INVERSE URBAN DESIGN SUPPORT
Attribute Extraction from the Local Context

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presented by
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ABSTRACT

Good quality public spaces can impact a wide variety of socio-economic and environmental aspects ranging from increasing the social interconnection and social capital, the promotion of economic exchange and economic effectiveness, influencing of the environment and energy, and issues with livability and well-being of the residents intended to be served.

However, due to the ambiguity of the concept of public space quality, the choice for its criteria is a difficult task. Public space quality is not a formal problem; thus, there are no specified rules for unambiguous criterion choice. In most of the well-established literature in the field, the criterion of public space quality is defined through subjective judgments of researchers based on personal experience and extensive empirical observations of a large number of samples (i.e. public spaces).

The problem of public space quality is addressed in urban design literature through a range of descriptive attributes – objective features of space. These are then linked to public space performance attributes through extensive empirical studies. In the literature, performance of good public spaces is often described through a number of interchanging terms such as vitality, liveability, viability and liveliness. Essentially, people are at the core of any stipulations about vitality and liveability of cities. The term liveliness can be considered within these two broader concepts. In general, when urban spaces are described in the literature as lively, it is most often referred to the level of perceived activity produced by the number of people using the space.

This research investigates the social aspect of existing public spaces, utilizing spatial “quality” as a metric. Conceptually, public space “quality” is synonymous to its “liveliness”, measurable through on site analyses/observations, which is a measure of how well utilized (or not) is a space. Liveliness is then analysed with respect to space descriptive attributes represented by the objective characteristics of the existing public spaces, such as geometry, topology, user profiles, and others. The main motivation for this analysis is to provide for a better understanding of public space characteristics that support vibrant social life within contemporary urban settings.

To test the interrelationship between liveliness and space descriptive attributes, an inverse design support method was developed. This approach is based on the analysis of performance and descriptive attribute information available for the target context, combined with
the review of literature in the research area. The approach encounters two main steps. In the first step, the liveliness of a public space is measured. In the second step the attributes of public spaces with high liveliness are analysed and compared to their counterparts – public spaces where liveliness is low. Such comparative study allows to distinguish the difference in the objective features of spaces that support or eliminate the use of the public space by people.

The application of the developed inverse approach across the nineteen case studies showed liveliness as effective criteria for public space quality evaluation. Using this measure, it was possible to detect public spaces that are considered to be successful according to local expert and public opinions.

The main scientific contributions of this work include: the theoretical framework for public space descriptive attributes measurement, the method for public space quality estimation based on liveliness measures and space descriptive measures, the setup of infrastructure for attributes measurement which leverages modern GIS-technologies, remote access and actual data bases, and the suggestions on attributes that con-tribute to a public space quality of a specific type.

Keywords

Urban design, public space quality, liveliness, quality attributes, computational design, GIS, database, parametric design
ZUSAMMENFASSUNG


Jedoch ist die Evaluation hinsichtlich positiv einflussnehmender Kriterien für öffentliche Räume ein komplexer Prozess ohne klar definierte spezifische Richtwerte und Regeln. In den meisten Fällen der Literaturforschung basiert der Bewertungsprozess auf subjektivem Urteilsvermögen anhand persönlicher Erfahrung und extensiver empirischer Observation öffentlicher Räume.


Diese Doktorarbeit untersucht die sozialen Aspekte existierender öffentlicher Räume mittels der Nutzung räumlicher Qualität als beeinflussender Indikator. Konzeptionell betrachtet kann die räumliche Qualität als Synonym der Lebendigkeit verstanden werden – ermittelbar via beobachtbarer Messwerte und Analysen im öffentlichen Raum – welche die Beziehung zwischen Mensch und öffentlichem Raum quantitativ sowie qualitativ beschreibt. Im nächsten Schritt wird der Zusammenhang zwischen Lebendigkeit und den gestalterischen Merkmalen des öffentlichen Raums analysiert. Diese Merkmale repräsentieren objek-


Der wissenschaftliche Beitrag dieser Forschung beinhaltet: ein theoretisches Rahmenkonzept zur Messung beschreibbarer Attribute für öffentliche Räume; eine Methode für die Qualitätseinschätzung öffentlicher Räume basierend auf dem Merkmal der Lebendigkeit sowie gestalterisch messbarer Qualitätswerte; den Aufbau einer Infrastruktur zur Ermittlung von Attributen durch die Nutzung von modernen GIS-Technologien und grösserer Datenmengen; und einen wissenschaftlich ermittelten Vorschlag für Attribute, welche die Qualität öffentlicher Räume beeinflussen.
PUBLICATIONS


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INTRODUCTION

This chapter outlines the problematic issues of public space quality within the context of rapid development of cities and its role in the sustainable urban development process. It starts by defining what public space is, setting it apart from its counterpart—private space. The balance between the two concepts is specified by social, economic and technological aspects which vary for different contexts. The text then proceeds to further define the context and the scope of the present research study. In particular, it regards the social component as an integral part in the discussion about public space quality and outlines the relevant research domains. It continues by defining the focus of the study within identified research domains and within the topic of study, which is the interrelation between public space quality regarded through social activity in public space—liveliness—and space descriptive attributes such as geometry, topology, user data, and others. It concludes with a brief outlook into the developed methodology to test this interrelation and touches upon the final results.

