, thanks to a full study of the park's context, community and resources. Defining attributes are summed into: *public participation in park project planning* and *public participation in park activities planning*.

2.5.1. Public participation in park project planning

Public participation in park project planning ensures the involvement of local citizens concerning the improvement of efficiency, effectiveness, preparation and accountability for park creation. Park managers need to be sure that plans (strategic plans, marketing plans, business plans, master plans) when implemented, respond to needs of users by incorporating ideas, suggestions and criticism by citizens.

(a) Current performance and traditional methods limitations on the High Line Park

"Through excellence in operations, stewardship, innovative programming, and world-class design, we [the organization] seek to engage the vibrant and diverse community on and around the High Line…"

(Friends of the High Line, n.d.)

The organization Friends of the High Line clearly defines its goals and objectives concerning citizen involvement. Even though the initiators also looked at the financial and economic potential that it could generate, they realized soon enough that the project was a success from a public participation point of view (Alvarez et al., n.d.).

Marzuki (2015) describes public participation as a process that allows residents to become educated about issues that directly affect their lives. It has been recognized though, that traditional forms of public participation - such as citizens' juries, education programmes, public hearings and comment procedures - still have some limitations. Indeed, challenges arise surrounding the potential for participation to be dominated by certain interest groups and pre-determined decisions, which may reduce the space for democratic engagement (Cretney, 2018). Moreover, the daunting amount of time that passes with little tangible action taken after hours of dialogue represents a substantial drawback of neighbourhood or association meetings (Alvarez et al, n.d.). Citizens might feel discouraged by long waiting times, and feel like their contribution is pointless: often, after first successful sessions they might decide to leave their ambitions to contribute (Grant in Alvarez et al., 1994).

Researchers have suggested that the High Line Park is striving for this participatory model, but results show an inconstant form of engagement: this aspect challenges the extent to which the association is actually taking care of involving West Chelsea residents with a form of community planning (Alvarez et al. n.d.). Hammond and David organized a set of meetings in the early stages, so to make everyone involved in decisions and possible solutions to improve the project. The initial involvement is often used by managers and planners to grasp opportunities and opinions, but more is needed: a constant and unbroken community involvement over time.

(b) BOLD assessment

Computer-aided technology has been seeking for easier, more effective and less expensive methods of citizen engagement in on-going projects. The power of social media contributes with the advantage of having people participating any time and from any location (Zhang & Feick, 2016). In the following, it will be explained how social media could effectively contribute to an increase of public participation in park project planning.

Rob Feick (2016) empirically examines the usability of geosocial media for local governments through a case study carried out in the Region of Waterloo (Ontario, Canada). Even though his study has demonstrated that social media posts are on average more negative than positive, it is still possible to obtain a valid method of user involvement for project planning. The three-step method described involves:

(1) Harvesting geosocial-media data from Twitter.

(2) Identifying text-based geosocial media messages that relate to local spatial planning issues.

(3) Semi-automatically summarizing the text content and explore main themes that appear from public input

The outcome of this work is a framework that helps decision-makers understanding park dynamics, by promoting a successful use of its premises. Relevance of tweets is detected though a Bayes estimate, by checking the probability distribution over the words each message contains. A threshold is then determined

to divide relevant from irrelevant messages, by checking single scores. Hierarchical topics are then used to detect micro categories that hide under main categories, creating a map that clusters relevant tweets.

This method entails a limitation related to the structure of the collected data which are unstructured, vary in quality and quantity (e.g. areas with a majority of young people have more data) and are often of unknown relevance for local government's needs. Ontology-based information retrieval (IR) methods can improve the efficiency of harvesting transportation planning-related information from social media text. However, these methods are not entirely suitable for geosocial media messages because: i) there are few universal ontologies available for local governments or even more defined fields like planning; ii) Many topics are location specific and centred on content that is relevant for a particular development plan or community. Developing an ontology based on local knowledge is possible, but it will be limited to each specific local context. Further complications arise from the fact that only a small portion of social media are tagged with explicit geographic coordinates and these data vary consistently in geographical representativeness within and across urban areas. This on top of the fact that only 1% of Twitter data is retrievable to be analysed by external parties (Twitter policy).

Social media messages need to be aggregated, in order to cluster topic that talk about similar arguments. Manual work is needed to understand and categorize public input, as much of the data would be irrelevant to governmental needs. For this aspect, further empirical research on how to harvest data on social media is needed. Moreover, this method works effectively only in major transit corridors, university areas and main urban attractions.

Similar to walking interviews, tweets can catch the changing environment in urban areas, but more than interviews, they can elaborate on incredibly bigger number of unbiased "interviewees". This leverages on one of the main social media added value: they can catch actual sights, smells, and tastes along with the tactile and emotional experiences encountered in everyday life" (Corburn, 2003). Participation is distributed over space and time, and it similar to a continuous involvement model: interviews are set in precise times, with defined catchment areas, while social media data are effective all year long, and on a wider scale.

This part referred to the use of social media to contribute solving planning issues. In the next part, another involvement strategy that leverages on a more active degree of involvement and participation is explained.

Living labs and open discussion forums

A living lab is a user-centred, open-innovation ecosystem often operating in a territorial context (e.g. city, agglomeration, region) (Nevens et al., 2013). This research concept has been addressed both as data space to reach an integrated, dynamic and inclusive interpretation of big data dynamics (Pentland, 2014) and a real-world environment for collaboration amongst stakeholders (Eriksson in Følstad, 2008). Living labs have been deployed as efficient tools to integrate research and innovation concepts and reach better outcomes for both public and private parties involved in complex urban dynamics (Nevens et al., 2013). *Co-creation*, *exploration*, *experimentation* and *evaluation* of innovative ideas are at the core process concerning the way Living Lab operate on the territory and through this transition between one-sided view to multi-actor involvement the important step towards the realization of a stakeholder ambitions alignment is reached. The concept of Living Lab involves both user empowerment and stakeholder engagement from the early stages. This is possible thanks to the possibilities offered by information sharing and alignment, data collection in real time and on-spot, experimentation on concrete urban situations.

The process through which living labs are a mean for public participation is a repetition of 4 activities (Pallot, 2009):

1. Co creation: ideation of new scenarios or concepts
2. Exploration: engagement of all stakeholders from the early stages to explore and confront different perspectives on the matter
3. Experimentation: experience live scenarios to discuss and implement the envisioned ideas
4. Evaluation: feedback sessions on the performance of the implementation

(c) BOLD contribution on HLP and added value

In regard to the study showed in the Region of Waterloo (Ontario, Canada) can be applied to the case study, with some required adjustments. Enormous amounts of Twitter data are available along the High Line (Twitter, n.d.), though which information concerning issues can be collected by citizens' tweets.

The difference between what has been done in Waterloo and what should be done in the context of public parks highly frequented by tourists, relates to the diversity of users. In an urban context where users are mainly locals, the direct participation though social media data would come from actual residents, people that have to deal with the project every day. When the attraction is mainly frequented by tourists, the identified problems might relate to temporary situations, and don't include residents in the public participation model.

This issue can be partly solved thanks to the concept of living lab, where citizens come together and share their viewpoint on relevant urban issues.

As one of the main problems of public participation has been defined as lack of involvement of the most ordinary people, social media information and living lab experience together could be a rather democratic instrument to give a say to the majority of the visitors, but especially neighbourhood residents.

A Twitter data collection on the area of interest represents the basis to assess the project and neighbourhood issues. The second step towards a more effective involvement would be better understanding what citizens and stakeholders wishes are and translate them into effective plans. Through the living lab and open forum experiences, all stakeholders can participate in the process of planning future steps of the project development.

2.5.2. Public participation in park programs planning

Park programs planning is useful to meet the needs of the community and attract participants by offering programs and activities that are interesting to residents of nearby areas. This includes obtaining information to develop programs in line with ideas, suggestions and criticism by citizens and it should be an effective way to present the project to the citizens as being a fundamental part of their community.

(a) Current performance and traditional methods limitations on the High Line Park

"Each year, Friends of the High Line creates fun and innovative opportunities for people all ages to experience the park in a new way. Through public programs, the organization encourages community engagement."

(Friends of the High Line, n.d.)

Friends of the High Line takes care of organizing a certain number of "live events". These include a series of participatory activities for visitors of all ages to experience the High Line through music and motion. From dance parties to the beat of Latin rhythms to poetry and spoken word festivals, this series mirrors the eclecticism of New York's arts and culture scene. Through the *wellness events* section of the project site, it is possible to have an overview on activities like Tai Chi or Meditation sessions, which are offered weekly by neighboring studios (Friends of the High Line, n.d.).

The organization of these activities certainly shows there is a specific calendar of activities aimed at citizen involvement, through which they can feel part of the project.

Rothenberg and Lang (2015) suggest that even though some activities are accessible only by paying an entrance ticket, many have been studied and targeted for local residents. It would be positive to find a way not only to involve citizens through planned activities, but also make them a part of the selection process to decide which activity is going to be planned. Eventually, potentially involving every citizen in the activity calendar planning could lead to a part of the solution to the exclusion problem. By choosing or planning the type of activity they are interested in, they would feel closer to the project.

(b) BOLD assessment

When using street interviews to facilitate citizens' engagement, once again, a limited number of users can be reached. Even though, the best model still remains reaching citizens directly, the preference choice should be done through web-based initiatives.

Here the concept of open forum applies as well, to extent citizens have the possibility to express through a shared platform, ideas and wishes on which activities they would like to join on the High Line Park. Some municipalities (e.g. Rotterdam) have already adopted a similar concept of shared participation in reporting urban issues, and this will be explained further on with the application of the BOLD framework.

(c) BOLD contribution on HLP and added value

Involving citizens in planning activities for the High Line would be not only a way to enhance public participation, but also a mean to make citizens feel more involved with issues concerning the project. This could help all members of the community seeing the project as part of the neighbourhood, as an urban good for everybody, where activities are organized by the community for the community as well. This concept brings the issue of public participation further over time (better compared to a mere initial involvement) and over space (better compared to a closed meeting)

B. Usership and satisfaction

Usage and attendance rates at a park are amongst the most tangible results for park system sustainability. In an iconic landscape architecture project of re-use of a brownfield site though, not always a high level of attendees signifies that the park is socially optimal. Indeed, the concept of *how* the park is used and by *whom* both become of extraordinary importance to assess the project performance. In the context of a project designed to boost the development of the surrounding area amongst other reasons, this turns particularly useful to assess and establish connections between relevant venues in the neighbourhood and the analysis of what happens around and across the park becomes more important than the limited vision of the mere project alone.

2.5.3. User satisfaction

User satisfaction identifies if the development of a park it's satisfying or if there are issues that need to be addressed.

(a) Current performance and traditional methods limitations on the High Line

Satisfaction is often a hard variable to assess. Indeed, many researches on residential satisfaction, underline the difficulties of assessing a phenomenon that highly relies on individual tastes and standards. In other words, it becomes harder to identify quantitative aspects generally suitable for the purpose (Jansen, 2013).

When it comes to assess satisfaction generated by urban landscape architecture projects, the aesthetic pleasure that their design is able to produce is one of the most important aspects to consider. Indeed, while cultural projects sometimes involve new construction, more often obsolete infrastructures and brownfield developments are transformed into conduits for aesthetic experience (Zukin in Rothenberg and Lang, 2015). This aesthetic experience can have a double-sided effect: on one hand, it can generate high level of satisfaction, on the other it can be seen as satisfactory just for some users. One of the biggest problems related to traditional methods comes with the difficulties in assessing the complex relationships between the project and the neighbourhood, or between different ways of experiencing the project in a more inclusive way. If a rather big sample of interviewees is asked on the High Line Park if they find the project satisfactory, the first problems will start by aligning the interviewer and the interviewee definitions of satisfaction. But most important of all, the answer will be based on a reduced number of users. How can BOLD assess urban satisfaction beyond the project borders, by taking into account the whole neighbourhood dimension?

(a) BOLD assessment

For the purpose of this research, satisfaction could be identified as a combination of attractiveness of a place and the positive feeling that gives after having visited it. The correlation between those two factors has been identified by combining two researches. The first, uses Twitter activity and popularity to define attractiveness of places (Bendler et al., 2015), the second refers to Rob Feick's research (2016) to decipher and interpret Twitter posts (as described in chapter 2.4.1). By looking at Twitter usage density, in combination with Twitter post content, it is possible to define which urban areas are more attractive than others.

(b) Defining attractiveness of places though Twitter use

Social media geo-tagged data could offer an inclusive assessment of the general feeling towards urban attractiveness generated by a project, or a neighbourhood. People uncover their traces in both geographical and temporal dimension. Bendler et al. (2015) make use of this concept by suggesting a model that entails the collection of Twitter data in cities coming from bars, stores, malls, public places.

Hangzhou Hu and Ritchie (1993) define a variable like "visitor satisfaction" as part of the "soft data", as it contains sources that, contrarily to "number of visitors per year" are harder to measure: it's not a single criterion that defines attractiveness, but it's a combination of multiple behaviours of tourists and residents. Of course, this will work only if a set on a rather high number of data is analysed, as general patterns define way more the weight of a variable than what a small group of interviewees can do.

Their method indeed only focuses on a geographical analysis of tweets, by showing geo-spatial and temporal visual patterns, which gives the advantage of having data univocally interpretable.

The method described enables the identification of distinctive usage patterns with respect to city district and time of day. It measures Twitter *activity* and *popularity* in urban environments. Twitter activity in a specific area is defined as the intensity of Twitter usage, while Twitter popularity is exploited when the usage is also accompanied by picture or videos of the visited place.

The analysis of Twitter data in their research brings to a categorization of venues, based on what makes them attractive, by defining "activity categories" with the help of Google Maps. The comparison and overlap between Twitter-based attractiveness and Map Data retrieved from Google Maps, done though a regression analysis, shows the correlation between activity categories and areas of interest within a city or a neighbourhood.

This process provides the identification of specific areas, where Twitter usage is higher. By correlation, it can be deducted that these areas are frequented by a large amount of people, but we still cannot tell whether people have a good or bad impression on those. For this, it's necessary to add the next step.

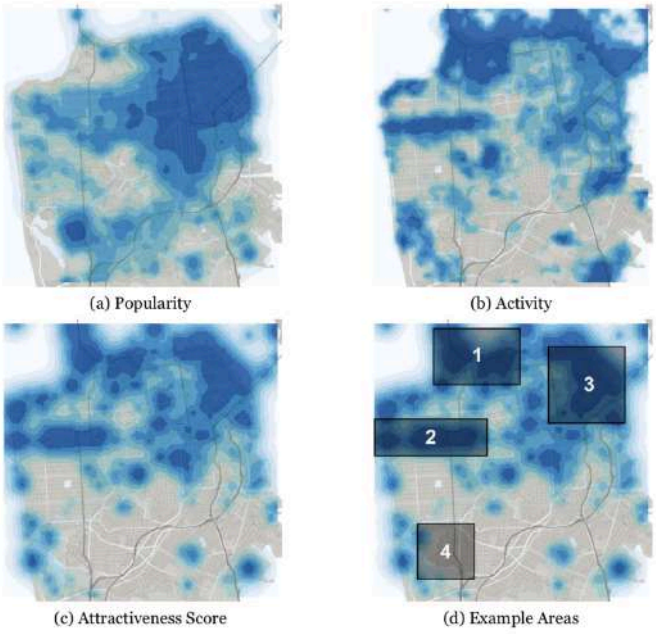


Fig. 16. Popularity, Activity and Attractiveness scores for San Francisco area. (Source: Bendler et al.)

This happens with the selection of "denser" area in terms of Twitter usage, followed by the analysis of the content of Tweets coming from those areas. Indeed, if the density map of urban areas is associated with the content of Tweets coming from the same locations, then it's possible to filter positive and negative comments (Feick, 2013), thus obtaining data on whether or not people like these places. Areas that will have a high density and a high number of positive reviews will be defined as "attractive areas".

This method doesn't include a study of the social background of the Twitter user, which is a limitation in understanding who specifically finds the place attractive. This aspect will be dealt with in the section regarding demography of the attendees (Chapter 2.4.5).

The method itself defines a correlation between Twitter activity and attractiveness of places, but this is a typical example of correlation analysis: causality is given by the interpretation of the results on a wide scale. The expertise of the urban planner has to come into place to assess and discern the validity of the assumptions defined through the BOLD analysis. A qualitative and experienced evaluation is always needed not to commit "false causality relations" mistakes.

If the demography study is correlated with attractiveness of venues, it would also be possible to estimate who finds which places particularly attractive, making it possible to visualize the different usage patterns, for instance, of tourists and residents.

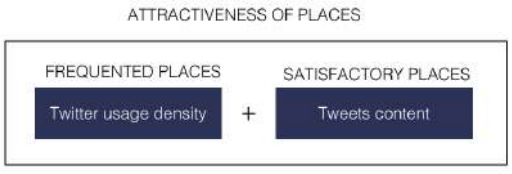


Fig. 17. Attractiveness of paces is the result of a study on Twitter usage density and Twitter content in those places. (Source: own drawing)

(c) BOLD contribution on HLP and added value

In West Chelsea, Twitter use both from tourists and residents is high enough to use this method with effective results, determining which geographical areas have a higher degree of urban satisfaction on a much broader scale than single on-spot interviews could do. This could help administrations in assessing why some places have high levels of attractiveness, but differ in satisfaction, and why some places are nor attractive nor satisfactory, helping them in highlighting the problem that needs to be solved.

2.4.4. Usership study

It defines level of user's behaviour against park facilities, defining mobility patterns along and around the project. This variable defines users' behaviour against park's facilities and the high or low level of attractiveness expressed by the user of a park. In the context of this research, this variable, answers questions on how visitors use the park and what in the park they use most.

(a) Current performance on the High Line Park

The analysis of users' behaviours against park facilities is one of the most important variable to understand if, and to what extent, the park is a success. The relationship between park and surrounding that Walker observes, can be taken as a starting point to grab the problem from a different angle: instead of looking from the inside of a park, the outside can be observed first to estimate where flows of people are directed in the physical space, how they possibly cross the park area and how surrounding facilities might influence the park development. Walker (2004) states that, amongst the levels under which the park usage could be measured, the "*how people use a park*", is the most complicate to assess. Indeed, to catch where are possible meeting points, where are the most used accesses and which directions are preferred, it is important to catch unbiased visitors' behaviours.

Traditional ways to solve the issue have used interviews on important NYC venues as Central Park. Between 1997 and 1998, managers in NYC wanted to effectively improve the whole area and assess trends of circulation. To prove or disprove the effects on the improvements strategies, they asked between 550 and 600 visitors which entrance they used to enter the park. Waiting times between measurements were long, interviews where biased and didn't catch a substantial sample of users.

Similarly, Usership study done in traditional ways and physical evidence show that spots for recreation activities are limited on the High Line: dog walking and biking are prohibited, due to its narrow pedestrian path. While benches are provided for seating and lounging along the sides, there are few spots in which a large group of people can meet and picnic and sports or active play are restricted, once again, by the structural limitation of the space (Rothenberg and Lang, 2015, p. 5).

If certainly the visible physical dimension of the park can give an immediate impression, there is far more hidden in the design of the High Line and in the relationship between the park and the surrounding neighbourhood. For instance, the neo-liberalisation of its design has been led by developments on the surrounding neighbourhood, almost following a form of "marketization" of the urban park, that strives to reach the existing venues or amenities. This process is one of the most evident products of a new form of governance, that strives to a maximisation of the initial or on-going investment (Lang and Rothenberg, 2015). The result of this strategy is a "carefully orchestrated view of the river, architectural jewels and building sites peopled with workmen, bulldozer and cranes at regular intervals" (Lang and Rothenberg, 2015).

The relationship between the High Line and its surrounding is made strong and palpable thanks to a subtle link between the design of the project and the inducement of visitors towards certain defined locations.

The light gentrification of Chelsea

In the context of park usership in relationship with surrounding venues, it's important to introduce the concept of gentrification in Chelsea. Even though The High Line has been appointed as major gentrification factor for West Chelsea, a deeper analysis suggests that its re-development was only a part of a process already into place. Indeed, when the first forms of light gentrifications where changing the future of Chelsea in the late eighties (Alvarez, n.d.), the High Line Park stood up as a remarkable trace to both follow and continue with that change.

While a form of strong gentrification often entails disruptive and immediate intervention, always without a long-term future sustainable plan, the light form of it it's just a natural process many cities around the world are facing to improve their image and deliver a better urban environment to their citizens. The so called "Chelsea phenomenon" has seen the neighborhood transformed from a rather unsafe area to a place that already attracted elites starting from the 80s, tracing an improvement path that stretched for more than three decades. This process has seen the transformation of the abandoned old Nabisco Factory into a mecca of food and

other high-end consumption goods. Art galleries have been popping up like mushrooms, (Rothenberg & Lang, 2015). In a whole transformation that was positive for the city tax revenues, for the image of West Chelsea and for the re-branding of the whole south-west Manhattan.

(b) BOLD assessment and added value

Knowing where visitors go most and where they would stop definitely represents a priority in urban areas management, but more efficient means of defining these relationships are needed. BOLD can help identifying patterns of visitors towards facilities and park structures.

Through geo-located social media data, relationships concerning usership of main venues in cities are identified. For this purpose, Arase et al. (2010) has conducted a research on identifying people's flows across places by using photo sharing on platform like Flickr and Picasa (Google Photos, 2018). Photo sharing is one of the most popular web services and it includes the possibility of geo-tagging the place where the picture has been taken. This concept becomes particularly relevant in times where each of us has a smartphone always available to picture what he or she finds attractive. To determine people's flow the concept of *photo trip* is introduced: it's a set of geo-tagged photos that people take during a trip from point A to point B in a city. In other words, a photo trip is the trajectory consisting of locations and duration of the visitor's stay.

A *photo trip pattern* is the sequence of frequently visited locations. The photo-trip-based method used by Arase et al. (2010) involves a big radius of action, extended to the whole city, but it could be easily adapted to West Chelsea smaller dimension. The spatial dimension that connects places in the "data space" has a practical repercussion on the "physical space": the intensity of the *photo trips* lines marks the points where people traffic is more intense. This could be fundamental to plan the space considering the estimation of possible people flow. This opens the way to a new idea of managing the urban space: managers don't plan a priori, but first they observe how a space is used, which access points are relevant for a bigger amount of people.

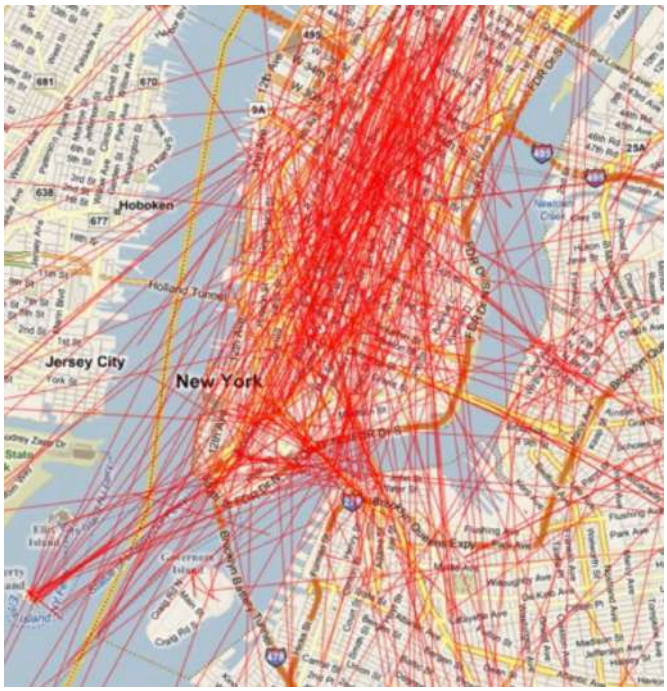


Fig. 18. Geo-tagged photo trips in Manhattan (New York) (Source: Arase et al., 2010)

The concept of photo trip extended to the bigger picture could be useful to understand the relationships between tourists flows considering the whole city dimension. Possible questions would be: Are tourists that visit the HLP also interested in the Statue of Liberty? What is the relationship between Central Park and High Line park? This opens the way to incredible opportunities to see connections and degrees of interest for venues in a city. Possible outcome would lead to opportunities for city managers to know which intervention on a specific venue will probably also have relevant consequences on another "linked" one.

There is an evident drawback of social media geo-tagged pictures trips: it takes much more into consideration what visitors observe and do, rather than locals. For this reason, a method that digs more into observing the locals' urban patterns is presented in the following. Cheng et al. (2011) describe how patterns of urban

mobility, thus access to projects in the urban environment, can be determined by using sharing services (LSS) like Foursquare. It underlines how geography and location in online services are becoming increasingly important to identify urban patterns: different from mobile phones data and trajectories derived from GPS trackers, check-ins have several unique features. First, they are inherently social, meaning that users include circles of friends when sharing. Secondly, check-ins are associated with particular venues (e.g. a restaurant), which allows a better analysis of venue type. Moreover, check-ins can be argued with comments, giving a qualitative impression or motivation of the choice (Cheng et al., 2011).

The method suggested analyses the "wheres" and the "whens" of the check-ins and it identifies some variables:

(1) *User displacement*: it represents the distance-based displacement of consecutive check-ins made by users.

(2) *Radius of Gyration:* the standard deviation of distances between the user's check-ins and the user's centre of mass

(3) *Returning probability*: the measure of periodic behaviour in human mobility patterns (the probability of returning to the same place previously visited).

Other initiatives have tried to catch people's movements in cities. Social Glass (http://www.social-glass.org) is a pioneer instrument in trying to collect big amount of data in the city of Amsterdam and confront it with traditional sources to have a broader view on city dynamics. In particular, through social media data is possible to obtain "arcs" between locations in the city, that denote paths taken by users. The thickness and colour of the path can also reveal the popularity of that path amongst the considered set of users. By clicking on an area or a path , a popup appears in the lower left part of the screen, which contains information such as: 1) The distribution of users according to their role, age and gender; 2) The popularity of point of interest and venue categories; 3) Temporal distribution of micro posts across week days; 4) Semantic profile of the users that were posting from the area; and 5) other static data taken from public data sources (e.g. crime rate) (Bocconi et al., 2015).

An application of Social Glass technology to detect how places are connected in the city and with which frequency could be applied to the structure to realize where the arches representing the major connections cross the High Line project area. Of course, it is not possible to focus on a micro scale, but rather on the macro scale of the neighbourhood, maybe even in its relationship with the whole city. Data are collectable and easily usable as the project is in an intense-traffic area, where visitors' activities are extremely high. A study of these phenomena can help understanding which gender, age, type of visitor decides to travel from A to B in Manhattan and crosses the structure in a precise point, which becomes a relevant point of the bigger itinerary. More than just a street or a physical connection, the space of data of virtual connections will determine how the space needs to be shaped and used. Possibly, connections between the Whitney Museum, Chelsea Market, The Statue of Liberty, The Old Nabisco Factory will show by whom, how much, and where the space is utilized. The intensity of these connections will design a data path, that will help understanding the data distribution. Limitations are related to the level of detail these paths can have: the wider the picture, the easier it is to design reliable data paths.

(c) BOLD contribution on HLP and added value

A possible application: the cultural path in Chelsea

To assess neighbourhood dynamics in Chelsea, it's important to first give a definition of what will be considered as the High Line neighbourhood in the context of this variable study. Chelsea lies in the west side in the borough of Manhattan, between the Hudson River and 6th Avenue, 14th Street and 34th Street (The New York Times, 2015). This area can be considered as the wider catchment area where the "Chelsea effect" has been taking action starting from the late eighties.

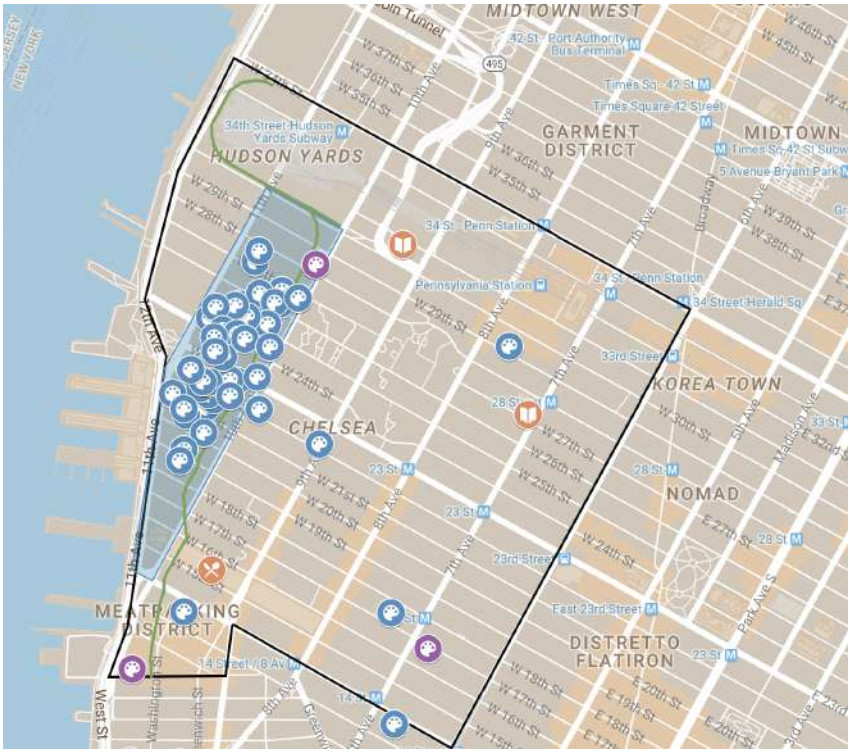


Fig. 19. Chelsea most relevant cultural venues. In blue, art galleries; in orange: universities and historic buildings; in purple: museums (Source: own drawing).

The focus of this BOLD application is in identifying a sort of "cultural path" that stretches along the most important venues of West Chelsea.

As it can be noticed from the maps in fig. 19, the majority of the relevant art galleries (blue icons) in West Chelsea are located within 11th Avenue and 10th, south of 30th street. Those blocks are exactly the ones that correspond to the main part of the High Line Park extension, thus giving a hint on the important effect that the High Line has been having on the neighbourhood since its opening. The temporal development of the neighbourhood has pretty much followed the direction of the spatial one: starting from east, the conversion of the old factories in technology and cultural poles has preceded the development of the High Line, which in turn has generated a continuous flow of development towards in the western part of Chelsea and the Harbour.

Fig. 19 shows spots where supposedly Twitter use in these areas will be high enough to bring the expected results. The goal of this Usership application is going beyond the physical and geographical representation on a map. It is well known that those represented are the main venues in terms of cultural interest, but how do they relate to each other? How do they relate to the High Line? How do they determine affluence of people and streams of visitors on the park?

Twitter, Flickr and Google Photos usage are denser in those areas of interest, as people take bigger amounts of pictures around the main venues. This gives the right instruments to design a photo trip path, which combined with a "map of attractive places" categorized by topic, as described in Bendler et al. (2015) (chapter 2.4.3), will determine the broader relationships between how people use cultural venues around the High Line. Moreover, it can show how people that are interested in cultural venues use the park in term of accessibility, also related to a time of the year. The picture obtainable is based on how big number of visitors and residents behave against surrounding facilities.

Results might show that visitors that are interested in a certain typology of art gallery find a particular area in Chelsea attractive. The analysis can reveal if there is a correlation between places in which art galleries have been located and attractiveness by visitors interested in art. Is there a link between the visitors' waves in the art galleries and the visitors wave in art museums, or are they different visitors groups?

Even though it's unrealistic to plan exclusively based on observation of people's flows, as the expertise of human professionals cannot be neglected in urbanism, it is possible to help planners taking big decisions concerning crowd management and smart access to facilities.

2.4.5. Social diversity: demography of the attendees

The park should be accessible by all members of the surrounding community without social barriers related to income, ethnicity, social status. The concept of demography of the attendees is used to discover the percentage of attendees from the targeted community versus the percentage of visitors from out of radius communities. Through the observation on how communities behave in and around the park, important conclusions can be drawn. Indeed, Walker (2004) observes that park's behaviour can be an indicator of social changes in an area. In the context of this research, the variable social diversity answers the question concerning *who* uses the park.

(a) Social diversity on the High Line Park

Despite many perceive it as an outstanding improvement for the whole neighbourhood, there have been some differences in the way Chelsea residents and tourists are perceiving the park. The High Line has been criticized for being too much tourist-oriented, or even for being a real estate development causing gentrification and displacement of previous inhabitants. "The park itself doesn't have open spaces for kids and it's more for tourists to walk through" (personal interview from Lang and Rothenberg, 2016). With all the limitations described concerning on spot interviews, they have often confirmed this trend.
This doesn't surprise, when considering the High Line as an iconic landscape architecture experience. Social inclusiveness or exclusiveness of such icons, indeed, recalls to a concept expressed by Bourdieu (1984): self-generating processes of exclusion occur due to the difference between the way higher and lower classes people experience a place. Also, certain people resist the imposition of a spectacularized landscape generated by architects, planners and developers (Rothenberg & Lang, 2015).

What is needed is a tool to allow urban planners and managers to assess the changing demographic situation of the neighbourhood, after the realization of specific interventions. For instance, when improving forms of public participation, it might be interesting to assess if they have actually been effective and if it has been reflected in the demography of the park.

(b) General BOLD assessment of the variable

For the assessment of social diversity in neighbourhoods, Hristova et al. (2014) suggest a method that has been tested and verified in London, a city that has been experiencing light and strong forms of gentrification. In the research context, relevant criteria are selected as follows:

a) *Brokerage* of a place: the level that measures the extent to which a place is able to bring together otherwise disconnected individuals in a physical space
b) *Serendipity* of a place: the level to which a place can induce chances of encounter between visitors.
c*) Entropy* of a place: the extent to which a place it's diverse in respect to visits.
d) *Homogeneity* of a place: the extent to which visitors behave in the same way concerning a place visit.

The authors were able to collect a dataset of Twitter information and Foursquare location information through Twitter where many users link their foursquare accounts automatically post-updated about their check ins.
On Twitter, the authors established *social networks* and *place networks*. Social networks are systems created by users following each other's activities, thus testifying that certain users belong to the same social "pool". Spatial networks are then created by the overlapping of social networks with Foursquare check-ins, which makes the relationship between people and places explicit.

The aim of the research is suggesting an interconnected geo-social network, composed of a network of places and people and how those two relate to each other. The research analysed distinguish between places that bring together strangers versus those which tend to bring together friends, as well as places that attract diverse individuals as opposed to those which attract regulars. This approach enables the measurement of social properties of places as well as the geographical properties of people in a place.

Some limitations to this method entail the fact that phenomena can be studied at neighbourhood level, with little or no detail on more specific streets or precise locations.

This research gives precise and clear outcomes: outdoor places, frequented by large numbers of professionals and tourists (like city parks and landmarks), have a high level of brokerage and serendipity, and for this reason are definable as *bridging places* (in contrast to *bonding places*, that have lower brokerage and serendipity levels). Examples of bridging places are: parks, landmarks, universities, a subway station. Bonding places are: housing developments, hotel bars, night clubs, laundries, a mosque. Outdoor spaces have high levels of entropy and social diversity of a place is highly dependent on geographical factors: venues in central areas of London have higher entropy and bring together more strangers who are less homogeneous. Thus, low brokerage signifies high social cohesion, while high brokerage might be caused by gentrification.

When assessing *who* uses the park, it is important to refer to Hamstead et al. (2018), where they use a method based on Flickr to assess whether park visitors are tourists or residents. They determined the hometown of individuals who shared photographs of NYC parks based on the self-reported locations shared on their public Flickr profile. About half of the accounts reported their hometown location and 96% of those where verified successfully through geocoded coordinates on a specific software (Twofishes, www.twofishes.net).

(c) BOLD contribution on HLP and added value

This assessment could be done on Chelsea, to determine the level of social inclusiveness of the place and controlling bad forms of gentrification through time: the method is really suitable to assess neighbourhood phenomena, rather than precise spots like the High Line park path. This doesn't immediately tell what is going on exclusively on the HLP, but it allows an overall neighbourhood assessment through time. It allows a study on how the neighbourhood changes from a demographical point of view, as a consequence of measurements applied on the HLP (e.g. increasing public participation). Over time, it's possible to monitor gentrification in the neighbourhood and have a clear measurement on the level of social cohesion.

Hristova et al. (2015) defines which venues usually perform as *top bridging* or *top bonding* places. It seems that Chelsea includes a large number of bridging places, thus being a suitable neighbourhood to enhance interaction amongst different social groups or typology of visitors. The secret of an inclusive place is indeed obtaining a large number of "bridging places", where levels of brokerage and serendipity are high: these places function as collector of individuals from different backgrounds and the stimulate interactions between them.

Tab. 20, suggests top bridging places for each relevant category. These places are almost all present in Chelsea, and the High Line contributed to the creation of even more of these, meaning that it has created a high potential to develop satisfactory levels of connections between diverse users and avoid the ghetto effect. More than that, the High Line Park development contributed to the opening or construction of many of those inclusive places. Indeed, the juxtaposition of luxury apartments and social housing, exclusive art galleries and accessible to all places, have made the High Line be one of the most socially diverse neighbourhoods in Manhattan (Rothenberg & Lang, 2015). Identifying which venues are responsible for everyday encounters between tourists and residents, richer and poorer, younger and older, it's the solution towards a more sustainable cohabitation in Chelsea.

Category	Top Bridging
Arts	Aquarium Art Museum Opera House Cricket Theatre
Study	Auditorium University Lab Rec center Bookstore
Food	South American Scandinavian German Dumplings Australian

Category	Top Bridging
Nightlife	Lounge Gay bar Pub Cocktail bar
Outdoors	Bridge Neighbourhood river Park Cemetery
Professionals	Hospital Landmark Courthouse Convention center Animal shelter

Category	Top Bridging
Residences	Residence Apartment building
Shops	Photography lab Antiques Mall Gift Shop Travel agency
Travel	Motel Pier Subway Light Rail Platform

Tab. 20. Top bridging places per category. (source: Hristova et al., 2015)

2.4.6. Equitable access

Equity in access and distribution of open spaces for diverse range of use for the entire community. According to Sarhan et al. (2016), this is one of the most important variables when talking about urban linear parks. The most important component of equitable access is *park land distribution*, defined as the presence of park lands at different scales and different service radii, in order to serve a discrete amount of population. Equitable access is probably one of the most relevant and extensively explained variables: it involves social, economic and physical components together.

(a) Equitable access on the High Line Park

While parks designed from scratch could and should be designed by taking into account specific needs a priori, like designing an equitable accessible structure, the situation is different for brownfield developments.

The American Planning Association (APA) defines in a scheme the variables that are to be taken into account when designing a new park.

THE PARK	PARK ACCESS	INFRASTRUCTURE
Directly influence where new parks are located	Coordinate clear entry/exit points with adjacent infrastructure	Incorporate level of service standards for the infrastructure leading to the park

Tab. 21. Variables for new park design. (source: APA, n.d.)

The variables “Park Access” and “Infrastructure” can be monitored and improved, while for obvious reasons it is not possible to choose the “best location” from scratch in brownfield developments. The surrounding then has to be tailored to “host” the park in the best possible way. The High Line Park has had to solve problems concerning the relationship with the surrounding environment, including existing public green, public transportation and infrastructures.

Despite these issues, it seems that the project itself has been performing well regarding accessibility: “Friends of the High Line” was proud to be recognized by the New York City Mayor's Office for People with Disabilities for its commitment to making the High Line an accessible place for all. Every part of the High Line was designed to be accessible, from walkways that accommodate the width of two wheelchairs, to multiple elevator access points spread throughout the 1.5-mile-long park, to integrated companion seating, and picnic tables with clearance for wheelchair users. […] The team has always wanted to ensure that the park remains an example of a truly accessible public space.”

If the project seems successful from an accessibility point of view, a more complete accessibility analysis would lead to a more complete result when connections with existing public spaces, transportation and infrastructure services is assessed. In other words, what makes a park more effective from a socially sustainable point of view is the degree of interconnection with other facilities. The question then would be: how do we assess if a sufficient interaction exists between the High Line Park and the existing public green? Can there be a system between an iconic project like the High Line and other smaller neighborhood parks? Could the integration of this system with public transportation infrastructures lead to a better integration between social levels in the neighborhood? It is possible that by looking at the broader picture and creating a system that goes beyond the High Line borders, by involving other public green, the whole community would beneficiate and by consequence accept the project in a smoother way.

Moreover, NYC and other urban communities are working towards the achievement of more sustainable and equitable park systems. Even though New York is one of the greenest cities in the U.S., New Yorkers don’t have easy access to park facilities: for example, only less than 40% of the population is within a 10-minute walk from a park. (Hamstead et. al, 2018).

No paper has been found that incorporates an inclusive way of measuring integrated systems of transportations and green spaces. Indeed, concerning this aspect, traditional methods seem too weak to catch the complexity of these phenomena, which could be explored instead though a broader vision including a geo-spatial social media analysis.

(b) General BOLD assessment of the variable

Geo-tagged social media usage helps assessing the accessibility problem on a broader perspective, compared to traditional methods. That is what Hamstead et al. (2018) assessed in their study on park characteristics, park accessibility and attractiveness for 2143 New York city’s diverse parks. To accomplish their aim, they conducted a social accessibility and Usership analysis, integrated with a physical / spatial analysis of accessibility. In particular, they built a method to assess park usage estimates by using Flickr and Twitter posts as data sources. From both platforms, they collected FUD (Flickr use per day) and TUD (Twitter use per day) for each of these parks, and characteristics on sizes, facilities, neighborhood socio-demographic and public transportation access. The research classifies parks according to:

a) Park facilities and characteristics
b) Neighborhood socio-demographic characteristics
c) Accessibility

This division will be further explained and applied in the application of the method in the case study section. By cross-checking results from the physical space study and the social study, the researchers found that even though social media posts are a great indicator to assess park usage, sometimes results are made

dirtier, for instance, by a different use of the Wi-Fi in park facilities: people tend to use more social media platforms when there's a Wi-Fi spot available on a park. Another drawback of this method is that in neighborhood playgrounds children are not contributing to the count of users, as they might not use a smartphone. Despite those limitation, a general assessment led to interesting results: for instance, percentage of green space is not a relevant predictor of park popularity, while the number of facilities available is more relevant.

(c) BOLD contribution on HLP and added value

A possible application: defining an urban green system

Researchers have proven that park equitable access across a community is reached only if the system is observed and analyzed in its completeness, rather than single park units. If for standard urban parks it's easier to understand dynamics between them, the situation becomes more complex when a brownfield development projects is designed in an urban dimension where other public parks are situated. It's interesting to notice the relationships between these two forms of urban park, and whether is possible to define a coherent "system of public green", where a correlation between parks gives more social benefits than a park alone. If a system is determined, urban planners could push for a more inclusive planning, aimed at giving benefits to the whole community, though a holistic and inclusive strategy that crosses the different types of public space. Art exposition or organized open air sports activities for instance could be not exclusivity of the High Line Park, but the system could be extended to the whole public green system.

The analysis to identify whether a system of parks would be possible, and which would be the elements is articulated in two steps: *spatial analysis* and *social* analysis. In the spatial analysis, the "system of public green" in Chelsea is identified and categorized following an interpretation of the outcomes from Hamstead's (2015) research, where physical characteristics of parks have been related to their popularity and attraction levels. Then, through a social analysis - coming from an interpretation of FUD and TUD – it's possible to assess the interaction of physical components with the characteristics of the visitors.

Spatial analysis

The first step towards assessing the park physical system is identifying the single elements that contribute to it. For this purpose, public green spaces within the borders of Chelsea neighborhood are identified. Following Hamstead's (2015) classification, 5 other parks and 3 playground areas are present in the area. The parks are: Hudson Park, Chelsea Park; Chelsea Waterside Park, 14th Street Park and Clement Clarke Moore Park. The playground areas are: Corporal John A. Seravalli Playground, Dr. Gertrude B. Kelly Playground and Penn South Playground (see fig. 22).

Fig. 22. "System of green" in Chelsea (own drawing).

The second step of the physical analysis involves understanding how the single “green entities” in Chelsea are connected to each other and with other venues. In particular, *public transportation connections* (bus, metro and train), *bike lanes* and *main roads* have been considered in assessing the spatial connectivity of the place (Hamstead, 2015).