1.1 CITY LIVEABILITY AND PUBLIC SPACE

Since more than a half of the world’s population lives in cities today, the urban environment is regarded as the primary milieu for contemporary social life (Arimah et al., 2009). The influx of people seeking education, new opportunities or simply a better life causes cities to expand. New urban areas are being developed and old ones are being redesigned. The concerns behind the rapid pace of urbanization have lead to the formulation of an agenda for sustainable urban development where the aim is to foster the formation of “… liveable, productive and inclusive cities, towns and villages” (Arimah et al., 2009; Stauffer, 2011). This is a continuous process that balances three main dimensions: environmental, economic, and social (Ghavampour and Vale, 2013). The present thesis concentrates on the role of public space in the process of creating sustainable and vibrant urban settings, focusing primarily on the social aspects.

Active use of streets, squares, parks, and other public spaces contribute to the liveability and the social life of cities. This thesis is driven by an aspiration to uncover factors that drive the use of public spaces.
The following questions served as the motivation for this research thesis:

- Why are some spaces preferred by people more than others?
- What are the global and local factors that should come together to produce vibrant public spaces?
- What are characteristics of an individual public space that attract people?
- Does the design of public space matter for its use by people?

The concept of public space was examined from the social use perspective, where the emphasis is placed on an existing individual public space, and regarded within a larger urban context (Figure 1).

Figure 1: The focus of this research is on public space examined through human use and regarded within a larger urban context

1.2 CONTEXT OF RESEARCH STUDY

Social life and public life are terms that are used interchangeably in literature when expounding upon the quality of public space; however, they have subtle differences which are highly relevant for the purposes of this research. To frame the context of this study, the terms public life and public space need to be first defined. Public life encompasses various groups of people and takes place within public space. In turn, public space is defined in literature as a place in a city that can be accessed by anyone at any point in time (Sennett, 1977; Carmona, Magalhães, and Hammond, 2008; Madanipour, 2003). Public spaces are nodes of activity that provide grounds for social interaction and where social relationships form. This is opposite to a private space, which is a more intimate domain and can only be used by certain groups of people, with its access controlled by to these individuals.
The balance between private and public life varies for different contexts. It evolves following changing technology, politics, and economy of countries through history (Carr et al., 1992; Sennett, 1977; Lang, 1987). Also, the values that people attach to public spaces depend on their cultural backgrounds, aspirations in life, and capabilities which significantly vary for different social groups within individual contexts, as well as across cultures (Carmona, 2010; Relph, 1976; Sennett, 1977). People embed spaces with meaning and assign values to them over the course of their everyday use. Through this process, public spaces become places. Referring to Relph (1976) Matthew Carmona defines places as “centres of meaning constructed out of lived experiences” (Carmona, 2010). Consequently, it is fundamental to understand through research who is the “public” and what is “public space” within a particular context (Moughtin, 2000; Habermas, S. Lennox, and F. Lennox, 1974; J. Jacobs, 1962). The context should drive the discussion about sustainable and liveable public spaces.

The disregard of context leads to a number of problems, with one of them being the erosion of cultural specifics of public space (Carmona, 2010), which happens due to a number of reasons, one of them being the rapid pace of urban development in big cities where standard solutions are applied due to constrained time periods of design projects. As a consequence, same kind of public spaces are being created all around the world while erasing unique cultural identities of places (Carmona, 2010). Historically, public space types emerged out of the immediate needs of people for social and economic exchange and thus they took forms specific to the processes and life styles of the local population. Another factor that is important to consider with regards to public space design today is the changing cultural socio-dynamic, especially, in big cities. Here public spaces are shared by people with different backgrounds which results in new modes of interaction between them that take place in physical space.