From an attentive analysis on Google Maps, the neighborhood of the selected parks has a high concentration of bus, metro stops and bike lanes. This suggests that the area doesn’t have particular connections problems to create a park system. As a remark, it is noticeable how the neighborhood south of the High Line has less interconnected transportation services. It can be deducted that, probably, the HLP has also contributed in bringing a stronger connection system, that in turn has beneficiated the other parks as well. This is an additional step forward towards the achievement of a system of parks. This effect could be called “attraction effect”, and it acts as a form of positive externality: a major development project brings positive developments and improvements from which also other facilities or venues in the immediate surrounding can beneficiate. Further away from the HLP, in the blocks within Gansevoort Street (south of the High Line tour starting point), West Street (the continuation of 11th Avenue), Hudson Street and 10th Street show a substantially reduced number of public transportation stations. This happens despite those blocks have the same geographic and urban characteristics of the northern part, where the High Line stands. Concerning bike lanes, a wider analysis on the whole Manhattan island (done though Google maps) has shown that the bike lane system is evenly distributed across neighborhoods from north to south: as an assumption, the HLP hasn’t brought any substantial improvement concerning this aspect.

Social analysis

A social analysis of Chelsea is useful to obtain relevant data useful to assess and understand the defined parks' usership. The study of the neighborhood social characteristics is relevant for Hamstead (2015) to define parks attractiveness and characteristics. Overlapping the spatial and the social dimension will give useful information on how different typologies of park could relate to each other, depending on the social background of the immediate surrounding. This assessment could be done more precisely by using Hristova et al. (2015), to identify through a more complex social media analysis who uses each of these small parks. Nevertheless, a more general and superficial level is sufficient for the scope of this assessment (see fig. 23).

Fig. 23. "System of spatial connections" in West Chelsea

Predictor	Metric	Spatial scale	Source	Values
Population	people / km2	neighborhood borders	2016 United States Census Bureau American Community Survey (ACS)	19.340,28
Ethnicity	White (% of total population) African American (% of total population) Hispanic or Latino (% of total population) Asian (% of total population) Others (% of total population)	neighborhood borders	2017 United States Census Bureau American Community Survey (ACS)	73,22% White 6,66% African American 29% Hispanic 13,45% Asian 6,67 % Others
Poverty	People living below poverty line (% of total population)	neighborhood borders	2018 United States Census Bureau American Community Survey (ACS)	n/a
Income	Low (< 25 k / year) Median (25 K < 100 K / year) High (100 k + / year)	neighborhood borders	2019 United States Census Bureau American Community Survey (ACS)	13% Low 31% median 56% High
Vacancy	vacant units (% of total units)	Chelsea and Clinton	Furman Center for Real Estate and Urban Policy	5%
Property value	Median property value	neighborhood borders	2021 United States Census Bureau American Community Survey (ACS)	$ 858.245

Tab. 24. Social analysis of West Chelsea (own adaptation of Hamstead et al., 2015)

The social analysis is followed by an analysis of each of the parks in Chelsea, to identify their characteristics and define which ones could be part of an integrated system.

Park	Park Type	Area (m2)	Green space	Impervious surface	Water bodies	Sports facilities	Wifi	Play areas (%)	Source
Hudson Park	Community	8.700	< 50%	no	yes	no	no	< 2%	NYC DPR
Chelsea Park	Playground	39.000	> 50%	no	no	yes	yes	50%	NYC DPR
Chelsea Waterside Park	Playground	10.800	< 50%	no	no	yes	no	> 50%	NYC DPR
14th Street Park	Community	3.600	> 50%	no	no	no	no	no	NYC DPR
Clement Clarke Moore Park	Neighborhood	4.900	> 50%	no	yes	no	no	< 50%	NYC DPR
Corporal John A. Seravalli Playground	Playground	4.613	< 25%	no	no	yes	no	> 75%	NYC DPR
Dr. Gertrude B. Kelly Playground	Playground	2.160	> 50%	no	no	yes	no	< 50%	NYC DPR
Penn South Playground	Playground	2.410	< 50%	no	no	yes	no	> 50%	NYC DPR
High Line Park	Community	3.750.000	n.a.	no	no	no	yes	no	NYC DPR

Tab. 25. Chelsea parks features analysis (own adaptation of Hamstead et al., 2015)

Social and spatial components combined

The last part of the assessment is based on the Usership study Hamstead et al. (2015) apply to define the correlation between spatial dimension related to accessibility and social categories that actually have access or prefer certain typology of park. At this point, the integration with the spatial analysis with data from social media platforms (FUD and TUD) comes at place.

First, it's important to resume the conclusions of the usership study done by Hamstead et al. (2015):
a) parks classified as playgrounds have fewer visits, as facilities are limited, park area is smaller and rules regarding play areas are limiting attractiveness. Also, users don't have a mobile phone, so it becomes hard to assess those facilities by considering TUD and FUD.
b) parks with a Wi-Fi connection attract more visitors
c) parks with greater areas of green space over the whole park percentage of space get fewer visitors
d) parks in neighborhoods with high proportions of minorities are smaller in size and tend to have lower level facilities.
e) parks in neighborhoods with high proportions of high income people are more visited by tourists

Conclusions

The observation of pubic green distribution in Chelsea is a reflection of the social fracture in the neighborhood. It has a high composition of high-income households, which reflects the development of bigger and more equipped facilities like the Hudson Park (more than 56% is high income). But low-income households (less than 15%) are still part of the social panorama in Chelsea, which is reflected in a quite dense presence of small parks and playgrounds, a reflection of poorer communities according to Hamstead et al. (2015). Lower income people are keener in frequenting small playgrounds, but they don't represent a satisfactory solution to the public green system issue in Chelsea.

Thus, even if an inclusive system was designed, playgrounds with more than 50% of play area might be excluded for the substantial difference they have in green presence, function and Usership behavior. Neighborhood parks are also too small, often serve as a crossroads center between streets, don't have a Wi-Fi connection, but usually have higher percentages of green. Despite this fact, according to Hamstead et al. (2018), public green without other facilities doesn't increase attractiveness levels of a park. Then, the High Line park stands as tourist attraction in this panorama of locally-frequented parks.

By cross checking TUD, FUD and parks' spatial characteristics it can be concluded that a system is difficult to achieve because of the high differences shown by the single elements. Once again, Chelsea's neighborhood frictions and inequalities are reflected by the study of public green. But, if from a social point of view there are still great differences between the Usership of Chelsea parks, the same cannot be said in terms of supportive grid of public transportation system and bike lanes. The physical dimension related to park physical accessibility is inclusive, and probably stimulated by the development of the High Line as the biggest part of the system. All the parks in the neighborhood have a good connection with public transportation systems and bike lane accesses.

Following these considerations:

a) Well physically-connected parks are a good starting point towards a further socially-inclusive park system.

b) Parks that belong to the category "Community park" could be included in a system, where artistic expositions, sports activities are organized in integrated and coordinated way, not only on the High Line, by creating a ramified network of social activities at neighborhood level.

c) A Wi-Fi connection should be extended to parks constituting the system, in order to make them as attractive as the main park.

D. Safety

A park should be free from crime and unreasonable physical hazards. Thus, monitoring the safety standards represents one of the most important criteria for proper park management.

2.4.6. Potential hazardous conditions control: the physical component

This variable ensures that the overall feeling of personal safety is maintained, and individuals are protected from harm through physical elements or the minimal presence of hazardous conditions, such as collision hazard or object hazards.

(a) Current performance on the High Line

While traditional urban parks often present more risks in terms of potential hazardous conditions, landscape architecture is by nature more controlled and planned, down to the smallest detail. Controls are more frequent, spaces are limited and structured and for this reason these types of parks appear to be rather safe. Being a highly planned and managed environment, landscape architecture does not encounter the issue of dark hidden corners or wide wild spaces. Even though some minor issues have occurred over time, they certainly don't represent a substantial problem. Paths and resting structures are well signaled, while fences and ropes limit the walking area and make the environment safe. At the moment, even though maintenance is constantly underway along the entire structure, there is no real-time system that could help solve arising issues as fast as they come and extended over the neighborhood dimension.

(b) General BOLD assessment of the variable

Support systems for urban maintenance have been at the center of the safety debate in urban environment monitoring with big data. Already, more than a decade ago, platforms for urban maintenance participation

and interaction have been developed to support city administrators facing urban maintenance issues (e.g. SenseWeb, 2011).

More recently, Blecic et al. (2014) experimented a web-based support system for urban maintenance. The main purpose of the system is to allow citizens to report neighborhood issues via Web and to integrate it into the workflow of the city maintenance services operations. Abandoned waste, untidy places, acts of vandalism, broken items are less a technological problem than a problem of public policy. The paper examines some basic principles that should always be observed when talking about public participation in reporting urban issues. Amongst them are transparency, openness and inclusivity and equity. The paper suggests that many initiatives exist to enhance public place monitoring, but the common shortfall is that they lack prioritization of the issues reported.

The aim of this paper is then to build a method based on "Google Forms widget", that not only allows real time assessment of the urban issues reported by citizens, but also incorporates a system useful to first solve the most dangerous or relevant issues. Even though this represents an interesting approach to manage urban maintenance issues, it also presents some shortfalls. The first, is related to the inevitable uncertainty of interpretation and fuzziness when expressing evaluative judgements: different citizens might have a different meaning of what is more relevant. The second is related to guided or strategic behavior, meaning that citizens make choices based on what they want to prioritize for their interest. Trust between citizens and municipal parties becomes essential to solve those issues.

The method works as follows:

a) Citizens report the issues via an online form (embedded Google Forms Widget): they can report the exact location, provide a description and upload photos. Waste, infrastructure problems, maintenance, acts of vandalism are the targeted issues that could be reported.

b) Data validation by back-office operators. The assessment is the first step before the issue is processed by the evaluation model (when ratings and a threshold are identified to prioritize the issues with an evaluation model). Operators can check if the issue has already been solved before, ask further clarifications and, if necessary, send out inspectors to observe directly on field.

c) Issue evaluation and rating of priority. The evaluation model, through an algorithm, assigns a priority rating to each issue, then all the prioritized items are made publicly visible.

The Web application for the city of Alghero, Italy, was entirely developed using Google cloud services. The application operates around a core developed using Google Spreadsheet (GS) App service. It is used for data storage, processing, and back-office interface with citizens, making it an extremely simple and cheap system to implement.

This method is based on a neighborhood level scale, which allows a general and broader picture related to urban maintenance: not only the project is assessed, but also issues related to neighborhood infrastructure problems can be taken into account.

(c) BOLD contribution on High Line Park and added value

Even though the landscape architecture project might be free from hazardous conditions that menace safety, it is important, once again, to consider the neighborhood dimension. The BOLD method previously described is not limited to the High Line itself, but it can be extended to the whole neighborhood, by making it more equal and inclusive. Indeed, if inhabitants are given the chance to participate in assessing and reporting dangerous hazardous conditions in Chelsea, this could enhance the overall feeling of public participation. The web-based support system for urban maintenance offers a chance to have a responsive and integrated way to make the whole neighborhood safe. Not only the park "under the spotlight" becomes managed and cured with regard to public safety, but the whole neighborhood becomes the area of interest. This for sure justifies the municipality to put in place a system that requires resources to analyze complaints and reports, to obtain something bigger in return: a sort of democratization process reduces the gap between what is privately managed and what is public space.

2.4.7. Crime prevention: the social component

Crime prevention represents the social-related component of safety in parks. Proper design and adaptation of current structures could help the prevention of crimes.

(a) Current performance on the High Line

Crime prevention in parks represents one of the most important aspects to take into account. Many research studies on park crime prevention and fear of crime have been done, but one in particular focuses on identifying specific park features that influence crime levels on the park and in the surrounding areas (Groff & McCord, 2011).

On the HLP is evident the double-sided use of space above and underneath the structure. On top, the famous path detached eight meters from the street level, underneath the complex relationship between the steel construction and parking spots, crossing roads, sidewalks, where safety problems might arise. Indeed, if the park on top is strictly controlled and managed, the part underneath has a major risk of being neglected in terms of crime prevention.

Michael Wilson, from the New York Times, describes the crime situation on the High Line as "strenuously policed […], with parks Enforcement Patrol officers walking all day. […] A vast majority [of crime infractions] were for drinking. Others were for dogs and bicycles, also forbidden. The feature of the High Line itself keeps criminality low. Everybody knows who's entering and who's going out at any time". (New York Times, 2011).

It is not surprising that such a controlled landscape architecture amenity has a low crime rate, on the surface. But, as stated for physical security prevention, the park cannot be a "white elephant" in the neighborhood context.

Fig. 26. A trait of the High Line seen from an unusual perspective. Safety issues have to be addressed with more care in these under-structure "blind spots".

(b) BOLD assessment and added value

Kang et al. (2015) designed a framework to analyse satisfaction in the residential environment using tweets, where one of the focus points was addressing safety by collecting direct opinions from users. The variables selected for the safety study are related to variables expressed in "Fear of night journey" where the searched key terms were "night journey" and "fear" or "fear_xx" (various suffix) (Kang et al., 2015). The authors then collected all the tweets related to safety and put them in a chart to map the areas where they were written. This approach is defined as re-active, as it is aimed at collecting people's reactions from urban context where safety related issues have already arisen.

Pro-active intervention, trying to prevent crime to happen rather than finding way to reduce the effects of it, are the next frontier of safety. This could be done by initiatives like the adoption of specific light settings, guiding the user in experiencing positive emotions, thus acting following responsible behaviours. To this purpose, some researchers have defined the most suitable light setting for public streets or parks. Concerning this specific aspect, a sort of conflict between environmental and social sustainability is highlighted by Pena-Garcia et al. (2015). Indeed, this research clearly states that, even though lower lights might be more environmentally friendly, they are less socially friendly, from a safety point of view. Despite this consideration, they suggest that "better light" is certainly more convenient than dim lighting. (Pena-Garcia et al., 2015).

A project that strives for a tangible demonstration of this statement has been set up in Eindhoven, The Netherlands. A team from Technische Universiteit Eindhoven is trying to prove that security not enforced but inducted might be the solution to public places exposed to risks of increasing violence and tension. Some authors believe that public violence starts way before the physical assault. According to them, aggression and violence are the product of a tense feeling in the atmosphere, which consequently leads to aggressive behaviours in the crowd (Kalinauskaite et al., 2016). Thus, sensing and preventing escalating behaviours becomes a way to combat crime and disorder: this is done through the use of interactive scenarios. The experiment has been developing and testing mechanisms for de-escalation through lights: lowering arousal levels, inducing positive mood, shifting and broadening attention, facilitating social behaviour, increasing self-awareness, and enhancing self-control." (De Escalate, n.d.). Light designers will translate these theories in practice, by integrating them in two escalation-prone locations designated as Living Labs, including the recreational district in Eindhoven. The scope of the project is quite ambitious. Indeed, researchers believe light settings will lower arousal levels, by inducing positive mood, shifting and broadening attention, facilitating social behaviour, increasing self-awareness, and enhancing self-control (de-escalate.nl, n.d.).

Fig. 27. Four different light settings in the context of "De Escalate project" (Eindhoven). (Source: The Escalate project)

This phenomenon is part of what theorists have called nudging. Thaler and Sunstein (2008) have defined it as part of a set of initiatives and practices that induce rather than oblige, direct rather than force, lead rather than pull the user towards a certain behaviour. To a certain extent is a paternalistic approach meant to show the right way of doing something. This approach could certainly bring to a new interpretation of safety in the built environment and open new ways to act against crime before a re-action to crime is needed.

(c) BOLD contribution on High Line Park and added value

The method designed by Kang et al. (2015), represents a good approach. When tweets expressing fear or lack of safety are obtained on a consistent basis over time, the issue has already occurred, and it can be, to a certain extent, stemmed. Following up through crossing police reports on crime rates (also retrievable online on the site of the NYPD) with the tweets expressing fear and lack of safety, it is possible to have a quite clear vision on the most problematic areas, where an immediate intervention is needed.

Crime prevention through change of light settings could be effective in some parts of the above-ground structure, but it would be an added value especially for streets and sidewalks that are below the structure of the High Line, where crime is more likely to happen. Different light settings could be installed in the most problematic areas of the structure and for each light setting crime rate police reports, video cameras and people's perception through Twitter could be analysed to gather information on whether significant changes occurred depending on the different lighting conditions.

2.5. The economic sustainability assessment

ASPECT	INPUT CRITERIA	VARIABLES	TRADITIONAL ASSESSMENT	BOLD AVAILABILITY	ADDED VALUE	OUTPUT
ECONOMIC SUSTAINABILITY	EMPLOYMENT	Employment increase	before / aftern analysis (Census data)	_	_	Traditional ways to assess Economic Sustainability through census and cadaster data deliver satisfactory results
	DEMOGRAPHY	Inhabitants increase	before / aftern analysis (Census data)	_	_	
	REAL ESTATE PRICES	Property values increse	before / aftern analysis (Cadaster data)	_	_	
	POTENTIAL FOR INVESTMENTS	New businesses increase	before / aftern analysis (Census data)	_	_	

Tab. 28. Input, availability and output model for Economic Sustainability. (Source: own table)

Economic sustainability of the project has a direct and indirect effect. The direct effect is what can be measured immediately and only depends on the nature of the project itself. It is strictly related to management cost and maintenance costs, depending on a proper evaluation of costs and revenues that the project is generating. At the design phase, it's important to have a precise business plan, which identifies the sum of total cost of the structure and maintenance costs minus the forecasted revenues. An on-going evaluation of these expenses will determine if the project itself is sustainable from an economic point of view, or if the ambitions of the idea wasn't complemented by an effective return or at least expense reduction for the management of the structure.

The direct effect on economic sustainability of the project itself can be easily assessed with no need for further consideration. Indirect effects of economic variables, such as the wider influence of the project on the neighbourhood, are harder to assess as they involve a bigger number of variables. This component refers to the inducted effect of the project on its surrounding, and it's made by complex relationships between social and economic, and sometimes environmental, effects.

Firstly, it's good to start with a definition from theory of what are the possible economic effects generated by a landscape architecture project. David and Margaret (2014) define 8 criteria related to the wider economic assessment of public spaces:

a) The space creates and facilitates revenue-generating opportunities for the public and/or the private sectors.
b) The space creates meaningful and desirable employment.
c) The space indirectly creates or sustains good, living wage jobs.
d) The space sustains or increases property values.
e) The space catalyses infill development and/or reuse of obsolete or underused buildings or spaces.
f) The space attracts new residents.
g) The space attracts new businesses.
h) The space generates increased businesses and tax revenues.

Traditional methods involving a before and after analysis concerning the aforementioned variables are sufficient to give a satisfactory assessment. Even though economic benefits might be quite evident and rather easy to assess in time (before and after the project), it's important to consider that what is more relevant and hard to grasp is the relationship between economic, environmental and social variables. Indeed, variables that have a positive effect on economic criteria are often in contradiction with environmental and social values. Those complex relationships are described in table 29.

Economic sustainability factors	Increased revenues opportunities	Increased employment opportunities	Increased job opportunities	Increased property values	Increased re-use of obsolete spaces	Increased number of residents	Increased business and tax revenues
Influence on Environmental sustainability	_	_	_	None	+	_	None
Influence on Social sustainability	None	+	+	_	+	None	None

Tab. 29. Correlation and influence of economic sustainability variables on environmental and social sustainability.

2.6. The relationship and influence between variables

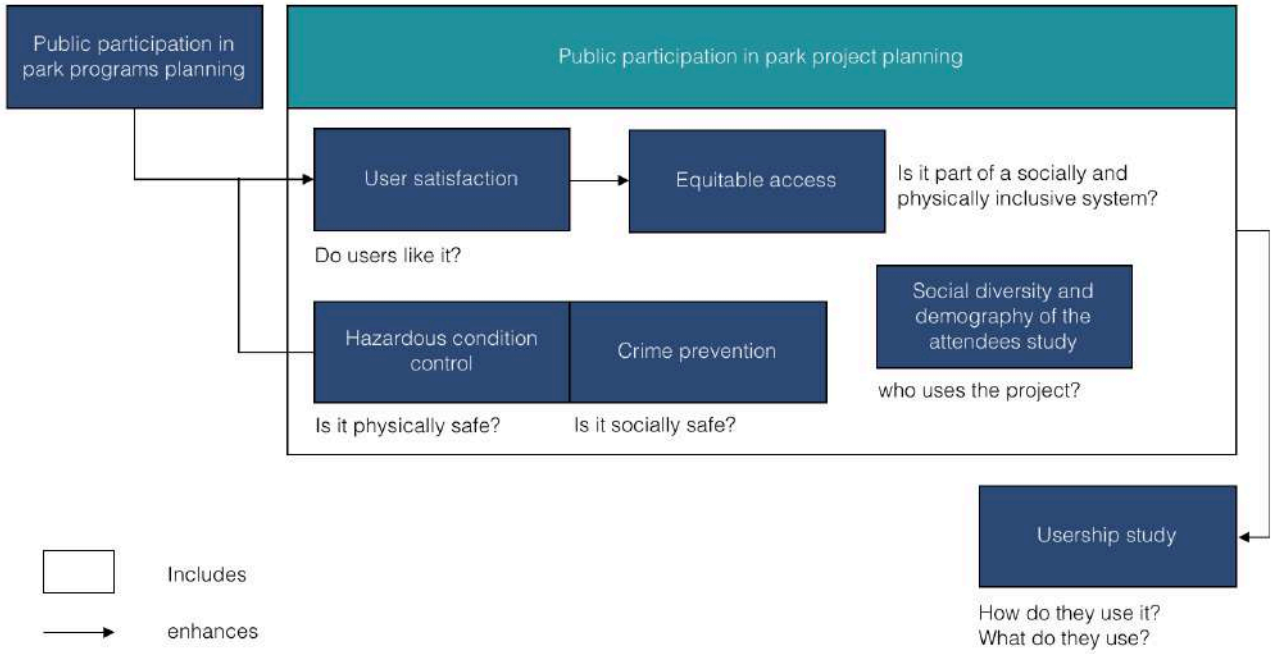


Fig. 30. Relationship and relevance of the system of variables.

As explained before, to reach a solid and valuable assessment framework, that takes into account the complexity of an urban reality, it's important to identify the relationships between the variable. This is the first step towards an assessment which aim is to discover relationships between sustainability dynamics, rather than assessing single variables separately.

For this reason, fig. 30 shows the relationships between social sustainability variables. The first immediately noticeable feature of the table, is that Public Participation in project planning includes many other variables like: user satisfaction, social diversity and demography of the attendees, equitable access, hazardous condition control and crime prevention. In fact, BOLD is a mean of extended public participation, if this is considered as indirect, raw and unconditioned say citizens have through their activity on social media platforms. Citizens are involved on a bigger scale, information is collected based on a bigger pool of behaviours, and this makes BOLD – especially concerning geo-located social media data - being more community-inclusive than traditional methods alone.

This analysis seems to reveal that BOLD indirectly enhances an extended public participation.

3. The decision making supportive tool

The study conducted so far on the High Line Park, was useful to understand how a relevant and representative example of landscape architecture project of re-use of obsolete or underused infrastructure performs in an urban context and how the use of BOLD could be useful to understand better its complex dynamics.

The final and conclusive part of this process is the construction of a decision-making supportive tool based on these discoveries, to help decision-makers assess and improve environmental, social and economic-related dynamics in such urban projects and neighbourhoods. The inclusive tables are reported in the appendix of this research (see appendix A, B, C).

As it can be noticed, the power of the assessment method is given by the fact that the BOLD assessment method includes both a more traditional approach - relying on municipal documents, fixed sensors, cadastral data and census analysis – as well as an innovative approach related to the analysis of social media data. Those have to be seen as complementary in defining a complete analysis of a project. From a first look at the three parts of the framework, it appears evident that the environmental component is assessable mostly through sensor data. The social component of sustainability is mostly assessed through social media data, while the economic component still relies on traditional census methods, as these are still considered the best option to assess these phenomena.

The aim of the framework is offering to managers an inclusive tool that could help assessing different case studies, in different contexts. This will open to a set of completely new considerations, through a theoretical exploration of possibilities and limitations that an inclusive framework will encounter. Some of them are:

a) The studied project has to be in a relevant urban area of the city: indeed, methods involving the use and study of social media data cannot be practically performed on projects that don't present a high level of social media activity in the immediate surrounding or that are not in highly frequented or inhabited areas. Indirectly, this means that there has to be a supportive urban system in the immediate surrounding of the project in order to make the framework applicable.
b) Some countries might have different social media platforms and related policies which might not correspond to the assessment done in the case of the High Line Park.
c) The project has to be of a certain relevance for the city, region or state. Big Data methods of planning might require intensive research activity and a lot of human labour. Indeed, the assessment is reasonable only if a good future potential is seen in its development.
d) The framework might be subject to changes, as the technological development of BOLD technologies runs faster than expected, with new technologies coming to place and immediately substituting the existing ones.

Keeping in minds its limitations, the method framework is essential to understand dynamics of in-operation projects. The argumentation of this research follows the line that this construct could help in assessing projects in their design phase as well. Indeed, as explained in the introduction the principal scope of the framework is using an on-going project as example to repeat or avoid certain successful or disruptive dynamics and apply the outcome to a project that has to be developed. For this reason, the selection of a case study in the Netherlands is presented in the following part of the research and it will serve as testing ground for the added value of the framework in assessing.

The following research part will answer the following: in which ways BOLD methods experimented in the theoretically-built framework could bring an added value to a case that needs to be developed? As it will be noted further on, social dynamics in the case study are the ones presenting the biggest issue for a successful development of the project, so the application will be focused on this aspect, once again revealing the complexity of social-sustainability related issues.

4. The decision-making supportive tool application: Rotterdam Hofbogen

In the following section, the theoretical framework is tested on the Hofbogen redevelopment case in Rotterdam. This process is designed from the perspective of a hypothetical manager with the responsibility of ensuring a successful project. Testing the validity of BOLD methods explored in theory is the main goal of this application, which is structured on two different levels:

1) Firstly, a process of analysis is introduced, where the Hofbogen re-development is described in its current situation and relevant issues obstructing a successful redevelopment are defined. In the analysis process, three relevant phases are identified:

1a) Definition of project features and current stage of development (chapter 4.1.1);

1b) Definition of neighbourhood features (chapter 4.1.2);

1c) Definition of stakeholders involved. (chapter 4.1.3)

The analytical process is largely based on traditional methods (interviews, web search and documentation consultation) to define the state of art before a BOLD intervention.

2) Secondly, a process of synthesis is outlined, where the BOLD method is introduced as the added value for the achievement of a more successful process. Three relevant stages belong to the synthesis process:

2a) Appraisal and ranking of involved stakeholders (chapter 4.2.1);

2b) Design of effective neighbourhood and project assessment model through BOLD (chapter 4.1.5);

2c) Design of effective stakeholder engagement through BOLD (chapter 4.1.6).

4.1. The Hofbogen case analysis

The analysis of the case will start with the identification of the relevant issues interfering with a successful sustainable development of the project. To this concern, social sustainability occurs as the most problematic issue. For this reason, the social sustainability aspect of the theoretical framework will be considered as possible solution to deliver a better outcome on the case study.

As the theoretical design has been largely tested on the HLP, a comparison between this project and the Hofbogen is drawn as added value to implement the process. This step is essential to understand how those projects relate to each other and in which ways it's possible to learn from past mistakes and repeat achieved successes.

4.1.1. A lesson from the High Line: BOLD as hard and soft data combined

The High Line Park analysis and results obtained are considered as a precious source of information and comparison. The overall table useful for the sustainability assessment of the project (see appendix B), expresses the action needed, followed by type of information required to complete the BOLD analysis of the issue.

Concerning the social sustainability part, which is the core that will be considered useful for the Hofbogen analysis, it is observable how social media analysis is the predominant BOLD instrument to analyse social dynamics around the redevelopment project. Registration, sensor and survey data are to a smaller extent contributing to the completeness of the method, and they complement the social medial analysis in assessing social sustainability.

These considerations are useful to set the definitions of what is "hard" and "soft" data in the analysis of the High Line Park study. Soft data are data coming from interpretation of social behaviours of citizens, that require a deeper reading and a large degree of interpretation (correlation) to identify phenomena. Hard data instead, is data coming from precise and numerical information based on sensors that deliver well defined results for well-defined purposes (e.g. measuring temperature on the project surface).

The combination of those two components defines the meaning of a BOLD approach: the study of urban dynamics is the sum of more qualitative considerations (correlation phenomena on social media analysis)

and quantitative measurements. Only if read in a complementary way, this information can deliver a complete representation of reality.

4.1.2. Definition of project features and current stage of development

Rotterdam Hofbogen is a 1,9-kilometer viaduct, first opened in 1907 as direct connection between Rotterdam city centre and Den Haag Scheveningen. It's a structure made by 189 archways running roughly northward out of Rotterdam and hosting mainly creative and artisanal activities and catering points. These activities were originally created as income generator for the viaduct's construction and exploitation (Hofbogen, n.d.). Due to its historical and artistic relevance (particularly the stucco ornaments), Hofbogen viaduct was declared National Monument in 2002: this put a milestone on the path towards a complete restoration and requalification of it.

Hofplein station, just 10 minutes walking from Rotterdam Central Station, is the southern point of the Hofbogen viaduct, and it is almost fully transformed in its arched part: redesigned glass facades have been installed under the vaults to improve the attractiveness of the place to bars, restaurants and cultural venues. A different situation concerns the Hofplein station roof, still rough and unfinished (Hofbogen, 2018). The last train transit on top of the station happened in 2010 and from then on, the area has been secured and cleaned to host temporary events on top (Hofbogen, n. d.).

Fig. 31. Hofplein station rooftop during the "Dakendagen" in Rotterdam depicted in a creative poster for the event. (Source: Rotterdamse Dakendagen).

Fig. 32. The Hofbogen viaduct south of Bergweg Station.

North from the starting point of Hofplein, Bergweg station has been fully renovated and rented to the Italian restaurant “Happy Italy”, currently one of the most relevant tenants concerned with the renovation process of the viaduct’s arched space.

On both northern and southern sides of Bergweg, a constellation of private activities is independently renting the majority of spaces below the arches. Entrepreneurs rent out the spaces from the owning housing associations cooperative (Vestia and Havensteder). The roof of the structure has been secured and restored by Pro Rail - the Dutch railway management company - which is the current owner of the upper part of the viaduct (2018). Housing associations and Pro Rail are willing to sell the structure to the best offer in the immediate future, while the Municipality of Rotterdam is interested in taking the full right to build on the rooftop. Even though some ideas of masterplan for a green roof have been designed from different professionals, Pro Rail still doesn’t allow a temporary occupation of it, by making the whole situation stagnant to experiments of transitory occupation.

In order to fully understand which parties are involved in the redevelopment, a full stakeholder study will be conducted in chapter 4.2.1. Thanks to this study, it will be possible to understand that a constellation of public and private dynamics has made finding a common ground for discussion harder.

4.1.2. Definition of the neighborhood features

The Hofbogen is situated in Rotterdam Noord: it stretches along Agniesebuurt from its southern end till Bergweg, while it runs between Bergpolder and Liskwartier in its northern end. Following a site inspection, it has to be noted that the project and the neighborhood dialogue with each other in different ways along the line of the structure.

For this reason, its current status concerning usership and physical shape can be read in four “blocks” (fig. 33). The northern part of the viaduct, from Gordelweg to Veurstaat, is mainly residential with little commercial activities on ground level. Commerce in this section is mainly on the western side and it is mostly made by artisanal shops and small warehouses for storage. From Bergweg down south towards Heer Bokelweg, the viaduct has been more attentively restored. In this part, all main retail activities are situated along Bergweg and Eudokiaplein, a small and lively square beside the restaurant “Happy Italy”. Residences with no retail on the ground floor are predominant in this section of the neighborhood, while higher-class retail, architecture studios and artisanal shops are renting underneath the arches facing social housing residential properties. South of this part, there is a small section where catering venues and artistic clubs are situated. Finally, the southern part of the viaduct, south of Heer Bokelweg, has recently been renewed to host mostly high-end catering activities.

It’s evident at first sight that the structure is a massive physical presence, which could represent a barrier between the two neighborhoods. With this mind, the spaces underneath the arches become an essential mean to re-connect the project to the surrounding neighborhood and its activities in the smoothest way possible.

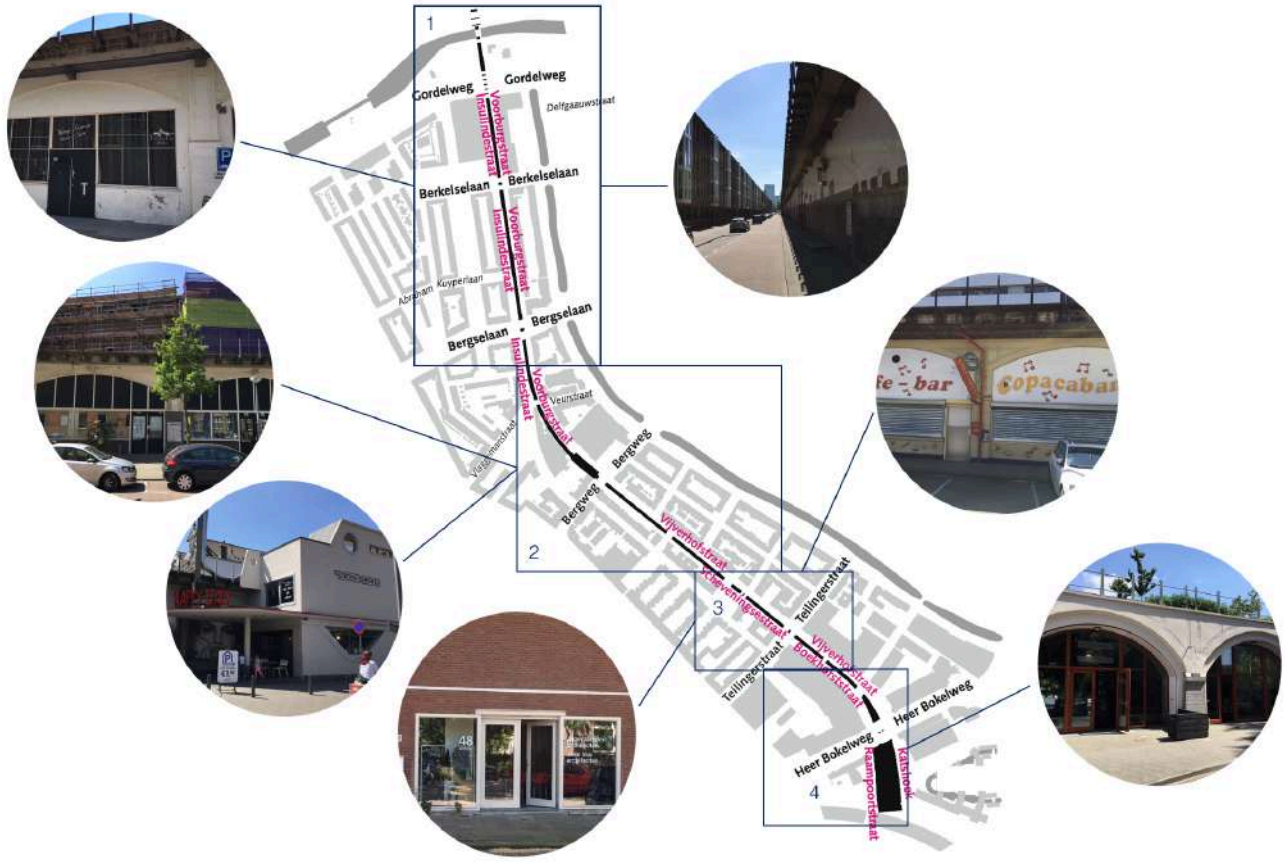


Fig. 33. The Hofbogen in its relationship with the surrounding urban environment. In quadrant 1: small artisanal shop on the west side, a trait characterized by a continuous wall on the east side. In quadrant 2: ERA Contour redevelopment project and the Italian restaurant Happy Italy. In quadrant 3: A high-end architecture studio and a pub. In quadrant 4: the fully renovated arched space of the Hofplein station. (Source: own picture)

The analysis identifies the complex relationship between project and surrounding neighborhood: some portions of the viaduct are constituted by walls facing residences, while other segments are populated by high-end shops, restaurants and boutiques. This functional fragmentation is surely reflected in a physical division: an alternation of full and empty spaces, of fully renovated and dismissed locations, dramatically defines the urban infrastructure.

A big part of the housing stock in the immediate surrounding is owned by the housing association cooperative Hofbogen BV (Crimson Architectural Historians, n.d.). This situation has been the main reason for these parties to purchase the arches underneath the structure. This clear sign of a so-called market-initiated project though, shouldn't prevent the project from being an example for public participation, involving local residents and tenants (Straub, 2012).

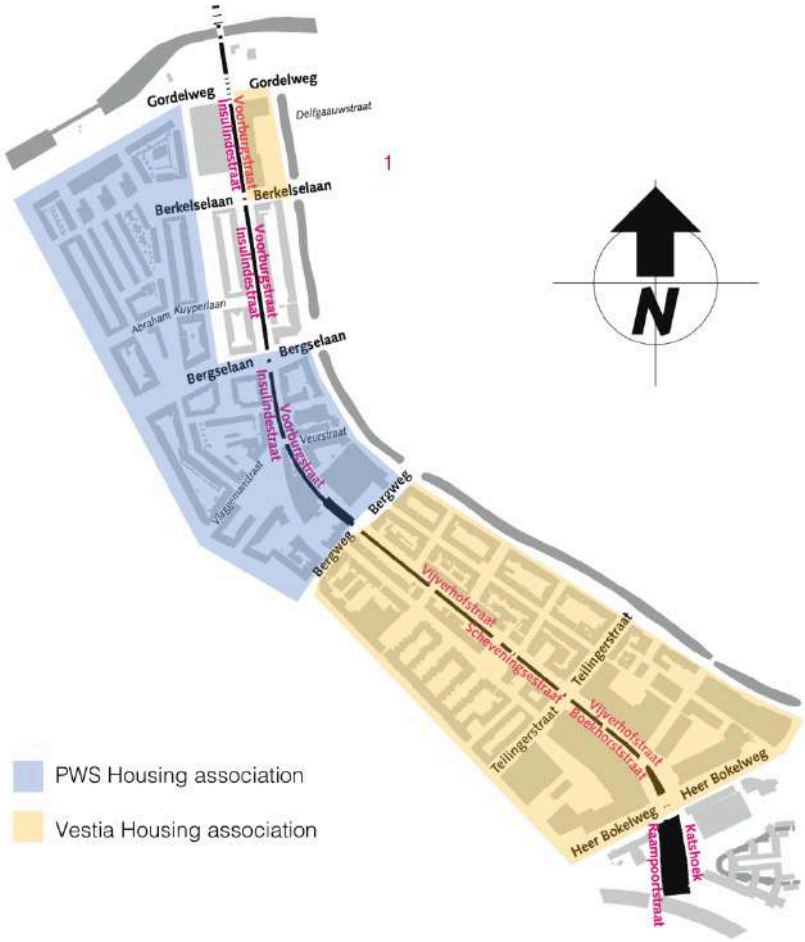


Fig. 34. Housing association ownership relevance in Hofbogen immediate surrounding.
(Source: Crimson Architectural Historians, n.d.)

The strong presence of housing association stocks in the surroundings has been the main reason for these parties to purchase the arches underneath the structure. This clear sign of a so-called market-initiated project, shouldn't prevent the project from being an example for public participation, involving local residents and tenants (Straub, 2012).

Hofbogen and High Line Park: a comparison

Daan Wesselman (2017) has noted in his book "Deconstructing the High Line", that the development of the project in Chelsea, New York, has served as "touchstone for a spate of post-industrial urban redevelopment projects around the globe" and that one tangible example is certainly found in Rotterdam Hofbogen. When the project was at its starting point in the process of re-definition, Crimson Architectural Historians (2008) spotted the immediate comparison by stating that the Hofbogen was explicitly asking to be read in the light of the High Line, amongst all other key international reference points for comparable redevelopments.

If these two projects are certainly comparable, to a certain extent, it is also evident that they are far by being the same typology of infrastructure: Hofbogen is mainly made of reinforced concrete, with some surface stucco decorations, and it's readable on two levels: the arched space and the rooftop cover. This situation contributes to the challenge of defining a clear ownership: while the High Line is entirely owned by the municipality of New York, the Hofbogen viaduct arches had been purchased by a partnership between Vestia and Havensteder (Hofbogen BV) in 2006. Instead, the upper part is owned by the Dutch railway management company Pro Rail. In 2008, almost simultaneously with the opening of the HLP, a study was initiated to bring stakeholders together towards a common vision for the project, and the idea of a solid requalification started.

To a certain extent, the Hofbogen has been compared to the Promenade Plantée, in Paris. But while the latter is highly oriented towards creating a green and resting pleasure space, in a neighbourhood that was already at its desired development, the former represents a declaration to make a step further in a totally different context. Rotterdam Noord requires a further development of activities, shops, restaurants, entrepreneurial initiatives that can improve the neighbourhood connectivity: as Wesselman (2017) remarks, a park alone in Hofbogen "would probably not be enough connected to the existing urban context". The difference between

the Hofbogen and the Promenade Plantée in Paris go beyond the ideological aspect: politically speaking, the project in Paris was completed in a decade (the nineties) where public parties' resources where still enough to only satisfy the desire of having a pleasant and green public space with less private participation.

Considering the diverging points, when it comes to comparing the Hofbogen and the High Line Park, it's not really about the architectural dimension. It's more about the effect that those infrastructures can generate in contributing to the recovery of post-industrial or, at least, less central areas. Indeed, both projects represent one of the possible solutions both Rotterdam and New York have or have had to invoke the associate discourse of gentrification and the creative city (Wesselman, 2017). The physical presence of their structure though, can be tricky to deal with in its relationship with the surrounding urban space: the idea of an elevated structure, "observing" the city underneath, can produce negative externalities if the development is not completed in a sustainable way.

Despite this similarity, the neighbourhoods in which they are located still show some relevant differences: Rotterdam Noord still hasn't emerged as gentrified neighbourhood as much as West Chelsea had done with all the development plans started during the eighties and even before. This aspect, might represent a limitation for the method application on the Hofbogen, as less venues, tourist attractions, started redevelopments surely produce different dynamics.

4.1.3. Definition of stakeholders involved

In this chapter, all stakeholders involved in the re-development of the Hofbogen are identified and categorized according to their “role” and “goals”.

STAKEHOLDER	ROLE	GOALS
Municipality	Right of building and managing the roof (> 2018)	1. Deliver quality space for citizens 2. Obtain right to build on the roof (>2018)
Vestia (Housing Association)	Owner of arches in partnership with Havenstender	1. Deliver quality space for tenants in surrounding areas and make arches profitable spaces 2. Intention to sell its permises (>2018)
Havensteder (Housing Association)	Owner of arches in partnership with Vestia	1. Deliver quality space for tenants in surrounding areas and make the arches a profitable space 2. Intention to sell its permises(>2018)
ERA Contour	Developers involved in the project "One Block City"	Create quality spaces for residents: possibility to create terraces on roof
Prorail (railway company)	Owner of the roof	1. Deliver a leakage-free structure 2. Doesn't allow temporary use of the roof to local entrepreneurs 3. Intention to sell its permises (>2018)
Ministry of Culture, Education and Science	Heritage protection	Preserve cultural value of the historical arches
Cooperatives and society organizations	Social Value protection	1. Preserve community value 2. Improve neighborhood characteristics and indirect economic return
Citizens	Direct interest in quality of space	1. Preserve community value 2. Improve neighborhood
Local entrepreneurs	Tenants arches	1. Increase business opportunities 2. Improve neighborhood
Crimson Historians	Project advisor	1. Improve neighborhood and project urban value

Tab. 35. Stakeholders’ goals analysis. (Source: own table)

The most relevant stakeholders for this project are surely the current owners: the Hofbogen BV, the housing association private cooperative. Hofbogen BV is the owner (2018) of the arched space since 2006. The housing association has tenants under the arches of the structure, but also a discrete number of tenants in the immediate surrounding, which will be undeniably impacted by the project redevelopment. Hofbogen BV’s ultimate aim is to sell the entire viaduct, a valid reason to hand in the whole property at its best condition: this means investing in thriving enterprises, attracting sufficient visitors, and delivering a well-functioning building.