The above issues are relevant to Western European context, which is the focus of this research thesis. Consequently, under “public”, it is assumed that an articulated, socialized, and commonly shared perspective based on the Western worldview was formed by the processes of de-industrialization, European integration and economic globalization (Madanipour, Knierbein, and Degros, 2014; Sennett, 1977; Carmona, Magalhães, and Hammond, 2008). Non-western European notions of public spaces are therefore outside the scope of this thesis due to the underlying cultural, political and economic differences affixed to notions the term “public” acquires outside this worldview (Eggermond and Erath, 2016; Lim, 2014).
The following section provides an overview of the historic processes that lead to the formation and consequent problems of contemporary public spaces in Europe (Habermas, S. Lennox, and F. Lennox, 1974). It must be underlined here, that within the regarded time frame the specific focus of this work is on the period from 1960s until the present years, when the discipline of urban design emerged and studies on public life and public space are being conducted.

1.3 Public Space in Europe

Public space has been continuously redefined in its meaning and purpose throughout Western European history (Carmona, Magalhães, and Hammond, 2008; Lang, 1987). One of the earliest examples of public space is the Greek Agora. Though access was not universal (women and slaves were excluded), it was a centre for trade, political debates, spiritual life, and some other “public” activities for free, male citizens (Orum and Neal, 2010; L. Mumford, 1961; Carr et al., 1992). In the medieval period in Western Europe, with the development of commodity relations, there emerged a new type of public space - a market - where economic, as well as social exchanges took place. From ancient times through medieval and Renaissance periods, and roughly until the end of WWII, public spaces had distinct geographical locations and were created through productive social and economic activities (Orum and Neal, 2010). Subsequently, processes such as production of goods, as well as social and economic exchanges were anchored to specific physical/geographic locations. With the development of industry, its consequent outsourcing and following a shift to service economy, these processes became globally dispersed, with some of them being moved to yet another dimension – the cyber space. As a consequence, the role of public space as a common social denominator was diminished.

The first half of the 20th century marked a period of long lasting geopolitical unrest, which encompassed the time from the beginning of WWI (including the Russian Revolution and the Great Depression) up until the end of WWII. After this period of great social upheaval, the state increased its presence in the social life of cities, particularly across Europe, after the wave of devastation and rebuilding. The presence of state in the process of rebuilding was reflected in the planning of cities through rigid and over-determined development plans which looked to quickly equip cities to modernization, to house those who were displaced, and to enable people to return to living productive lives (Giedion, 1951; E. P. Mumford, 2000). The over-constrained planning became pervasive in modern urbanism (Madanipour, 1999). Consequent reconstitution of the interrelation between public and private space in this period caused major changes in the form and
in the use of public spaces. Large parcels of land between buildings were left empty, which was sought to bring “more light and air” and to allow people the ability to freely stroll in “healthy” urban green. However, this never manifested into reality due to a loss of human scale, as well as due to the loss of place-based character imposed by the International Style. In addition, a growing dependence on cars and a simultaneous desire to spread outwards towards suburbia resulted in the physical disconnection between areas of work and residence (Madanipour, 1999). The vertical model for (building) densification also allowed greater provisions for more open and “healthy” urban spaces as a response to cluttered industrial cities of the beginning of the 19th century, as well as a greater provision for more space for the automobile movement however, it also “disconnected” people from the ground (street) level (Gehl and Svarre, 2013). Furthermore, the segregation between professionals, such as engineers, planners, architects, and others involved in city building lead to incoherent city plans with the prime focus being on traffic infrastructure, rather than on the social use of public space (Gehl and Svarre, 2013; Lang, 1987). The increasing speeds and volumes of automobile movement, and infrastructure needed to support them, claimed large parts of urban space, which became incompatible with the pace and nature of pedestrian movement, bringing spaces as well as people further apart. Madanipour (1999) provides the following characteristics of a modern city:

The modern city has therefore gone through a spatial and temporal dispersion of its functions and a despatialization of some of its activities, which have created multiple nonconverging networks working against the cohesive nodal role of the urban public space.

Subsequent changes in the means of transportation and modes of communication, such as the advance of telecommunication systems, resulted in further despatialization of social life (Sennett, 1977). The role of public space as a ground for social encounters, economic exchange, and for political debate quickly diminished. It is suggested in (Madanipour, 1999) that prior to the aforementioned technological advances, public spaces were necessary activity hubs where all the previously mentioned processes took place “through face-to-face communication”. By the end of the 20th century, they were no longer tied into any particular physical and/or geographic location. (Stamps and Smith, 2002) had characterized this particular period as a time of the “lost geography”.

The diminishing role of state intervention in economic and social activities, de-industrialization, and the consequent move to a service economy from the 1960’s onward caused yet another “transformation of the public sector and its role” (Madanipour, 1999). Large-scale privatization of urban space resulted in an imbalance in the planning
and management of cities, especially as the tax base was transplanted into suburbia. When the design of public space is driven by private interests, the “public” welfare takes a secondary position. The main interest of investors, in this case, is the in economic profit, or as Matthew Carmona calls it “a safe return on their investment”. As a consequence, public spaces gradually lost their cultural uniqueness and became “…treated as a mere commodity” (Madanipour, 1999). "Good" and meaningful public spaces should be social constructs that form through time, which should be gradually adapted by people to their needs and uses.

... public spaces are supposed to function as receptors designed to absorb and modulate the full range of expressions of the societies they serve... This vital function of public space has evolved over time (Lim, 2014)

Globalization has also had major repercussions upon public spaces around the world, since it is a multi-layered process in which decision-making can take advantage of economies of scale and uniform standards (Carmona, 2010). With the increasing “standardization” of public spaces in various cultural contexts, public spaces lose their meaning as an expression of the local people’s attitudes and needs. The aspect of cultural significance is critical for the human feeling of “belonging” and feeling of attachment to a particular territory. The unintended consequential relationship between local and global processes is that global large-scale economies gradually erase those at the local scale, such as culturally specific nuances (Carmona, 2010). Transformation of political and economic systems in Western European cities has led to a redefinition of public spaces which are mostly used for consumption and leisure purposes today and are targeted as the new “public” of “white-collar workers” rather than “blue-collars” of an industrial city (Madanipour, 1999).

In summary, modernist planning resulted in disintegration of urban fabric and disconnection between functions that had a negative impact on the public life in cities. Today, privatization leads to a disregard of “public” needs in public spaces because urban development is often driven by private interests, which are profit-oriented. Moreover, globalization induces the creation of standardized solutions for public spaces within cities around the world that do not reflect cultural specificity. The increasing difference in income levels, especially seen with the emergence of service-based economies, creates major social segregation. The redefinition of public space meaning and use calls for new design strategies that would accommodate changing needs and uses of public space, while preserving the role of public space as a socially common denominator in contemporary cities. Well-designed and, more importantly, well-used public spaces, can create a number of important positive socio-economic and environmental changes, such as increasing the social interconnection and social capital, promoting the
Due to its complex nature and its important role in social, economic, and political life of cities, public space has been studied from various perspectives within a broad range of disciplines. The present thesis refers to (Neal, 2010), who identifies three distinct perspectives. The first one is the political perspective, which zooms into the role played by public space within an evolving democratic processes, both literally as a gathering place and figuratively as a site of empowerment. The second one is the legal/economic perspective that looks for specific answers about space ownerships and financial management. Finally, the third one is the socio-spatial perspective which concentrates on the aesthetics (design) and purpose (use) of public spaces.

The consideration and study of public space as a social common denominator, as well as a place that brings people together for a variety of purposes, such as for cultural exchange, as a democratic place where people can express and share their opinions, etc., all constitute the themes of social and political philosophy (Neal, 2010; Arendt, 1998; Habermas, S. Lennox, and F. Lennox, 1974; Parkinson, 2012).

Public spaces are also “means of marketing localities” (Madanipour, 1999). The image of a city is often communicated to the rest of the world through its public spaces, such as Times Square in New York City or Red Square in Moscow. The “positive” (plausible) and memorable urban image is targeted at attracting mobile capital, including tourists, investors, and foreign specialists (Carmona, 2010).

As an economic entity, public space may be owned and managed by the state or by private developers. Developers are encouraged to provide public spaces, and their activity is controlled by regulatory documents that prescribe the development densities and the amount of open space to be provided for public use. The major concern from the legal-economic perspective is with regards to public space feasibility. Among the main benefits that public space brings to the economy of cities are a positive influence on property values, the increase of retail
activity, and the positive impact on regional economic development, and others (Carmona, Magalhães, and Hammond, 2008).

Finally, the way public space should be designed and also the manner in which its attributes interrelate with the use and behaviour of people constitutes the base of the socio-spatial perspective. Most of the recent research stems from the foundation laid out by (Lynch, 2012; J. Jacobs, 1962; Whyte, 1980). Each of these studies addressed the issue of public space design from a slightly different perspective. Kevin Lynch focused on the spatial aspect of public spaces, which were combined into mental maps and enabled the audience to explore complex design settings simply and analytically. As previously mentioned, the research of Jane Jacobs focused on the social functions of public spaces, such as population density and diversity, and their connection to the spaces’ liveliness and safeness. William Whyte developed a methodology to make an empirical connection between form and function at various scales from small urban plazas and beyond (Orum and Neal, 2010).

All these studies were driven by a unifying goal to achieve better quality of urban space in general and public space in particular (Moudon, 1992). This thesis follows the latter socio-spatial perspective and utilizes liveliness as a space performance attribute which characterizes its quality.