The Dutch railway maintenance company ProRail, on the other hand, has a totally different ambition for the rooftop management. It’s interested in selling the rooftop to a third party on a relatively short term. It seems that the company doesn’t have interests in supervising the future development of the viaduct. Another minor private party is represented by ERA Contour, the developer involved in the project “One Block City”, a project of requalification of the block of flats called “Spoorpunt” (nearby Bergweg Station). ERA Contour is interested in using part of the adjacent Hofbogen viaduct and develop some outside spaces for the residential units (Heurkens, 2018).

Local entrepreneurs that rent the arched spaces represent an important voice coming from the private side. They are interested in a successful development of the viaduct overall, as they are completely involved with their commercial activities underneath the arches, but some of them in the immediate surrounding as well. A successful realization of the rooftop will certainly bring more clients to their activities, so their interest goes beyond the mere commercial space they are renting out from the housing associations. Some of them are

interested in expanding their activities on the rooftop, while all of them should be interested in the achievement of a successful rooftop plan development.

Amongst the public parties, the municipality plays a major role. Its interest of maintaining the rooftop as a public area, in order to deliver quality space for citizens is certainly a priority. After 2018, they will be granted the right to build on the rooftop (independently from who will be the future owner), which in the case of community-led development will be directly appointed to the community. This is possible thanks to the transfer of the "right to build" permitted by the Dutch law (an insight on this development strategy will be given later in this chapter). A minor, but authoritative, stakeholder in the public is the Ministry of Culture, Education and Science: they listed the project as national monument in 2002, thus playing a key role in a rigorous preservation of the whole structure.

In between private and public parties, stand cooperatives and society organizations. The interview with Heurkens (2018), assistant professor in Urban Development Management at Delft University of Technology who suggested a model of redevelopment for the Hofbogen case, has revealed the major problem of public participation in the process: bigger parties don't share a common vision, and they have limited possibilities of confrontation. Moreover, a substantial disparity exists between the willingness of citizens, cooperatives and local entrepreneurs to actively participate in debates, even when they would be given the possibility to do so.

Amongst other minor stakeholders, Crimson Historians consultancy firm stands as a project advisor, interested in the historical evolution of the project over time. They specifically focus on the refurbishment of the roof of Station Hofplein.

The main civil actor in Hofbogen is represented by the "Vrienden van de Hofpleinlijn". This resident-group was set-up in 2009 by associates of the Bewoner's Organisatie Liskwatier. This group of external civil-actors is highly interested in the re-development of the Hofbogen and is seeking a co-creation relation with the Hofbogen BV. The group has also organized some events for their members concerning the re-development over the past years. (Straub, 2012)

As it can be noticed from this first analysis of the project, this multitude of stakeholders and different goals makes it harder for the project to kick off. Nevertheless, it is still possible to define a common path and make all parties aware that different goals could in any case be transformed in the shared ambition of leading to a satisfactory result for multiple points of view.

In the next session, an overview of the suggested projects and proposals is made.

4.1.4. Re-development proposals and the problem statement

At the moment, some rules for a green development of the roof have been set. These directions, from a mere urban planning point of view, include:

a) Continuing the green line, which has to be minimum the 25% of the roof width
b) Continuing the path, that also has to be minimum the 25% of the roof width
c) Free completion of ideas coming from local community and entrepreneurs (50%)
s) All remaining parts have to be "green".

(Heurkens, 2018)

Despite some design ideas for redevelopment, Heurkens (2018) points out the difficulties in achieving a common goal and agreement amongst stakeholders. The main issue concerning this project is not related to its design, but rather on the way parties should be socially, legally and financially involved. To this purpose, Heurkens (2018) suggests two financially and legally feasible strategies for the future development of Hofbogen, one of which is directly inspired by the High Line Park model. These two strategies are:

Strategy 1. Community-led: a model inspired by the High Line Park and based on the "right to challenge". In this case, citizens could take over the "right to build" from the municipality and redevelop and maintain the roof. Legally, Rotterdam municipality passes on maintenance of the roof to the Hofbogen Cooperation (Housing associations) with local community members, renters and entrepreneurs. The roof would be financially maintained through public funding, subsidies, crowd-funding, co-financing by entrepreneurs that make partial use of the roof.

Strategy 2. Community/corporation-led: this model is based on the "right to bid": community and corporations with social responsible goals buy the entire Hofbogen object as the "Hofbogen Cooperative". The roof part would be public or semi-public and maintained by the cooperative, following a financial model mostly led by private funding.

Both solutions are effective in including the community in the realization of the project, involving genuine forms of public participation from both legal and financial points of view. Nevertheless, both suggestions could be socially sustainable on the long term only if broader means of community inclusion are developed. What this means, is that a real form of public participation (in its broader meaning) is not necessarily reached by applying a community-led form of development, as the lesson learnt from the High Line Park has shown. Even though in the High Line case the community has been involved from the beginning, it's not deniable that governance and stronger parties' interests have taken the lead over time. Indeed, the unstable balance between neighbourhood bosting role, and project for the community seemed to have been lost along the way. Community involvement on the HLP had been based on meetings where representatives of the community were too few to represent the overall wishes and ambitions. Yet, community-led developments don't always produce the effect of considering the whole neighbourhood social dynamics. A better frame of action would be needed to ensure an effective redevelopment.

4.1.5. Limitation of traditional approach in the Hofbogen case

Limitation of traditional methods are evident on the Hofbogen case as well. Meetings between stakeholders, interviews are often not as effective as they should be: they are time-consuming, they usually prioritize certain elites, they are not based on tangible facts and they don't offer valid instruments to facilitate information disclosure. Concerning the Hofbogen project, citizens have been represented by only one member at meetings with other stakeholders involved (Heurkens, 2018). Cooperative groups and associations are also representatives of elites, and not of the whole societal class: this is true for the High Line, and it is also true for the Hofbogen. For instance, "The Friends of the Hofbogen" is an association made by members of the highly-educated middle classes living north of Agniesebuurt, which might not represent the willingness of the whole society living in the immediate vicinity of the project (Heurkens, 2018)

To this purpose, a complete community-led approach is reached only when these limitations are overcome and when neighbourhood dynamics and expectations are clear to all parties involved. This includes:

- Overcoming problems of participation typical of weaker stakeholders (citizens, entrepreneurs and cooperatives). Those parties need a form of inclusive public participation, that gives them the opportunity to suggest proposals and participate to the many phases of the development.
- Overcoming apparently different ambitions and helping them defining a common goal. This is done by showing that the redevelopment could be beneficial for all parties involved (spin-off effect).
- Overcoming the traditional vision according to which sustainability components are defined a priori and by considering separate and not interconnected parameters and evaluation measures.

At this point, the question is: How can we enhance these aspects with the help of the BOLD framework described in theory towards the achievement of a more socially sustainable project?
BOLD can step in as a method to combine a more fixed and limited assessment with a more dynamic overview on urban issues.

At the time of the final writing of this research (June 2018), the rooftop of Hofplein station has opened with a temporary and not extensive solution of green open-air park: the Luchtpark. This initiative might look like a step forward trough the realization of the new "High-Line", but as some journal articles argue, it looks like "citizens have still to wait a longer time to be able to walk their way through the whole path" (AD, 2018).

Let's explore how to make this time as short as possible.

Fig. 36. The Luchtpark on the Hofplein station. (Source: Twitter)

4.2. Towards a BOLD method to achieve a socially sustainable project: the synthetic managerial process

At this point, the process of synthesis begins with the acknowledgement of the help that BOLD can give to achieve a more sustainable project. The role of the manager (or consultant) becomes extremely important as provider of a solid innovative solution to previously explained issue. The process is defined as follows:

1. Appraisal of the stakeholders involved: recognition of their actual power and identification of gap between actual and future involvement

2. Data collection on the neighbourhood to assess social sustainability

3. Stakeholder engagement through BOLD

4. Final participatory model

4.2.1. Appraisal of the stakeholders involved: from lack of participation towards an inclusive participation

The process starts by considering the stakeholders assessment previously done and defining the impact the project will have on them and the influence they have on the project. After this assessment it's visible how BOLD can help some of the weak ones realizing the important transition from powerless to empowered.

STAKEHOLDER	ROLE	IMPACT	INFLUENCE
Name and function	What is their role in the project?	How much does the project impact them? (low/medium/high)	How much influence do they have on the project? (low/medium/high)
Municipality	Right of building and managing the roof (>2018)	High	High
Vestia (Housing Association)	Owner of arches in partnership with Havenstender	High	High
Havensteder (Housing Association)	Owner of arches in partnership with Vestia	High	High
ERA Contour	Developers involved in the project "One Block City"	Medium	Low
Prorail (railway company)	Owner of the roof	Low	Medium
Entrepreneurs	Tenants arches	High	Medium
Cooperatives and society organizations	Social Value protection	High	Medium
Citizens	Direct interest in the neighborhood	High	Low
Crimson Historians	Project advisors	Low	Low

Fig. 37. Diagram for stakeholder's appraisal (Source: own table).

Based on the previous assessment table, all stakeholders involved can be appraised through a matrix where their impact and influence are visible. The chart is an impact-influence matrix where each of the involved stakeholders have been placed according to the actual level of influence they have in steering the project and the level to which decisions concerning the project affect them.

The matrix is composed by four quadrants, each for one category of actors:

- *Authorities*: the parties that have a certain degree of influence on the project but are almost not impacted by decisions concerning it. The Ministry of Culture, Education and Science belong to this category, as they are only responsible for a well-thought-of use of the structure that is a national monument.

- *Decision-makers:* above the authorities, those are actors that currently stand in the best possible position: they have, or will have, high influence and they are interested in taking responsible decisions as the project will have a high impact on them. In this category we find the municipality of Rotterdam (even though it doesn't have the right to build yet), and the owners of the arches (Vestia and Havensteder). Despite the Municipality will enter the project in a future stage, and the Hofbogen BV wanting to sell its premises to a third party, both stakeholders will continue to be influenced by the decisions concerning the re-development. Pro Rail has a rather high influence at this stage (2018), but the project re-development won't have a great impact on the company as they expect to sell and not being involved in any further redevelopment plan. For this reason, Pro Rail positions quite low on the decision-makers diagram.

- *Spectators*: Those stakeholders still have a low or really low influence, but they will be, generally speaking, hardly impacted by the project. Citizens and entrepreneurs, for instance, are concerned

by future developments of the project, but they still don't feel involved as expected from them. This represents a paradox to be solved in the following phase.

- Outsiders: stakeholders that have a low influence level and basically won't be impacted by the realization of the project. In this category we could find consultants (e.g. Crimson Historians)

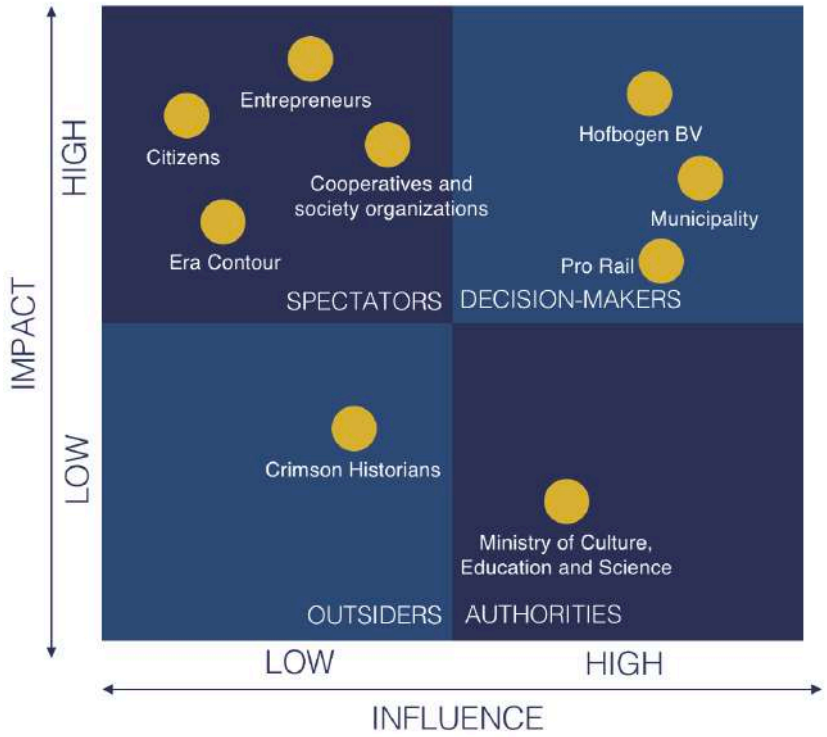


Fig. 38. Stakeholder appraisal. (Source: own drawing)

According to what has been stated in the previous chapters, citizens, local entrepreneurs and cooperatives should belong to the process of decision-making, thus being moved from the left part of the diagram towards the right end. This process comes with the analysis of stakeholders' needs:

- Authorities: need to supervise development stages in order to ensure respect of the monumental value
- Decision-makers: need to take action and step in as soon as possible to grant social sustainability of the project.
- Spectators: need empowerment tools to actively contribute in creating a sense of community and socially accepted project.
- Outsiders: need clear picture of project functioning to intervene with suggestions
- Authorities: need to supervise development stages in order to ensure respect of the monumental value

4.2.2. Towards Public participation and stakeholder alignment through BOLD

In this phase, the study of the High Line turns out to be particularly useful to understand the importance of stakeholder involvement on a broad scale and stakeholder goal alignment. Some of the social housing residents in West Chelsea, still perceive the High Line as an "alien object". Indeed, the model of inclusion deployed at early stages has seen more the participation of the cooperative members and not a capillary inclusion of citizens. Moreover, this participatory model has shown its lacks over time. These aspects are part of the dissatisfaction expressed by some citizens in West Chelsea. To this concern, BOLD could bring public participation "to the door" of every citizen at early stages in the Hofbogen but could also provide a solid and inclusive participatory model over time.

Public participation in park project and programs planning from a BOLD perspective

How can public participation be enhanced through available BOLD means?

Traditional forms of involvement – especially for citizens and entrepreneurs - have shown their drawbacks in the Hofbogen project. Thus, what BOLD has to offer is a more inclusive participation through:

1) *Twitter*: Social media data can be used as an *indirect* form of public participation, where natural users' behaviours are observed from top: raw data are collected, and decisions are made based on these results. The exploration of Twitter methods designed on the HLP is valid in this case, but more is needed when reduced amounts of quantitative data are available (due to different neighbourhood characteristics): an "soft" exploration on neighbourhood discussions through social media. These processes will be better defined later on.

2) *Open forums*: To achieve a higher level of *direct* public participation, opportunities arise with a possible use of open forums to discuss relevant issues from multiple perspectives: not only citizens, but also all other stakeholders involved could participate and express their opinions per topic and on a constant basis. The power of this tool is the extended and quite democratic accessibility from all parties involved. Further explanation on this concept will be given in the participation model description (chapter 4.2.4).

3) *Living labs:* this concept becomes particularly relevant in a project design phase. Exploring urban solutions on spot can produce more effective and useful results. Thanks to the living lab experience, community members and other stakeholders have the chance to confront each other indirectly (through shared information collection based on the open forum) and directly (through live meeting in the urban environment where data are discussed).

The integration of these means will be explained in the final solution model. Fig. 39, shows the switch that is allowed by the deployment of these means of participation: from the situation described in fig. 38, towards a condition of weaker stakeholder participation and involvement. BOLD can be used as an instrument to facilitate the shift from left to right in the diagram: spectators have to be empowered and included in the decision-makers category.

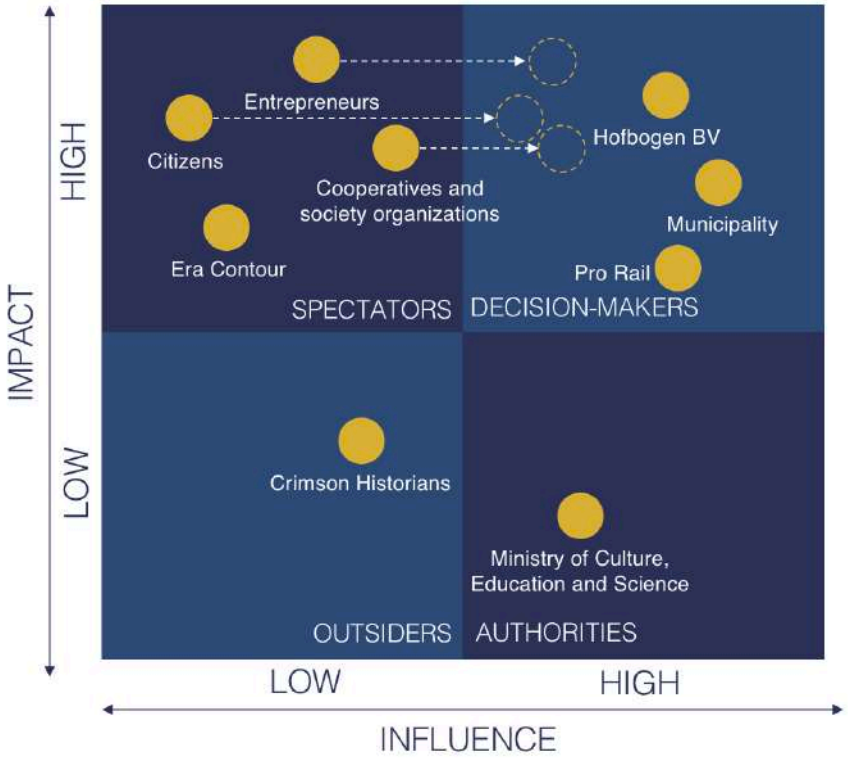


Fig. 39. Stakeholder empowerment through BOLD representation. (Source: own drawing)

4.2.3. Data collection by action-takers

The first step of the process to integrated decision making and stakeholder alignment involves data collection on the neighbourhood and project performance. At this stage, public and private decision-makers are involved: Municipality, Vestia and Havensteder, which have to take the role of action-takers at an early stage, to start the assessment of the present situation on the project and the neighbourhood. These parties' have to perform:

a) A "Hard-data" and "soft data" combined collection (based on table in appendix B): quantitative and qualitative information on the neighbourhood and project social sustainability. Usership satisfaction, usership study, social diversity, hazardous condition control and crime prevention are assessed through the techniques explained on the High Line case, deploying teams of computer scientists and IT experts.

b) A "Soft-data" collection: qualitative information on the neighbourhood and project-related mood and feelings through social media. In this phase, consultation of social media pages helps having a clearer idea on what people perceive, think, do or even would prefer doing in the neighbourhood, by identifying patterns of issues and successes already achieved.

These two processes of data collection represent an indirect form of public participation: citizens' natural behaviours (e.g. the spontaneous use of social media platform to express feelings, emotions or desires) are taken into account. This process certainly represents an innovation: it is possible to have on a desktop page a collection of moods and an expression of different behavioural and unbiased patterns. This can help building a new form of capillary citizen engagement.

a) The project and neighbourhood hard and soft data collection through BOLD

As a first step of the strategy decision-makers have to take the lead in conducting a BOLD analysis of the neighbourhood. This analysis starts with the first steps of the development, to have a clear picture of neighbourhood dynamics, but it's not limited at the first stage. The assessment turns out to be useful also when deployed over time, through different stages of the development. Municipality and housing associations are responsible for this process, and they can each conduct an analysis on their own to collect data and have their own interpretation of the problem from different perspectives. Following the next stages of the process, sharing results becomes a basic ground of confrontation for the first discussion meetings. This will help decision-makers setting goals, ambitions and targeting the project toward realistic and suitable expectations.

The neighbourhood BOLD social sustainability assessment tool, designed in the first part of the research (appendix B), is used with the purpose of collecting hard data for the analysis of the neighbourhood, and it's reported in tab. 40. The result of this assessment offers an analytical basis to start the discussion in meetings between Municipality and Hofbogen BV.

	PARAMETER	DESCRIPTION	ASSESSMENT	VARIABLE	BOLD TOOL			PARAMETER	ACTIONS	STAKEHOLDER ACTIVELY INVOLVED
					REGISTRATION / SURVEY	SENSOR	SOCIAL MEDIA			
SOCIAL ASSESSMENT OF PROJECT AND NEIGHBORHOOD	USER SATISFACTION	User satisfaction level against project and neighborhood	Assess user satisfaction level with park features	Level of user satisfaction			Twitter	1. Tweet content 2. Twitter usage density	1. Identify project neighborhood borders 2. Perform Collection of data on Twitter (Tweet content + Tweet density) and compare outcomes with urban features of places on Google Maps	Hofbogen BV Municipality
	USERSHIP STUDY	User behaviour against project and neighborhood	Assess user behaviour against project premises and in surrounding neighborhood related to *how* the project is used and *what* is used on project and neighborhood	Number of location check-ins			Flickr and Google Photos	Venues check-ins	1. Identify project neighborhood borders 2. Perform Collection of data on social media (trajectories through picture sharing) and compare outcomes with urban features of places on Google Maps 3. Identify urban paths by specific themes and compare it to attractive places identified in "User satisfaction" section	Hofbogen BV Municipality
				(a) User displacement; (b) Radius of gyration; (c) Return probability			Foursquare	Venues check-ins -		
	SOCIAL DIVERSITY	User diversity and demography on project and neighborhood	Assess user diversity on park permises and surrounding neighborhood, related to *who* uses the park	(a) Place Serendipity level; (b) Place Brokerage level; (c) Place Entropy level; (d) Place Homogeneity level			Twitter Foursquare	Contacts network Venues check-ins	1. Identify project neighborhood borders 2. Perform Collection of data on social media platforms and compare outcomes with urban features of places thorugh Google Maps to identify top bridging and top bonding places 3.Establish usership dynamics in relation to who uses the park 4. Monitor development of bridging places to increase social diversity	Hofbogen BV Municipality
	EQUITABLE ACCESS	Inclusive spatial and social distribution of project premises	Assess spatial and social distribution of park permises by identifying if system of green can be designed and if sufficient connections between project and surrounding neighborhood are identifiable	Level of park attractiveness, attendancy rates in combination with park physical and social features			Twitter Flickr	TUD (Twitter usage per day) FUD (Flickr usage per day)	1. Identify project neighborhood borders 2. Identify neighborood green areas 3. Collect social media data on parks' usage 4. Perform social analysis of neighborhood and park usership to classify green areas 5. Perform spatial analysis of neighborhood and public transportation system to assess accessibility 6. Determine whether park system is achievable and adds value to the project	Hofbogen BV Municipality
					Cadaster Census		-	Park typologies and land distribution		
	POTENTIAL HAZARDUOUS CONDITIONS CONTROL	Control over potentially dangerous project and neighborhood temporary or permanent features	Monitor and reduce potential hazarduous conditions on project permises and in project neighborhood	Number of reported issues			Google Widget form	Number of crimes reported	1. Identify project neighborhood borders 2. Perform Collection of information through Widget form to identify issues 3. Associate issues to urban areas thorugh Google Maps to solve issues 4. Keep record of major neighborhood issues over time	Hofbogen BV Municipality
	CRIME PREVENTION	Control over crime on park and surrounding neighborhood	Monitor crime and increase safety on project permises and neighborhood	Number of tweets expressing fear			Twitter	Tweet content	1. Identify project neighborhood borders 2. Perform social media analysis (Twitter) to detect perceived sense of fear in the neighborhood 3. Utilise effective light settings to prevent escalating behaviours 4. Cross reference change in crime rates with police reports to monitor results of pro active measure	Hofbogen BV Municipality
				Number of crimes reported under different light settings	Police crime reports	Cameras in changing light settings		Crime rates on different light settings		

Tab. 40. Assessment of social sustainability on Hofbogen project and neighbourhood. (Source: own table)

For all the following variables, the neighbourhood borders identified include Agniesebuurt, Bergpolder and Liskwartier in Rotterdam Noord. Data collection refers to:

A1) User satisfaction

Identifying which neighbourhood areas and which activities or venues below Hofbogen arches are more satisfactory or popular than others can give a useful overview on strengths and weaknesses of both the existing project and the surrounding neighbourhood. Citizens' feelings are observed through Twitter in most relevant venues.