1.5 PUBLIC SPACE USE AND ITS QUALITY

The issue of public space quality is addressed in urban design literature through a range of characterisations and descriptors of public space. The latter are linked to (performance) qualities mostly through extensive empirical observations (Beirão, Chaszar, and Čavić, 2015; Carmona, Magalhães, and Hammond, 2008; Bossel, 1999).

Based on the definition provided in the previous section, public space is regarded in this thesis as an open space in a city that can be accessed by anyone at any point in time and free of charge. Furthermore, within the defined context, this thesis predominantly examines public spaces that imply non-privatized functions (e.g. transport nodes or shopping centres). According to the well established research literature, the success or quality of such types of spaces may be evaluated through the level of social activity, or as it will be termed in this study, the liveliness (Montgomery, 1998; Cilliers et al., 2015). Thus, the term quality in this research thesis is defined as:

“The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs” (Cowan, 2005)
In the present thesis, characteristics of space are referred to as descriptive attributes, while the performance of space (i.e. the ability of space to comply with human needs) is regarded through liveliness. According to well-established literature, the study of public space (e.g. purpose, form, location etc.) in conjunction with its use by people, is basic to the understanding about its quality (Carr et al., 1992). The goal of the current study is to test the interrelationship between liveliness and space descriptive attributes such as geometry, topology, user profiles, and others, where the main motivation is to provide for better understanding of public space characteristics that support vibrant social life within contemporary urban settings.

Two previously mentioned early pioneers, Jane Jacobs and William Whyte, first regarded the quality of urban space from the social use perspective (J. Jacobs, 1962; Whyte, 1980). They systematically examined into the reasons for which there are more people in some urban spaces while others remain abandoned. They asserted that quality of public space depends on street life and the variety of corresponding activities that take place there (Montgomery, 1998; Gehl and Svarre, 2013).

Social activity in public space is a product of very complex processes that occur at various levels of urban scale; thus, the quality of public space is also a multivariate concept that requires consideration of many factors. Jane Jacobs observed and documented several social, economic, and physical/design attributes at several distinct urban scales to provide a deeper insight into the way public spaces are formed and used, as well as defined metrics for what made them “good” (Gehl and Svarre, 2013). According to Jane Jacobs, the preconditions for activity in urban spaces are a mixture of primary uses, intensity/diversity of secondary uses that support primary uses, permeable urban form, buildings that vary in age, as well as form and use. Jane Jacobs affirmed that “simple on-site observations” are key to understanding the interaction between public spaces and public life.

The works of Jane Jacobs and William Whyte have been later adopted and developed by a number of researchers and practitioners in the United States, as well as in Europe, within the last fifty years. Their studies guided the ideas of such design researchers and practitioners as Jan Gehl, Allan Jacobs, John Montgomery and others (Gehl, 2011; A. B. Jacobs, 1993; Montgomery, 1998; Appleyard, 1981). Cumulatively, these works suggest a wide range of descriptive attributes that characterize “good” public spaces derived through extensive empirical observations, which laid out the foundation of this thesis and are reviewed in Chapter 2.
The descriptive attributes range from physical space attributes to the desired set of economic and social attributes, and they were developed in response to challenges created by modernist planning. Jane Jacobs specifically underlined the problems of urban formal, functional, and social segregation, which in turn lead to the reconstitution of the form and meaning of public places. Thus, the deterioration and the loss of quality of public space became the main topic of the urban design discipline which emerged in 1960s (Moudon, 1992). Initially concerned with physical urban form, urban design today implies a wider approach and is mainly preoccupied with making urban spaces or “public” spaces which can be used and appreciated by people (Carmona, 2010). Along these lines, a number of tools were proposed in research and design literature for design of “good” public spaces, which will be briefly touched upon in the next section and will be described in more detail in Chapter 2.

**1.6 PUBLIC SPACE ANALYSIS AND DESIGN TOOLS**

Bryan Lawson states that “A design solution is characteristically an integrated response to a complex multi-dimensional problem” (Lawson, 2006). In the case of public space, the range of problems that design should respond to is extremely broad. The primary question that the author asks is how does one know if the chosen design solution is the best possible for the range of identified problems? Indeed, it is an inherent part of the urban design process to compare design outcomes against a certain quality criteria (usually, dictated by design project goals) and this process implies the use of performance and descriptive measures that are jointly used to estimate the quality of a design.

Public space quality involves the consideration of multiple space characteristics, and more importantly, it relies upon their interrelation. In order to approach the problem of space quality in design practice, such characteristics should be measurable. By quantifying characteristics or attributes of public space, design practitioners are able to understand the different states of public space before and after the proposed changes. By comparing measurement results to a certain performance criteria, the qualitative dimension can be added to the process (Beirão, Chaszar, and Čavič, 2015). Based on this premise, a number of tools for public space quality evaluation and design process support were proposed in the research literature in the field since the emergence of urban design discipline in 1960s. The tools described use qualitative, as well as quantitative methods. Some are based on the first-hand field observations and are principally theoretical (Canter, 1997; Punter, 1991; Montgomery, 1998; Mehta, 2014; Varna, 2014), while others employ computational methods for space analysis (Hillier, 1996; Berghauser Pont and Haupt, 2010; Oliveira, 2013).
Theoretical frameworks combine and synthesize findings from preceding research studies that focus on such aspects as social use, space perception, and economic activity (J. Jacobs, 1962; Lynch, 2012; Whyte, 1980) with studies that concentrate more on physical form/morphology of public space (Cullen, 2007; Krier, 2003). Among the earlier examples of such theoretical frameworks are Krier (2003), Canter (1977), and Montgomery (1998). One aspect that all three studies have in common is the synthesis of knowledge from preceding research within the three main elements which should be considered in the process of public space quality evaluation: physical spaces, the sensory experience, and activity. This categorization is based on the premise that a certain amount of data homogeneity is needed in order to reduce the complexity and better grasp the interrelation between different types of attributes. Where Punter (1991) lacks details on the particular attributes for each component, Canter (1977) and Montgomery (1998) offer more detailed descriptions. Each component is assigned a number of descriptive attributes that should be considered in public space quality evaluation.

The recent efforts within the theoretical framework of public space are presented in Mehta (2014) and Varna (2014). Varna (2014) suggests ways to evaluate public space based on the concept of space “publicness” by utilizing a range of descriptors/indicators, such as ownership status, walking opportunities, sitting opportunities, diversity of activities, means of control, physical maintenance, and others. Mehta (2014) elaborates on a Good Public Space Index that measures the intensity of use at a number of streets’ segments (case studies). Vikas Mehta’s work also suggests a range of indicators that are more socially oriented, such as the age groups of people using space, their gender, their activities, and others to evaluate the space quality and its appropriation by people.

With regards to computational tools, Space Syntax employs mathematical methods to study the behaviour of urban environments based on topological characteristics of their urban morphologies (Hillier and Hanson, 1993). The determinant factor for movement densities, according to Space Syntax methodology, is the configuration of space (i.e. the structure of urban grid), while economic attractors serve as “multipliers” (Carmona, 2010). There are several measures that can be calculated using Space Syntax, such as integration, connectivity and choice. Urban spaces with higher connectivity and integration values, according to the authors, provide for higher movement densities.

Another set of quantitative measures for urban densities is suggested by a study by Berghauser Pont and Haupt (2010) in which the authors develop a set of indicators that are able to grasp density variations at different urban scales. Historically, density measures were used as
early as the beginning of the twentieth century as a means to regulate the development process and to create healthier and more socially viable urban settings (Berghauser Pont and Haupt, 2010). The two extremes of development densities are low-density/high-rise developments set in within green space advocated by the modernists planning and the low-rise “compact city” developments advocated by (J. Jacobs, 1962). Variations in densities are associated with different qualities of social life. Spacematrix develops a range of density measures and associates them with certain performance characteristics. The authors underline that varying densities provide for different performances for the built environment, such as degree of urbanity, attractiveness, or privacy. They distinguish between “hard” and “soft” performances. The first type can be analysed quantitatively and is more related to the physical shape of the built environment (e.g. daylight access). The second type, such as place attractiveness, requires more qualitative evaluation and empirical correlation to describe these “hard” performance indicators.

Beirao, Chaszar, and Cavic (2014) suggests ways for computational representation of urban open spaces in a form of solid voids where a set of morphological attributes of the resulting shapes is measured and interrelated with space qualities, such as enclosure, connectivity, granularity, and others.

One aspect that all of the previously mentioned frameworks and tools share in common is the use of indicators for urban/public space analysis and quality evaluation. The evaluation process involves measurement of indicators or attributes for case studies with the goal to get certain ratings for individual spaces, as well as to compare and contrast different examples. Measurement outcomes vary depending on the context within which a case study is set; thus, the question that arises is: Do certain indicators’ values mean higher/lower quality of space or not, and what are the criteria against which they should be evaluated?

To answer these questions, Berghauser Pont and Haupt (2010) and Beirao, Chaszar, and Cavic (2014) suggest to add a set of performance measures to the descriptive attributes. A similar path is followed within this research thesis.