A2) Usership study

Identifying in which way the neighbourhood is used and which venues are more connected than others is useful when it comes to understanding what the project's points of strength should be, and eventually which connections should be enhanced. In particular, an usership analysis as applied on the High Line Park gives an insight on relationships between places. Some limitations are evident in Rotterdam. In a neighbourhood that still hasn't seen its full development process, it might be harder to retrieve such data coming from pictures shared on Google Photos, Flickr and Foursquare, due to the reduced number of users. If a complete vision on the neighbourhood might be challenging to obtain, what can be more easily observed are the relationships between the neighbourhood and a broader area in Rotterdam. This information is useful to understand for instance which part (northern or southern) of the project would be more frequented by visitors, and from which part of the city they would come. The extended usership study, through its ability to captures trajectories of visitors flows, represents an innovation for planning: a higher potential of certain traits of the viaduct will indicate that those will need further design improvements or additional accesses.

A3) Social diversity

Social diversity identification in Rotterdam Noord venues also requires a substantial use of Twitter and Foursquare. The method described on the High Line case can be applied on the bigger scale in Rotterdam Noord. The social grid of Twitter users is indeed identifiable, as well as comparable with Foursquare check-ins. Through place entropy level and homogeneity level it is possible to understand whether neighbourhood

venues are only used by people that already know each other (neighbourhood inhabitants) or also people that are not socially linked to each other (neighbourhood inhabitants and strangers or visitors are coming together). Through levels of brokerage and serendipity it's possible to detect if connections between those visitors are enhanced or inhibited. Compared to a mere study of traditional land use plan information and directions, the assessment of how the neighbourhood is changing is the added value of this technique: observing social media activity leads to a major shift from a fixed situation to the assessment of changeable patterns. This tremendous contribution shows how the city analysis is shifting from a priori assessment to dynamic assessment over time, not only based on traditional registration data (highly reliant on who inhabits the neighbourhood "here" and "now") but measuring, for instance, who the neighbourhood is going to attract in the future: this instrument can be used as one predictor for gentrification in the neighbourhood.

On practical terms, thanks to this method, it is possible to check on the cadastre venues typologies and then confront with a Twitter-based definition of which venues represent "bonding" or "bridging" places (Hristova et al.) and striving towards a change of land use plan that includes the creation of more bridging places, where people from different backgrounds can meet, exchange experiences and information.

A4) Equitable access

This assessment is based on Twitter and Flickr user analysis for the assessments of park visitors. This can lead to explore possibilities to create a park system and eventually reconnect fragmented green areas into a more inclusive green scheme. The lecture from the High Line though, can teach that a system of parks makes sense only if the right parks are made part of it. The area in the immediate surrounding of the Hofbogen is rich in playground areas, which are mainly frequented by local young kids and families: the idea of integrating the main green infrastructure with neighbouring facilities might be then not achievable if looking at the smaller picture. Nevertheless, the method is used by decision-makers to have a broader picture on possibilities offered by the neighbourhood green system. A valid system of bike lanes and pedestrian connections are already part of the neighbourhood, and it has to be ensures and developed further to reach out to new opportunities to make it an easily accessible structure for pedestrians. The streets running besides the project are mostly slow mobility or neighbourhood streets, but no direct prioritization for bikes or pedestrian is appointed. In a scenario where the neighbourhood dimension is considered, where the project is seen as booster for improvements that go beyond the park's borders, possibilities should be considered to integrate to the rooftop redevelopment with a redevelopment of public spaces alongside the viaduct. This analysis aims at identifying those opportunities, which compared to the existing land use plan and physical dimension of the city gives a clear perspective: it is not only the single viaduct redevelopment that matters to reach a sustainable perspective. What TUD (Twitter usage per day) and FUD (Flickr usage per day) reveal in public spaces around the Hofbogen is the extent to which those places are frequented in relation to the number of visitors that frequent the Hofbogen. This procedure gives a dynamic perspective that can also be reported to variables like "hours of the day", or "visitors attendance rates in rainy days", factors hardly measurable with traditional means.

A5) *Potential hazardous condition control*

The municipality in Rotterdam already has a system built for citizens to report issues concerning public safety (https://www.rotterdam.nl). This system has some limitations concerning the non-integration of spatial and political dimension: issues are identified in precise urban locations, but a lack of prioritization of issues might represent a problem to have an immediate and solid response. The added value of a BOLD method described in the general framework through the use of a Widget form gives a positive outcome concerning this specific aspect. A BOLD method deploying Google Widget form questionnaires allows an efficient integration of spatial dimension and reported issue, with a special concern for prioritization. This aspect contributes to time savings in the first phases of the assessment and it's particularly useful over time, when prioritization of issues concerning hazardous conditions are particularly important.

A6) *Crime prevention*

Control over crime in the neighbourhood is more effectively done through Twitter sentiment analysis used in combination with police crime reports. Rotterdam Noord along the Hofbogen doesn't present evident and critical safety problems at the moment. What could play a role in keeping this level of safety constant and preventing the escalation of aggressive behaviours, even when more people would be attracted to the neighbourhood, would be the use of proper light setting, such as identified in De Escalate project in Eindhoven, to establish a feeling of safety. This works especially along traits of the viaduct where luminosity is not at optimal levels (e.g. under the arches or in points where there are long segments of wall and a feeling of being unsafe might prevail).

While on the High Line Park, it has been shown that safety is not a problem at all on top of the park, this effect is reached through a persistent patrol of the area by guards and cameras. Going beyond this "privatization" of the safety issue should be a goal in the Hofbogen project, which has to be extended and monitored on a bigger scale than just the project. There has to be no substantial difference between how a citizen feels on the rooftop or in the street to reach it by night: that's also one of the fundamental steps towards the achievement of a process that brings as a result a democratic acceptance of it by all layers of the society.

Through this type of data collection on the neighbourhood through social media analysis, an indirect way of enhancing public participation is achieved. Usership studies, correlations between venues, citizens preferences, are all observable and serve as a solid indirect basis to understand in which ways the project will potentially perform in the neighbourhood. This method doesn't only involve locals, but whoever leaves a social media trace concerning the neighbourhood or the Hofbogen project, by making it an even more inclusive view on possible future developments. The negative aspect of this form of public participation, is that only active citizens on social platforms might have a say concerning their preferences. But this is only a first step towards an inclusive form of involvement, which also entails a more qualitative analysis on the neighbourhood, still performed by decision-makers. Before digging into the explanation of this analysis in the Hofbogen case, the concept of qualitative and quantitative issues integrated is explained in the following section.

Hard and soft data combined analysis

During the course of this research, BOLD has often been defined as a tool or method that can break traditional measurements barriers and go towards new ways of looking at urban phenomena. Concerning this aspect, more can be observed with a further reflection and analysis of these possibilities.

Let's consider the social issue related to increasing public green. From an environmental sustainability point of view, for instance, it can be noticed that traditional and new ways of measuring the related indicators are mostly based on fixed and mobile sensors. Indeed, those are the tool that give us the opportunity to observe environmental-related issues from a scientific point of view. While traditional sensors are often reliable and precise, it has been noticed that it is often too difficult to involve the population in taking part of such measurements.

It might be hard indeed to organize meetings and initiatives that catch citizens interests and convert them into being sensible to the environmental or social issue and thus actively participating in the project design phase. For this reason, it's important to create conditions for indirect forms of involvement, a way for decision-makers to utilize "what is already there" and it's delivered to them by citizens through their social media activity.

The integration of BOLD means offers great opportunities from this perspective. If one side, decision-makers often have precise information on how the levels of pollutant concentrations should be reduced, they often don't have the perception of what the real problems is, or simply what citizens' ambitions are concerning the issue. A scientific quantitative measurement has to meet the qualitative sentiment of citizens: sensor measurements can be confronted with a sentiment analysis on social media like Twitter, Facebook, Instagram to understand whether what sensors tells us is actually reflected in what people feel about the environmental issue.

This process of social media observation and monitor becomes not only a way to assess whether a project performs optimally from an environmental sustainability point of view, but in a wider perspective, it becomes a mean to bring attention to the project as a possible solution to those issues. If the municipality or cooperatives in Rotterdam are interested in bringing more green spaces in Rotterdam Noord, and citizens are expressing the same needs on social media, then BOLD becomes a way of bringing together two previously "distant" parties in sharing a common goal.

To this purpose, (indirect) public participation is seen as a way to understand what citizens need without needing them to all physically gather, and simply by surfing the wave of their habitual means of expressions on social media platforms.

An exemplary explanation of this process and its importance is given in tab. 41, where the issue related to "public green" in the neighbourhood is shown.

Concerning this aspect, for instance, what gives the best result is not the mere technical analysis of sensors alone. In this phase municipal authorities recognize the problem from a quantitative point of view. This step is used as a basis to start with the measurement of the specific phenomenon, but it only delivers better results when the discussion around it could be intercepted through social media analysis of relevant discussions on the topic, to understand whether the measured outcomes might find a relationship with citizens' (or other stakeholders involved) ambitions and expectations. In this second phase, a qualitative process comes to place. The correlation between those two phases leads to a more complete frame for stakeholders' goals alignment and a possible co-participated solution to the urban issue. The power of this integrated tool is in the fact that one component needs the other to work: a solid quantitative basis gives the opportunity to give scientific background to the issue, while the social component gives the opportunity to collect useful information on people's feelings about it.

Tab 41. Example of BOLD as integrated and cross-domain tool to solve a specific urban issue. (Source: own drawing) redo in blue

In the Hofbogen case, this supposition can be directly demonstrated by observing the high activity on social media around the Hofbogen project. Indeed, the outcome of a social media qualitative analysis in Rotterdam Noord shows what people would like to do or would like to see on the Hofbogen, depending on the content of the post and the reactions of people to it. The Twitter research performed mainly through the hashtags #Hofbogen, #Rotterdam Noord, #Agniesebuurt shows that people in the neighbourhood are interested in the natural component of the project and they particularly enjoy open air activities such as gardening or physical exercise, such as open-air yoga. The green component is the most relevant and observable presence just by scrolling the Twitter page with the selected hashtags. (part of the outcome of this analysis is showed in pages 62 and 63).

This case testifies an indirect level of public participation through observation of people's activities and preference through the lens of social media, thanks to which minor stakeholders don't have to be present in meetings with authorities and decision-makers anymore, as they are observed in their natural behaviour through Twitter.

These results, observable on a quite extensive scale in the neighbourhood show the high interest of citizens in the achievement of more green spaces in the neighbourhood, confirming that the final project design will have to take into account green shared spaces, or even shared rooftop gardens as a relevant part of it, as this trend is observable on multiple levels thanks to citizens activities on social media. What society wants is a relevant concept to consider making the project accepted as part of the community, but these observations have to be combined with a viable and effective solutions also from a financial point of view: as expressed in the previous chapter, social and environmental sustainability alone are not enough to respond to a city's need in a climate of governance. Overall, it's perceivable from the Twitter analysis a sense of care for the community and a willingness to contribute through social and environmental sustainable solutions.

A confrontation with traditionally given directions (e.g. the minimum green surface required by the municipal land use plan or the 25 % required) and environmental sensors to measure environmental pollution gives a clearer answer on the extent to which further green implementation is needed.

Dakgaard @ Dakgaarden ·4 Oct 2017 ·

Proud to be a # rooftopfarmer on # rooftophorchard the # Dakgaard !!! ... on the former railwaystation # **Hofplein** in # Rotterdam ! # Hofbogen # Hofline

1 2

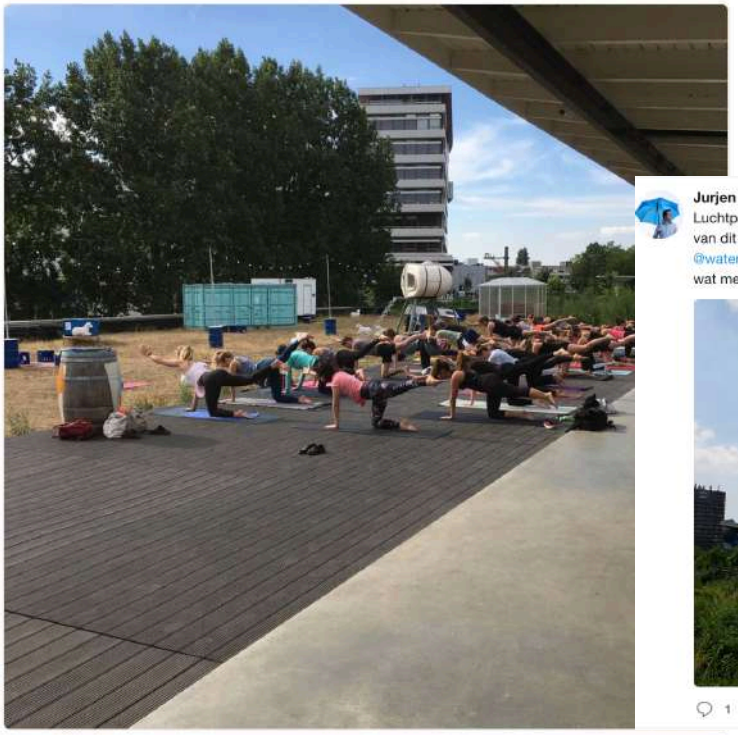
DakAkkers @ d_akkers ·29 Dec 2016 ·

The rooftopfarmers-crew in action on the # rooftop railway on the abandoned railwaystation # **Hofplein** ... the "liberation" of the fruittrees ..

1 1

Theo Coskun @TheoCoskun · 16 h

Ook dit is de #**Agniesebuurt** ....avondgymnastiek op Station Hofplein



5

Jurjen Jongepier @jurjen_j · 3 giu

Luchtpark #**Hofbogen** wordt dit weekend geopend, gerse boel, tof nieuw doel van dit oude dakperron. Meteen twee dagen lang inspiratiemarkt van @hhsenk, @waterloket010 e.a voor ander gebruik van daken in @Rotterdam. Er kan nogal wat met al die ongebruikte m²'s! 👌

1 5 17

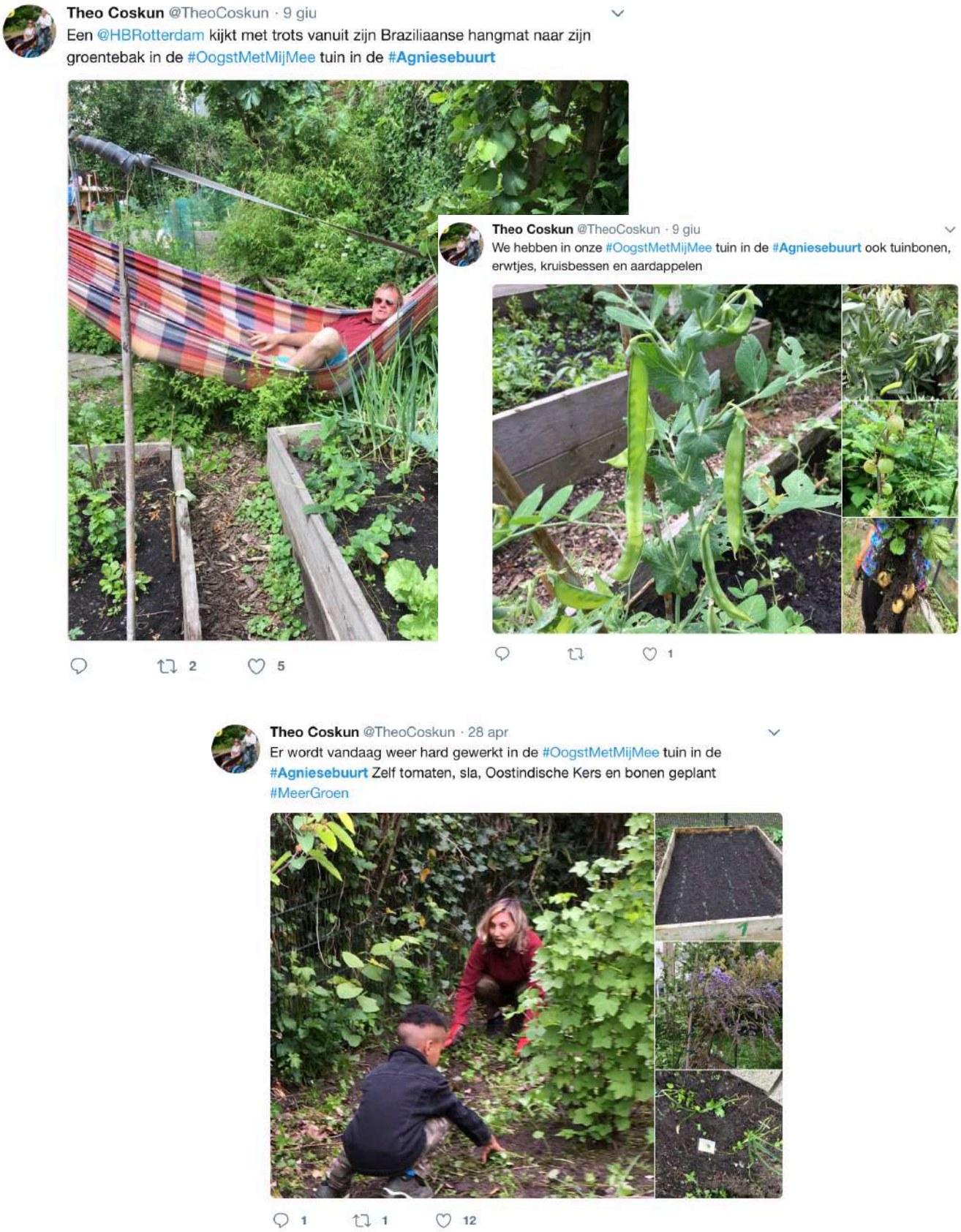


Fig. 42. Trough Twitter it's possible to conduct a qualitative analysis of people's reactions to events organized. To a certain extent, this can reveal quite a lot on people's desire to finally see a result of the re-development transformation. (Source: Twitter)

The result of these data collections is discussed in meetings involving decision-making parties and other relevant private and public actors: the developer ERA Contour, representatives of the entrepreneurs, and Pro Rail and the Ministry of Culture. Information disclosure and clarity is ensured by the obligation of showing quantitative data retrieved through the neighbourhood analysis, thus re-directing the discussion towards the same figures collected by all different parties. This first phase serves as an initial understanding on neighbourhood issues, to have a clear picture on how it's changing, and towards which directions. It is important in this phase the role of local entrepreneurs' representatives: they represent wishes and ideas suggested in previous meetings within all the entrepreneurs involved.

This first analysis of neighbourhood and project is fundamental to start the analysis and have clear and realistic suggestions as a product of the encounter of public and private decision-making parties. At this point, decision-making parties might desire to attract new entrepreneurs, investors or capital. At this point interests are defined:

a) Hofbogen BV: desire of attracting reliable and profitable tenants for the arches space, as well as for the surrounding neighbourhood.

b) Municipality: desire to attract investors, that through a form of PPP (Public and Private Partnership) can contribute with ideas, funds and suggestions for interesting and attractive forms of developments.

Having set goals, ambitions and especially, having data on the neighbourhood development black on white can smoothen this process involving a proactive search for external private actors.

The combination of this dynamic, is showed in fig. 43.