The present thesis draws upon the descriptive attributes of public space collected from the well-established literature in the field, local expert feedback, on-site visits, and uses liveliness as a performance criteria for these descriptive attributes. Liveliness, in this case, is assumed as an objective expression of the degree to which a space is appreciated by people. This performance characteristic was measured through people counts and interrelated with descriptive attributes through empirical analysis (Figure 2).
This thesis proposes a methodology that allows to test interrelations between descriptive and performance attributes of public space in an objective manner. The developed method lays out the basis for the inverse design process by starting from captured evidence of ‘good’ public use by means of performance indicators which are then correlated with descriptive attributes. If certain public spaces are considered to be “good”, then one can determine possible ranges of values for intrinsic attributes describing those “good” spaces. As a result, recommendations for public space design originate from its social purpose and intrinsic attributes within a certain range, which may induce good quality of space, as opposed to abstract technical design specifications which can fail in doing so. In the latter scenario “goodness” of space may be a random phenomenon. For stable and robust development of urban areas, the first methodology provides obvious advantages over the traditional one. Within the developed methodology the potential of GIS technologies, remote access and data bases are explored.

1.7 THE IMPORTANCE OF PHYSICAL PUBLIC SPACE FOR THE YOUNG SOCIETY

This chapter concludes with the discussion of the role of public space for contemporary society, particularly for the younger generation. It was purposefully placed at the end of this part of the thesis to underline the intention and motivation of this work to contribute to creating a healthier and happier young urban society.
In contemporary society, much of our social activity within public spaces is largely driven by consumption; however, spaces with minor or non-commercial function, such as those examined in the present study, tend to receive less consideration within research and practice. Nonetheless, they remain crucial for psychological well-being. In their everyday life, people need to interact with one another face-to-face. They need to stay active doing sports or playing games. They need to take walks in order to exercise and connect with nature. Finally, they just need to escape from the hustle and bustle of city life from time to time. These activities would hardly be possible inside of popular shopping malls or along the busy, often over-crowded, commercial streets. While these public spaces may fit some needs, cities need a certain diversity and a range of places to accommodate the mental and physical health and well-being of a diverse, culturally rich populace.

In the course of this research study, it has been observed that many young people (approximately fourteen to twenty-five years old) use public spaces for a variety of activities that involve face-to-face contact, such as sports, chatting, or dating. New means of communication eliminate such direct social contact. One example being the idea of an increased “mobility” described by Norberg-Schulz (1971). The use of social media is widespread today and suggests a greater variety of potential social interaction not only beyond chance encounters but also beyond the realm of social circles – which once were facilitated by public space. The author opposes this suggestion by stating:

“... such a mobile world, which is not based on the repetition of similarities in connection with a stable system of places, would make human development impossible”

Christopher Alexander writes along the same lines that certain human behavioural anomalies, such as mental instability, follows from lacking close human interaction. A “healthy” level of interaction requires people to see each other more or less daily. The role of public space in human social interaction can be illustrated by the example of early childhood development.

Throughout their early life stages, children (and later on teenagers) learn basic skills and rules of social interactions, or as parents usually call it - “they test their boundaries”. They send certain signals – verbal or physical – and then learn from the response within their social group. The most basic example is a kid calling his friends names. In return, he or she gets back an appropriate response: either kids call him/her names back, or they retaliate emotionally with violence, tantrums, etc. From such situations, children learn what is possible and what is not in a civilized society. This type of communication is only possible via face-to-face contact in a physical public space. In
contrast, in a cyber space, young people can say anything or pretend to be anyone without getting an ample feedback or retaliation which can impede their psychological development. Psychological research suggests that a very important component of face-to-face interaction is provided by visual and vocal cues. Such non-verbal exchange can include eye contact, posture, tone of voice, etc. Processing non-verbal communication correctly is extremely important because it allows us to adjust our behaviour in response to the replies of others. A person’s ability to quickly process and react to such cues is related to that person’s success socially and academically (Knapp, J. A. Hall, and Horgan, 2014). Even children who are better versed in emotional intelligence can easily develop impressive social and leadership skills. But, non-verbal cues come across much stronger while interacting in person versus electronically (Sherman, Minas, and Patricia, 2013). For children, as well as teenagers and young adults (people in their early twenties), digital interactions can lead to underdeveloped social skills (Giedd, 2012).

Public spaces are grounds also for children to play, which is fundamental for their development process (D. G. Singer and J. L. Singer, 1990; D. G. Singer and J. L. Singer, 2005). At playgrounds, children learn how to share, how to invite others to play, and how to make friends. Apart from getting basic social skills, they develop physically through running, climbing, and jumping (Hart, 1994).