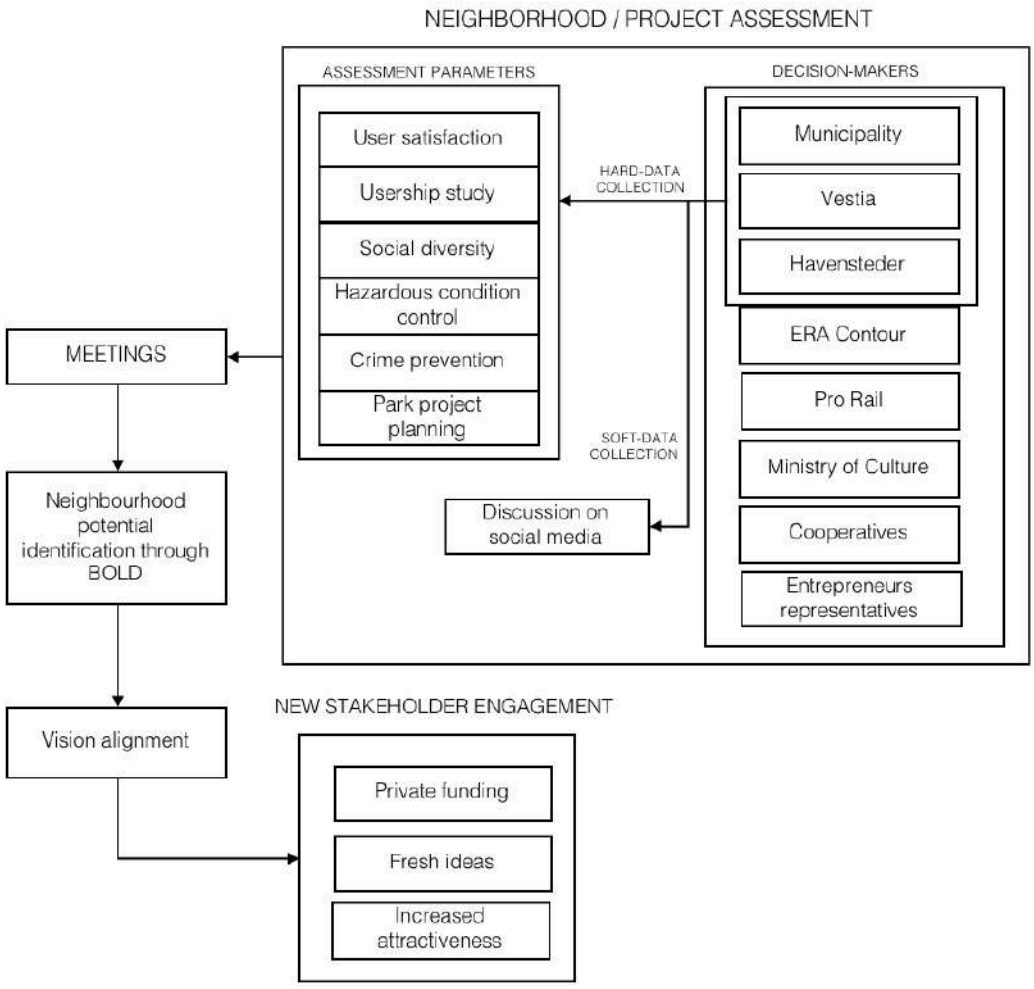


Fig. 43. Neighbourhood and project current assessment and model for new stakeholders' involvement. (Source: own drawing)

4.2.4. Extended stakeholder engagement

After the phase of data collection on the neighbourhood is over, and consultation amongst decision-makers is concluded, the second phase, involving stakeholder involvement, can start. In this phase, decision-makers recognize the importance of public participation throughout the development of the project and take action to support it in an extensive way.

The result of the meetings is the suggestion of possible ideas for future development of the project, as seen by the public and private parties after consultation of land use plan and possibilities realizable. These ideas are shared on the common general forum, that citizens and entrepreneurs can access singularly to consult and to further contribute actively. Comments and suggestions are open in response to the proposals made by main decision-making public and private parties. The general forum entails a section where questionnaires are available, where respondents insert their preferences concerning various issues of the future re-development, as testing ground for proposals previously discussed. Results are then collected and visible by decision-makers. Specifically, citizens are called to contribute in:

1) Park project planning: citizens express preferences and suggestions regarding future possible developments of the project.

2) Park programs planning: citizens express preferences and suggestions regarding possible future activities that could be organized on or around the project.

The platform is updated constantly through the re-development decision-making process and it's open to every citizen that wants to make a contribution directed to a specific issue. Then, it's left to decision makers and authorities the power to filter this information by relevance and suggest only the ones relevant for and in line with realizable and formal plans or regulations.

How can managers make sure that suggestions and questionnaire are actually taken into account by decision-makers in the following phase, when it's time to actually start the re-development process?

Indeed, the first step is granting tools for general involvement of citizens or other minor parties, but the second concern should be related to how to ensure that those suggestions are actually considered over time. This happens through the concept of living lab, promoted by the strong cooperative will of providing more equal and sustainable spaces in the neighbourhood. Cooperatives, act as mediators between public, private parties and citizens.

Cooperatives involvement in promoting living labs

The democratization of the process is realized through the concept of living lab. Cooperatives take the role of promoters of this idea. In fact, they are already largely involved in initiatives concerning the realization of public green in the neighbourhood and they already have an idea on how the transition should be managed and less powerful actors should be involved in the decision-making model.

Cooperatives represent a fundamental party in the process to connect citizens and public and private main decision-makers. Specifically, in Rotterdam Noord, the mediating role of cooperatives like "Vrienden van Hofpleinlijn" and "Wijk Coop 010" is proven by the demonstrated interest in realizing neighbourhood needs for environmental and socially sustainable spaces. In the suggested stakeholder management model, they act like facilitator for the process of living lab to happen. They use their expertise in citizen counselling to create the condition for a successful living lab process to happen, alongside the main public decision-making party: the municipality of Rotterdam.

These associations stand for delivering good quality of urban green and public space for all. De Naturlijke Stad, for instance, is a cooperative that operates on Rotterdam Noord only, and has the goal of involving all citizens in making the neighbourhood a better place for everybody (wijkcoop010.nl). They explicitly declare to be a place where residents can meet each other and also share with each other ideas about neighborhood improvements. This context is pretty much similar to the Living Lab idea. "Vrienden van Hofpleinlijn" has clear goals on delivering a space for the neighborhood (Heurkens, 2018), but the association is still made by a group of people that belongs to a certain neighborhood "elite". What comes clear from the analysis of this situation is that a lack of integration between different layers of the civil actor is the major obstacle towards the achievement of a successful form of extended public engagement. The suggestion of involving cooperatives has to be seen as a possibility but living labs can be also started by other main decision-makers parties, depending on the situation at the moment of re-development.

The actual living labs meeting happen on the project, where citizens have the chance to taste the project and to feel involved from the beginning. The physical presence on spot, with all other parties involved, represents an extraordinary opportunity for ideas exchange based on previous suggestions and feedbacks made on the general forum (process of "Exploration" of opportunities). On spot, citizens who feel more involve, can decide to register for the living lab and get the chance to confront their ideas with decision-makers and conclude the process of "co-creation", "experimentation" and "evaluation" of ideas.

The outcome of the discussion is updated in the forum in form of clear explanation of next commonly-envisioned steps for a successful re-development. A plan is stirred by decision-makers: nevertheless, the redevelopment plan will be still subject to criticism on the long term of its on-going process, step-by-step adapting to new dynamics and modification of ambitions and suggestions.

At this stage, the convincement that the project is a benefit for every party involved should be a must. The innovativeness of the process stands in concern of its circularity and its democratization of decision-making. Regarding circularity, the model gives an input, which is subject to processing phase, and in turn it releases an output. The information flow enters the process, is elaborated and gives back information over time. The democratization of the process is evident through the whole process, but specifically through the living lab actuation.

If the first process of decision-making and the second process of stakeholder engagement are put together, we obtain a circular model (Fig. 44). The innovativeness of the process stands in concern of its circularity and its democratization of decision-making. Regarding circularity, the model gives an input, which is subject to processing phase, which gives an output. The information flow enters the process, is elaborated and gives back information over time. The democratization of the process is evident through the whole process, but specifically through the living lab actuation. This sort of concept is what makes BOLD methods of interaction between private, parties and society innovative, and for sure can give a solid contribution towards the achievement of a more socially sustainable project for all.

The concept of circularity of information flow is evident and particularly important here. Information is not a one-source stream anymore, from decision-makers to users, but it can be seen as a double-sided source where inputs and feedbacks are constantly happening, and not necessarily following one direction. Indeed, from the general common forum, accessible at any time by all parties involved, information on progress could be retrieve and work as feedbacks to further improvement from all actors.

This flow is intended to overcome the difficulties related to communication when it has to go through time-consuming and always not productive meetings. Moreover, the space of information through the space of data is always crossing the concrete reality thanks to the Living Lab application, where suggestions are directly tested and discussed on spot between all parties involved.

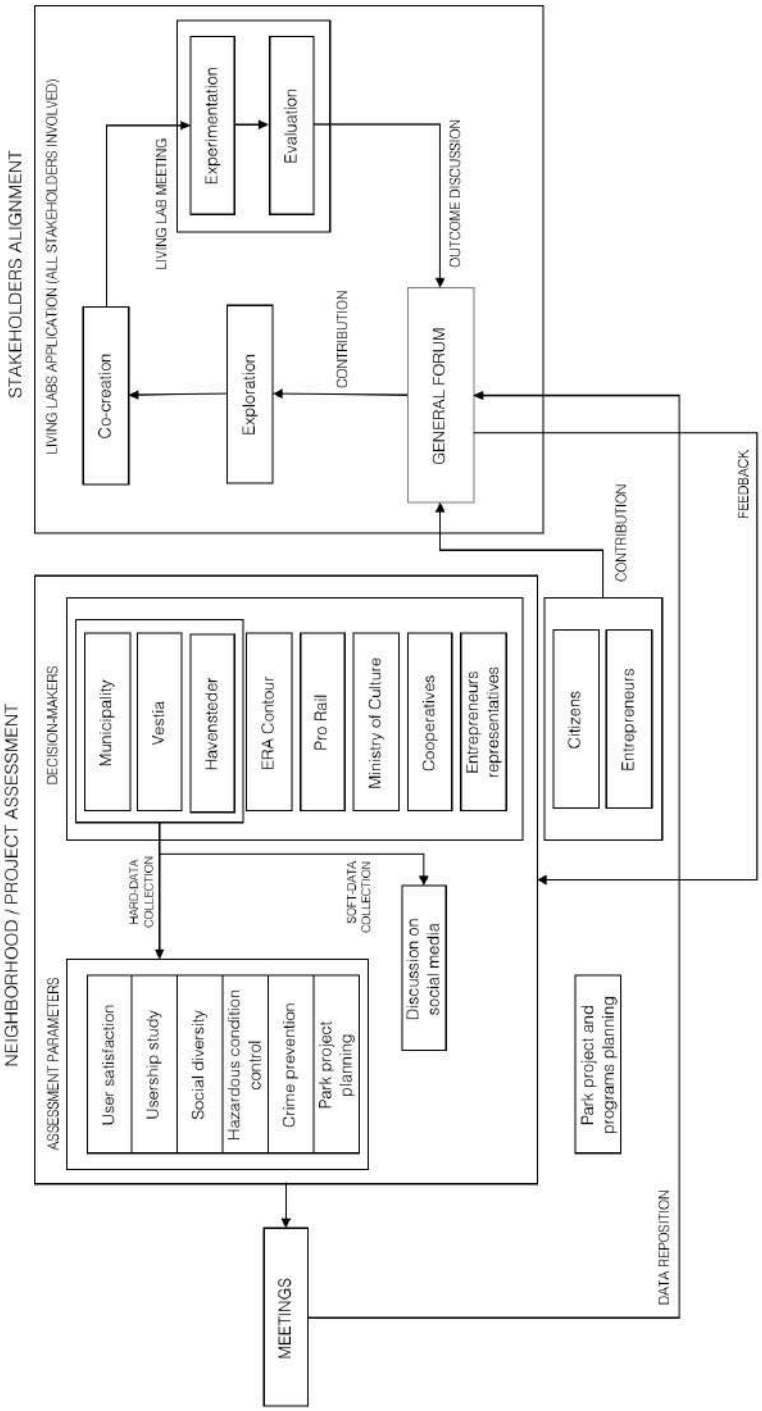


Fig. 44. Integration of step 1 and step 2 in a complete flowchart model showing the overall outcome of data collection, discussion and stakeholder participation. (Source: own drawing)

5. Conclusions

This research started with an introduction to a relevant societal matter: what is the effect on environmental, social and economic dynamics of projects of re-use of obsolete infrastructures. In a scenario dominate by new governance dynamics, where cities' need for sustainability is counterbalanced by the need of re-developing and improving bad-performing neighbourhoods, it's important that environmental effects are balanced with social and economic ones.

The main research question has been formulated as follows: How can BOLD help city planners and managers determining the real-time and holistic impact on social, environmental and economic dynamics in projects of re-use of obsolete or underused infrastructures?

Traditionally, these components have been assessed with techniques (LPA, MSA) that aim at measuring a situation a priori, to establish sustainable goals and ambitions for the future performance of a project. Traditional assessment techniques for the on-going phase of a project - such as interviews on spot or meetings - have revealed their lacks in assessing the bigger picture and the changing dynamics that involve such developments.

At this point, big open linked data comes to place as a relevant tool to perform the sustainable assessment in a new way, which includes an assessment based on the important relationships that these components have on each other. Indeed, this new approach strives for an assessment that brakes the established borders between sustainability fixed variables and measurements and looks at the bigger picture involving the relationship between them.

First, an environmental sustainability assessment is done, by considering the limitations of traditional techniques and then trying to find a new BOLD method to assess it more efficiently. The study on this specific part has shown that methods relying on traditional sensors are satisfactory to assess and improve the environmental sustainability of a project. Indeed, environmental-related parameters are highly technical and fit more in the micro dimension of the project. Shared sensing on smartphone applications and sensing through moving vehicles (e.g. Google car) have revealed their potential in assessing a more dynamic situation, where the bigger picture of the neighbourhood is also shown, along with its changings in real time. What has been considered relevant, is that environmental scientific assessment alone is not enough to sensitize citizens into a more responsible behaviour: these measurements, coupled with social initiatives of sensitization, can bring more attention to the environmental issue.

Related to this connection between environmental and social dynamics, an important conclusion has been drawn at the end of this research process, when talking about stakeholder involvement in the Hofbogen case study. In this part, it is argued and proved that a more responsible and inclusive decision-making process takes place in the design process of a project, if quantitative variables ad measurements are confronted with a qualitative exploration on social media. After having assessed the relevance of the environmental problem from a mere technical point of view, the discussion about the same issue on social media might lead to a solution that wouldn't have been otherwise contemplated. Here it can be notice an example of how the correlation between phenomena and between types of measurements (environmental and social components) is more important than a fragmented analysis.

Secondly, the social sustainability assessment, and consequent resulting framework, are introduced as the core of this research. Indeed, the social sustainability assessment entails a complex system of correlations between variables and dynamics that are hardly assessable with traditional techniques only. The product of this analysis shows the relevant role of geo-located social media data to understand how people move, and where do they move in the urban environment. All BOLD methods explored in this section contribute to an inclusive assessment framework that highly relies on the use of social media in the urban environment. Traditional sources, where necessary, complement lack of a mere use of social media.

The social sustainability assessment gave the opportunity to come up with interesting conclusions about the role these projects of re-use might have in a city context. As demonstrated for the High Line Park, these developments are often only a part of a light gentrification process that involves the neighbourhood dimension. Light forms of gentrification, happening through a neighbourhood improvement over decades, shouldn't be confused with disruptive processes that harshly modify a city's nature. What shouldn't be neglected, is the balance between these processes and social sustainability of these projects, and the framework designed aims at providing an opportunity to avoid unbalanced situations.

When assessing social sustainability through BOLD, some major limitations of the approach become evident: for instance, the method is good to define correlation between event, but it's only thanks to a clever, attentive interpretation of a prepared manager if the right cause of certain effects is identified. For instance, it can be detected through social media data that a specific crossroads is particularly busy, and thus the project requires an entry point close to it. Correlation defines the presence of a big amount of people in a place, but causality is not clear: it might be that social media usage in that spot it's particularly high only due to a free Wi-Fi spot. For this reason, it's important to make the potential of BOLD meet with the attentive intuition of

prepared professionals, to assess the situation and to understand whether or not certain actions are needed. This clarifies that technology is there to help, not substitute, the “human touch”.

Finally, economic sustainability is analysed and, despite being a multifaceted and complex component, no relevant BOLD methods have been found to assess it with an added value compared to what we already use for the assessment of these phenomena. An interesting analysis though, has derived from the association of economic indicators with social and environmental ones: the outcome was a clear understanding of which economic phenomena related to the area development are mining environmental or social components. In the triangle where environmental, social and economic successful dynamics stand, it is impossible to reach the maximum outcome for all three: in all cases, at least one component has to sacrifice for a satisfactory outcome of the others.

The final results of this analysis are resumed in the decision-making supportive tool to assess and improve a project’s sustainability through big data and traditional methods. What BOLD can grasp is a complete picture of social, environmental and economic dynamics, always depicted as connected to each other. Possibly, these opportunities can be the first steps towards urban assessments that go beyond the sectorial and fragmented analysis done indicator by indicator. The framework identifies the strong correlation, and importance, of BOLD methods combined: hard and soft data analysis are coming together to offer a complete assessment of environmental, social and economic sustainability. The final product, though, also have some limitations: being built on the High Line Park allows an easier study of urban dynamics around it: social media, census, sensors data come in high quantity and quality in the context of such a big a famous project. Moreover, social media usage is still limited to only portions of the population, so a mere social media analysis wouldn’t be enough to understand urban phenomena in their totality.

One of the most satisfactory outcomes of this BOLD assessment is that this method has shown the importance of the context when assessing a project. With geo-located social media data, used instead of punctual and on-spot interviews, it is barely impossible not to consider the bigger picture: more data, more places and multiple dynamics are assessed. In these terms, the study of an urban project through BOLD can be seen as a catalyst for a neighbourhood improvement. The previously discussed drawback of BOLD being unable to focus on precise and punctual issues, becomes a positive feature: indeed, the fact that big data cannot catch extremely punctual phenomena, is favourable to open the doors for a wider study that embraces a bigger urban dimension. The whole neighbourhood can then beneficiate from a BOLD assessment, partly re-joining the gap that exists between the project and the immediate surrounding. If the two are assessed together, then differences between success of the project and success of the neighbourhood might be reduced, causing a higher degree of satisfaction amongst a wider portion of the population.

This observation has opened the door to the next research step: the application of the theoretical framework on a case study in the Netherlands, the Hofbogen viaduct. The problem concerning this development in its initial phase is particularly evident concerning stakeholder involvement and bigger neighbourhood dimension consideration. At this point, the social sustainability framework built on the High Line Park has been used to try to solve issues like public participation and stakeholder goal alignment. The general framework has shown its adaptability to a case study and it has revealed its potential by successfully giving an integrated solution. This ensures social sustainability goals are and will be met in the Hofbogen re-development case. For instance, the neighbourhood assessment through BOLD can influence the way the project will be developed and contributes to put the accents on relevant issues that will need to be faced.

5.1. Limitations and further recommendations

The application to the Hofbogen case, done after a study on the HLP, has revealed the differences in assessing a project that is not yet in operation. For instance, availability of data might be less compared to the High Line neighbourhood, which will result in a lower possibility of getting an inclusive picture based on geo-located social media data. On the other hand, Hofbogen is a project in its design phase, and this gives a lot more opportunity to deploy BOLD to offer a solution that brings the development on the right path in future stages.

The research has shown some other limitations including:

1) BOLD methods are highly dependent on the context in which the analysis is made. Different urban backgrounds, policies, political dynamics might change the possibility to use big data in such analysis. The European context, for instance, might have a different use of social media platforms compared to the US.

2) The method is highly reliable on social media platforms. They have the power to decide whether or not these data could be used by managers to study urban issues. Moreover, for some platforms like Twitter, available data at the moment only represents 1% of the overall data produced by users, by reducing the opportunity to have a broader picture on users’ behaviours. Data disclosure from social media platforms is still a big issue.

3) Social media data (big data) alone cannot provide an extensive answer to the problemed deployed alone. Traditional data, social media data and sensor data are always needed in correlation and combination with each other. This can be seen both as a limitation of big data, but also as a general benefit for the overall success of the BOLD method: its success is determined by the complex combination of these variables.

Concerning these limitations, some suggestions for further research could be made. For instance, the same study that has been shown on the High Line Park in New York could be done in other case studies in different contexts, to understand how different realities might shape the final framework due to limitation of BOLD tools or other issues. Moreover, further research on privacy issues could be conducted to discover more limitations that might practically interfere with the deployment of big data full potential. Finally, the application of the theoretical framework to other projects in their design phase might reveal other hidden potential of the framework itself, the same way the Hofbogen application has revealed its potential to provide a solution to the social component.

Overall, it's important for future applications that a sufficient degree of integration between urban sciences and computer sciences is reached, to realize the holistic view BOLD has been promising: urban planners and IT experts should work together more and more to discover all the potential informatics can have on successfully deliver cities for people, for the planet and of course, even for a profit.

6. Reflections

The choice to manage sustainability-related issues in urban environments has come from both the realization that sustainability in cities goes far beyond the mere environmental issue as well as the realization that a big open linked data approach could bring a positive contribution in its assessment.

Cities needs have been changing not only due to a re-direction towards sustainability as solution to environmental, social and economic challenges, but also due to new approaches in facing those issues. An attitude towards new forms of governance indeed often presents a possibility to contribute to societal challenges from multiple points of view, but at one condition: new methods of involvement, evaluation and participation in projects have to be defined and experimented.

The challenge presented at the beginning of this research was to use BOLD as an opportunity to meet those conditions and to offer a new and dynamic approach for the assessment of complex urban situations. Overall, the approach has demonstrated its validity in showing the BOLD potential in a tangible way. The aim of the general assessment was to inform the reader on the general potential those new tools have if deployed in the right context and at the right moment. Specifically, the integration between two disciplines before so distant – Computer Science and Urban Planning – is made possible by the deployment of a holistic approach that makes use of data mining to deliver concrete results in our living environment. The challenge in the future will be reaching higher degrees of integration between disciplines and viewpoints, in order to collect all different knowledges and learnt practices from various fields and bring them together to solve what a single discipline alone couldn't solve with a sufficient level of deep understanding. In the middle age, Architecture and urban planning were mostly related to protection of properties or villages, or to show off beautiful decorations and construction features. Nowadays, architecture and urban planning are the answers to more complex dynamics, sometimes easier to be understood thanks to the deployment of new methods coming from other disciplines.

The role of facilitators between the old and this new understanding of cities and urban spaces, could be taken on as a responsibility by us, managers in the built environment. We have the responsibility to acknowledge that this transition is occurring, and we have to be sure to provide tools and condition for this to happen in the most meaningful way possible. "BOLD cities" are dynamic, vibrant, innovative, contemporary, experimental cities where this transition has been already foreseen. This concept is the core link between this research and the master track Management in the Built Environment.

The mentors had given slightly more freedom at the initial phase of the process, allowing me to choose the direction I wanted to tackle the problem from. After the P2, feedback sessions have become more intense and oriented towards a more defined outcome. The suggestion of using a tangible case study for the application of the framework turned out to be particularly useful as it made me discover some important aspects of BOLD that I linked back again to the first more theoretical part, in a loop learning process of trial and error. I specifically found useful the suggestion of dealing with stakeholder engagement and alignment issues, as it finally appears to be an aspect that reflects a big part of the utility of BOLD as a tool for the community. The "open approach" of mentors in giving feedback (often based on suggestions and useful insights) gave a lot of freedom, as well as responsibilities to plan, manage, conclude the work in an efficient way. If some say that the journey itself is the most important part of a travel, this was certainly true for this research: I found it stimulating to learn how to improve, alone or with confrontations with other students. Every milestone reached, made me look back at the improvement gap between how I used to do it and how I learnt to do it better. If I had the chance to go back, I would certainly re do some things differently, but that's part of the learning process: I will use what I learnt to bring my knowledge to the next project.

If I had to cite one thing I've learnt from my own work, for sure is looking at the broader picture. I started with the idea of solving the issue only related to the project borders, and I was trying to find ways to analyse the situation concerning the green roof of the High Line. But soon enough I realized that a way more interesting analysis comes from the assessment of the inter-related neighbourhood dynamics, and how they interact with the project. In a way, BOLD shaped the way towards the realization that, when it comes to deploying this method, it appears natural to consider the "bigger picture", and not only a single spot in the urban environment. This is the biggest lesson learnt throughout the development of this research.

References

Aclima (2016). Taking it to the Streets: Aclima Brings Street-Level Environmental Sensing to CicLAvia, Retrieved on 23rd November 2017 from: https://blog.aclima.io/taking-it-to-the-streets-aclima-brings-street-level-environmental-sensing-to-ciclavia-7aee2c94e8b5

Alberti, J., Balaguera, A., Brodhag, C., Fullana-i-Palmer, P. (2017). Towards life cycle sustainability assessment of cities. A review of background knowledge, *Science of The Total Environment, 609*, 1049-1063

Alvarez, A. B. (n.d.) New York City's High Line: Participatory Planning or Gentrification? *The Pennsylvania State University*

Arase, Y., Xie, X., Hara, T., & Nishio, S. (2010). Mining people's trips from large scale geo-tagged photos. ACM Multimedia.

Antoniou, V., Morley, J., Haklay, M. (2010). Web 2.0 Geotagged photos: Assessing the spatial dimension of the phenomenon, *Geomatica, 64(1):99-110.*

Barth, D., Carr, M. (n.d.). Using a Delphi method to develop criteria for high performance public spaces that contribute to community sustainability

Beretta, I. (2017). The social effects of eco-innovation in Italian smart cities, *Cities 72*, pp. 115-121.

Bettencourt, L. M. A. (2013). The Kind of Problem a City Is, *Santa Fe Institute*, Santa Fe, USA.

Bettencourt, L. M. A. (2013). The Uses of Big Data in Cities, *Santa Fe Institute*, Santa Fe, USA.

Bliss, L. (2017). The High Line's Next Balancing Act, Retrieved on 25th November 2017 from: https://www.citylab.com/solutions/2017/02/the-high-lines-next-balancing-act-fair-and-affordable-development/515391/

Bocconi, S. Bozzon, A., Psyllidis, A., Bolivar, C. T., Houben, Geert-Jan (2015). Social glass: A platform for Urban Analytics and decision-making through heterogeneous social data, international World Wide Web Conference Committee (IW3C2).

Brandt, T., Neumann, D. (2015). Does Social Media Reflect Metropolitan Attractiveness? Behavioural Information from Twitter Activity in Urban Areas.

Brundtland, G. H. (1987). Our Common Future: Report of the World Commission on Environment and Development, Oslo

Corburn, J. (2003). Bringing local knowledge into environmental decision making, *J. Plan Educational research, 22, 420-433*

Groff, E., McCord, E. S. (2011). The role of neighbourhood parks as crime generators, Security Journal 1-24

Guerreiro, R., Eloy, S., Guarda, I., Lopes, P.F. (2012). Networks and Opportunistic Urban Design: a strategy for regeneration of public spaces in Lisbon, *International Seminar on Urban Form 2012*, Delft.

Chenail, R. J. (2009). Interviewing the Investigator: Strategies for Addressing Instrumentation and Researcher Bias Concerns in Qualitative Research. The Qualitative Report, 13(4), 14-21

Cranshaw, J. Schwartz, R., Hong, J. I. (n.d.). The Livehoods Project: Utilizing Social Media to Understand the Dynamics of a City, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA.

Cucca, R. (2012). The Unexpected Consequences of Sustainability. Green Cities Between Innovation and Eco gentrification, *Sociologica 2*, Società editrice Il Mulino, Bologna.

Dale, A., Newman, L. (2009). Sustainable development for some: green urban development and affordability, *Local Environment*, 14:7, 669-681.

Dizdaroglu, D., Yigitcanlar, T. (2016). Integrating urban ecosystem sustainability assessment into policy-making: insights from the Gold Coast City, *Journal of Environmental Planning and Management*, 59:11.

Dudas, G., Vida, G., Kovalcsik, T., Boros, L. (2017). A socio-economic analysis of Airbnb in New York City, *Regional statistics*

Elkington, J. (1997). Cannibals with Forks: The Triple Bottom Line of 21st Century Business*, Capstone, 1997*

Environmental Science and technology of NYC (n.d.) website. The High Line: The View from the Top. Retrieved on 28th October 2017 from: https://macaulay.cuny.edu/eportfolios/lewisf10/parks/the-high-line/

Eurostat (2015). Sustainable development in the European Union. 2015 monitoring report of the EU Sustainable Development Strategy.

Følstad, A. (2008). Living labs for innovation and development of information and communication technology: a literature review, *The Electronic Journal for Virtual Organizations and Networks, vol. 10, "Special Issue on Living Labs"*

Friends of The High Line website (n.d). Retrieved on 26th October 2017 from: http://www.thehighline.org/about/faq

Glaeser, E. L., Kominers S. D., Luca, M., Naik, N. (2015). Big Data and Big Cities: The Promises and Limitations of Improved Measures for Urban Life, *HKS Faculty Research Working Paper Series*

Gould, K. A., Lewis. T. L. (2017). Green Gentrification: Urban Sustainability and the Struggle for Environmental Justice, *City and Community*, 16(3), 348-350

Hamstead, Z. A., Fisher, D., Ilieva, R. T., Wood, S. A. McPhearson, T. (2018). Geolocated social media as a rapid indicator of park visitation and equitable park access. *Computers, Environment and Urban Systems.*

Hristova, D., Williams, J. M., Musolesi, M., Panzarasa, P., Mascolo, C. (2015). Measuring Urban Social Diversity Using Interconnected Geo-Social Networks, *International World Wide Web Conference Committee (IW3C2).*

Heerschap, N., Ortega, S., Priem, A., Offerman, M. (2014). Innovation of tourism statistics through the use of new big data sources, *Statistics Netherlands*, The Hague, The Netherlands.

Hofbogen website (n.d.). Retrieved from https://www.hofbogen.nl/

Jansen, S.J.T. (2013). Why is Housing Always Satisfactory? A Study into the Impact of Cognitive Restructuring and Future Perspectives on Housing Appreciation. Social Indicators Research, Vol. 116, Issue 2, 353-371.

Joassart-Marcelli, P., Wolch, J., Salim, Z. (2011). Building the healthy city: The role of non-profits in creating active urban parks, *Urban Geography, 32(5),* 682-711

Kalinauskaite, I., Haans, A., Kort, Y. de (2016). Studying aggression in the field: influences of dynamics of the setting on atmosphere and aggressive behavior. Conferentiebijdrage EDRA47Raleigh 18-21. May, Raleigh NC, USA.

Kane Ahkter, J., Soria, S. (n.d.) Sentiment analysis: Facebook Status Messages, *Final Project CS224N*

Kang, Y., Park, J., Kang, A. (2015). An Analysis on the Spatial Characteristics of Satisfaction on the Residential Environment Using Tweets, *International Journal of Geospatial and Environmental Research, vol.1, article 5*

Kumari, J., Rajesh, R., Pooja, K.M. (2015). Facial expression recognition: A survey, *Procedia Computer Science 58*, *486 - 491*

Lang, S., Rothenberg, J. (2016). Neoliberal urbanism, public space, and the greening of the growth machine: New York City's High Line Park. *Environment and Planning*, 49(8), 1743-1761.

Lehman, S. (2010). Green urbanism: formulating a series of holistic principles, *S.A.P.I.E.N.S.*, 3

Leitao, A. B., Ahern, J. (2002). Applying landscape ecological concepts and metrics in sustainable landscape planning, *Landscape and Urban Planning 59*, 65-93.

Li-Minn Ang, Kah Phooi Seng (2016). Big Sensor Data Applications in Urban Environments, Big Data Research, vol. 4, pp. 1-12

Luo, Yi, Ming-Han, Li (2014). How does it change after one year? A comparison of the landscape architecture foundation's published case studies in 2011 and 2012/2013

Macmillan, S. (2006). Added value of good design, *Building Research and Information*, 34:3, 257-271.

Marzuki A. (2015). Challenges in the Public Participation and Decision-Making Process. *Sociologija I proctor*, *53 (2015) 201 (1): 21-39*

Mehdipour, A., Rashidi Nia, H. (2013). The Role of Brownfield Development in Sustainable Urban Regeneration, *Journal of Sustainable Development Studies, Vol. 4, N. 2, 78-87*.

Mostafavi, M., Doerty, G. (2010). Ecological Urbanism. *Lars Müller Publishers*, Basel, Switzerland

Navarro, M. (2015). In Chelsea, a Great Wealth Divide. New York Times

Nevens, F., Frantzeskaki, N., Gorissen, L., Loorbach, D. (2013). Urban Transition Labs: co-creating transformative action for sustainable cities*, Journal of Cleaner Production, 50: 111-122.*

Newman, J.P., Seymour, M., Yee, T., Renteria, Longcore, J., Longcore, T., Wolch, J.R., Shishkovsky, A. (2013). Green Alley Programs: Planning for a sustainable urban infrastructure? *Cities*, N. 31, 144-155.

Pallot, M. (2009) Engaging Users into Research and Innovation: The Living Lab Approach as a User Centered Open Innovation Ecosystem.

Pantano, E., Priporas, C. V., Stylos, N. (2017). "You will like it!" using open data to predict tourists' response to a tourist attraction. *Tourism Management, 60, 430-438*.

Pongnumkul, S., Chaovalit, P., Surasvadi, N. (2015). Applications of Smartphone-Based Sensors in Agriculture: A Systematic Review of Research, *Journal of Sensors, Volume 2015*

Rabari, C. and Storper, M. (2013) The digital skin of cities: urban theory and research in the age of the sensored and metered city, ubiquitous computing and big data, Cambridge Journal of Regions, Economy and Society 2015, 8, 27–42

Raven Marie Cretney "Beyond public meetings: Diverse forms of community led recovery following disaster" (2018)

Resch, B., Mittlboeck, M., Girardin F., Britter R., Ratti, C. (2011). Real-time Geo-awareness – Sensor Data Integration for Environmental Monitoring in the City

Richards, N. M., King, J. H. (2014). Big Data Ethics. *Wake Forest Law Review*, 2014

Rothenberg, J., Lang, S. (2015). Repurposing the High Line: Aesthetic experience and contradiction in West Chelsea, *City, Culture and Society 9 (2017), 1-2*

Sarhan, A. A., Farghaly, Y., Elsayed, R. (2016). Measures and attributes for sustainability of parks, *Procedia Environmental Sciences*, 34, 453-460.

Steiner, F. (2011). Landscape ecological urbanism: Origins and trajectories*, Landscape and Urban Planning*, *100*, 333-337

Straub, S. (2012). Co-Creation in Real-Estate: A framework to steer upon value-creating firm-consumer relations in demand-driven development.

Tallon, A. (2010). Urban Regeneration in the UK, Routledge

Thaler, R. H., Sunstein, C. R. (2008). Nudge. Improving Decisions about Health, Wealth, and Happiness, *Yale University Press*.

The Guardian (2015). New York's historic elevated train line becomes a park. Retrieved on 26th October 2017 from: https://www.theguardian.com/artanddesign/2008/nov/18/new-york-high-line-park

Tretter, E. (2014). Sustainability and Neoliberal Urban Development: The Environment, Crime and Remaking of Austin's Downtown, *Urban Studies*

Uffer, S. (2017). Using Big Data to Deliver Better Parks and Public Spaces, Burohappold Engineering, Retrieved on October 2017 from: https://www.burohappold.com/news/using-big-data-create-parks-public-spaces-people-love/

United Nations (2014). World's population increasingly urban with more than half living in urban areas.

Walker, C. (n.d.). Understanding park Usership, *the urban institute (The Wallace Foundation)*

Wilson, M. (2011). The Park is Elevated. Its Crime Rate Is Anything But, New York Times

Wolch, J. R., Byrne, J., Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities "just green enough", *Landscape and Urban Planning*, 125 (2014) 234–244

Xu, Jie, Wu Cheng Zhao, Ma, Xiu-Wen (2014). Landscape Performance Assessment of Urban Wetland Park Planning and Design: Case Study of Wuzhou Wetland Park in China, Landscape Research Record No. 2

Yangzhou Hu, Brent Ritchie J.R. (1993). Measuring Destination Attractiveness: A Contextual Approach, Journal of Travel Research, Volume: 32, issue 2, page(s): 25-34

Yigitcanlar, T., Ho Lee, S. (2014). Korean ubiquitous-eco-city: a smart-sustainable urban form or a branding hoax? *Technological Forecasting and Social Change, 89*, pp. 100-114.

Yin, R.K. (1994). Case Study Research. Design and Methods – Second Edition, *applied Social Research methods Series, vol. 5*

Yuki Arase, Xing Xie, Takahiro Hara, Shojiro Nishio (2010). Mining people's trips from large scaled geo-tagged photos, *Proceedings of the 18th ACM international conference on Multimedia, pp. 133-142*

Zainal, Z. (2007). Case study as a research method, *Jurnal Kemanusiaan bil.9, Jun 2007*

Zhang, S., Feick, R. (2016). Understanding Public Opinions from Geosocial Media. ISPRS International Journal of Geo Information, 5(6), 74. Multidisciplinary Digital Publishing Institute.

Zucchetti, M. (2015). Storia Futura dell'Energia, *Clut*, Torino.

Appendix A.

Environmental sustainability assessment

	INDICATOR	DESCRIPTION	ASSESSMENT CRITERIA	ACTIONS	VARIABLE	BOLD TOOL			PARAMETER	STAKEHOLDER ACTIVELY INVOLVED
						REGISTRATION / SURVEY	SENSOR	SOCIAL MEDIA		
ENVIRONMENTAL	HYDROLOGY	The project brings a positive contribution concerning water runoff reduction and evapo-transpiration levels	Assess and ensure evapo-transpiration increase and water runoff reduction on the project roof surface.	1. Sponsor usage of app to collect data on the project. 2. Collect and monitor users' measurements done through citizens smartphones 3. Insert data in shared platform	a) Level of evapo-transpiration; b) Level of water runoff		Traditional sensors		Percentage of water runoff	Decision-makers
	ECOLOGY	The project brings a positive contribution concerning heat island effect reduction	Assess and ensure heat island effect reduction on the project.	1. Sponsor usage of app to collect data on the project through social initiatives 2. Monitor users' measurements uploaded on platform by citizens	Level of heat island effect		Smartphone applications Traditional sensors		Temperature	Citizens; decision-makers
	POLLUTION	The project brings a positive contribution concerning pollutant concentration reduction	Assess and ensure pollutant concentration reduction on the project.	1. Sponsor usage of app to collect data on the project through social initiatives 2. Collect and monitor users' measurements done through smartphones 3. Insert data in common platform	Level of pollutant concentration reduction		smartphone applications Traditional sensors		Pollutant concentration	Citizens; Decision-makers; External stakeholders
				Collect data from Google and Aclima on measured pollutant levels			Google Car moving sensors		Pollutant concentration	
				Enhance sustainabiility inirectly, through organization of social initiatives of sensitization		Meetings				

Appendix B.

Social sustainability assessment

	INDICATOR	DESCRIPTION	ASSESSMENT CRITERIA	ACTIONS	VARIABLE	BOLD TOOL: REGISTRATION SURVEY	BOLD TOOL: SENSOR	BOLD TOOL: SOCIAL MEDIA	PARAMETER	STAKEHOLDER INVOLVED
SOCIAL	PUBLIC PARTICIPATION IN PARK PROJECTPLANNING	Community involvement in planning park features and structures, also in relation with surrounding building environment	Assess and increase current level of public participation in park project planning.	1. Collect data on project and neighborhood performance	Level of citizen involvement			Twitter	1. Tweets content 2. Living lab discussion outcome 3. Open forum discussion outcome	Decision-makers; citizens
				1. Collect data on project and neighborhood performance 2. Insert data on common platform (forum) 2b. analyze input by citizens on open forum 3. Identify and involve stakeholders through Living Labs 5. Manage feedbacks and update common platform		Living Lab meetings		Open forum Living lab experience		
	PUBLIC PARTICIPATION IN PARK PROGRAMS PLANNING	Community involvement in planning project activities	Assess and increase current level of public participation in park programs planning	1. Collect data on citizens and involved stakeholders preferences on open forum 2. Give feedback on open forum suggestions	Level of citizen involvement			Open forum	1. Open forum discussion	Decision-makers; citizens
	USER SATISFACTION	User satisfaction level with park neighborhood and project permises	Assess user satisfaction level with park features	1. Identify project neighborhood borders 2. Perform Collection of data on Twitter (Tweet content + Tweet density) and compare outcomes with urban features of places thorugh Google Maps	Level of user satisfaction			Twitter	1. Tweet content 2. Twitter usage density	Decision-makers
	USERSHIP STUDY	User behaviour against project permises and neighborhood	Assess user behaviour against project permises and in surrounding neighborhood, related to *how* the project is used and *what* is used (project + neighborhood study)	1. Identify project neighborhood borders 2. Perform Collection of data on social media (trajectories through picture sharing) and compare outcomes with urban features of places thorugh Google Maps 3. Identify urban paths by specific themes and compare it to attractive places identified in "User satisfaction" section	Number and location of check-ins			Flickr + Google Photo	Venues check-ins	Decision-makers
					(a) User displacement; (b) Radius of Gyration; (c) Return probability			Foursquare	Venues check-ins –	
	SOCIAL DIVERSITY	User diversity and demography on project permises and neighborhood	Assess user diversity on park permises and surrounding neighborhood, related to *who* uses the park. Identify changes over time in usage of neighborhood and park permises in relation to dynamics of social groups	1. Identify project neighborhood borders 2. Perform Collection of data on social media platforms and compare outcomes with urban features of places thorugh Google Maps to identify top bridging and top bonding places 3.Establish usership dynamics in relation to who uses the park 4. Ensure development of bridging places to increase social diversity	(a) Place Serendipity level; (b) Place Brokerage level; (c) Place Entropy level; (d) Place Homogeneity level			Twitter	Contacts network	Decision-makers
								Foursquare	Venues check-ins	
	EQUITABLE ACCESS	Inclusive spatial and social distribution of project permises	Assess spatial and social distribution of park permises by identifying if system of green can be designed and if sufficient connections (public transportations and roads) between project and surrounding neighborhood are identifiable	1. Identify project neighborhood borders 2. Identify neighborood parks 3. Collect social media data on parks' usage 4. Perform social analysis of neighborhood and park usership to classify parks 5. Perform spatial analysis of neighborhood and public transportation system to assess accessibility 6. Determine whether park system is achievable and adds value to the project	(a) Level of park attractiveness, (b) Attendancy rates (c) Neighborhood physical characteristics (d) Neighborhood social characteristics			Twitter	TUD (Twitter usage per day)	Decision-makers
								Flickr	FUD (Flickr usage per day)	
						Cadaster		–	Park typologies and land distribution	
						Census			Neighborhood soci	
	POTENTIAL HAZARDUOUS CONDITIONS CONTROL	Control over time of potentially dangerous project and project neighborhood temporary or pemament features	Monitor and reduce potential hazarduous conditions on project permises and in project neighborhood	1. Identify project neighborhood borders 2. Perform Collection of information through Widget form to identify issues 3. Associate issues in urban context thorugh Google Maps to solve issues 4. Keep record of major neighborhood issues over time	Number of reported issues			Google Widget form	Number of crimes reported	Decision-makers; citizens
	CRIME PREVENTION	Control over crime on park ad park neighborhood	Monitor crime and increase safety on project permises and neighborhood	1. Identify project neighborhood borders 2. Perform social media analysis (Twitter) to detect perceived sense of fear in the neighborhood 3. Utilise effective light settings to prevent escalating behaviours 4. Cross reference change in crime rates with police reports to monitor results of pro active measure	Number of tweets expressing fear			Twitter	Tweet content	Decision-makers
					Number of crimes reported under different light settings	Police crime reports	Cameras in changing light settings		crime rates on different light settings	

APPENDIX C.
Economic sustainability assessment

	INDICATOR	DESCRIPTION	ASSESSMENT CRITERIA	ACTIONS	VARIABLE	BOLD TOOL			PARAMETER	STAKEHOLDER INVOLVED
						REGISTRATION SURVEY	SENSOR	SOCIAL MEDIA		
ECONOMIC	EMPLOYMENT	Variation in employment rate in project neighborhood	Monitor variation in employment rates in project neighborhood	1. Identify project neighborhood borders 2. Check before and after data on census reports	Unemployment rates	Census			–	Decicsn-makers
	DEMOGRAPHY	Variation in number of inhabitants in project neighborhood	Monitor variation in demography in project neighborhood	1. Identify project neighborhood borders 2. Check before and after data on census reports	Neighborhood population	Census			–	Decicsn-makers
	REAL ESTATE	Variation in property values in project neighborhood	Monitor variation in real estate prices in project neighborhood	1. Identify project neighborhood borders 2. Check before and after cadastral data on real	Housing prices	Cadaster			–	Decicsn-makers
	POTENTIAL FOR INVESTMENTS	Variation in number of small and medium sized activities in project neighborhood	Monitor variation in number of businesses	1. Identify project neighborhood borders 2. Check before and after cadastral data	Increase or decrease in number of businesses	Census			–	Decicsn-makers