Public spaces also provide opportunities for socio-cultural exchange, which is of special relevance to the multicultural and democratic scene of Western Europe. In this regard, public spaces can act as "stages" where people can observe and learn from others about the local behaviours and customs of others. In particular, the work of Karin Peters is largely focused on the positive role of public spaces (dedicated to leisure activities in particular) within the cultural exchange between native and non-native citizens in European cities (Peters, 2011).

The above implies there should be physical setups, such as public spaces in contemporary cities, that can accommodate a wide range of activities for young people, as well as the uses and needs of numerous other social groups varying in age, income, and physical capabilities. The heterogeneity of social groups living in cities today calls for differentiated urban environments, in which public spaces are the enclaves that accommodate this difference in its various forms and meanings. As stated in current literature, the idea of a public space that is good for all is out-dated (Carmona, 2015).

Therefore, it can be concluded that the design of such spaces should be based on the understanding of interrelation between activity in space (i.e. space performance), which is expressed through space liveliness.
in this research study, and the objective characteristics of space (i.e. space descriptors).

The use of liveliness as a quality criterion with regards to social aspects proved to be effective since it was possible to differentiate between the types of spaces by the qualitative range and, subsequently, to measure the type-specific descriptive attributes. The detailed discussion on the use of the developed method to support the design of diverse and lively public spaces will conclude this thesis in Chapter 6.

1.8 Thesis Outline

This thesis is structured around seven chapters. The first chapter outlines the challenges of defining public space quality with regard to contemporary trends in the design and use of public space. The main challenge that arises is that contemporary public spaces are deprived of their original function and of their meaning as a common social denominator, and the reasons for that are manifold. On one hand, the design of public space is governed by (globalized) needs imposed by the service economy. The success or quality of public space in such situations is measured mostly through returns on stakeholder's investments. On the other hand, several social interactions are now taken into another dimension - cyber space. Despite the increasing popularity of cyber-encounters, face-to-face interaction within physical public space is still necessary for the normal psychological development of young people, as well as for the psychological well-being of grownups. This fact is confirmed during observations conducted within this thesis which demonstrates that many people, especially young people in their early twenties, as well as the families with young kids, extensively use public space for a variety of activities. In order to support these activities, it is necessary to understand what people need and how these needs can be supported through the design of public spaces. Spaces that successfully respond to the needs of users are considered to be "good". The attributes of good public spaces were prescribed since the origin of urban design as a discipline in the 1960s, which was a response to challenges created by modernist planning. These attributes are reviewed in Chapter 2 together with frameworks and tools that utilize different methods to evaluate public space quality. The review of literature has yielded a cumulative list of attributes that can be organized into two groups: descriptive attributes and performance attributes. Descriptive attributes are those which factually describe certain properties of public space, such as geometric characteristics, topology, number of retail shops within close proximity, potential user groups, and others. These attributes describe space but do not provide any information on performance or perception by people. Another set of attributes relate to the performance of public
space – namely liveliness, which is expressed through the number of people using place. Based on these two groups of collected attributes, it is hypothesized in Chapter 3 that there exists an interrelation between the two. To test this interrelationship, a method is proposed in Chapter 4 that suggests ways to quantitatively measure both sets of attributes where liveliness is represented as a proportion between people passing and people staying within public space. The application of this method is then presented in Chapter 5. The results of this method application suggest that the proportional correlation between people staying and people passing through public space turned out to be an effective measure of space quality. It allows one not only to detect places that are considered “good” by local design practitioners and in local design reports, but it also allows one to distinguish between/categorize public spaces according to their type. This finding is confirmed through the application of the newly developed method across a representative set of cases studies in Zürich, and the results are discussed in Chapter 6. An important differentiation of this research from others is in the use of the inverse approach which is based on the paradigm of synergetic effect from the interaction between various kinds of space attributes of public spaces that brings them into the category of “good” public spaces. This approach is based on the “final” result/outcome, such as the quality of existing actively used public spaces that are deliberately defined as “good”, which sets the range for space quality attributes - space descriptors not deducing the space outside the quality boundaries. Chapter 7 discusses the potential further implication and development of this method. In the future, it is planned to apply the method developed in the present thesis on a larger data set using data mining, which would help to solidify the methodology.
The use and the image of public spaces are constantly changing through time. Such changes are caused by transformations in social, cultural, economic and political structures of cities. The first part of this chapter provides an overview of public space evolution from ancient times until present day within Western European context, in order to give a broader understanding of public space with regards to local specifics. The next section focuses on a period from 1960s until now, which frames the main scope of the literature review in this thesis. The latter time period was chosen to establish a connection between the newly emerged discipline of urban design in 1960s, the use of urban space by people and related questions about public space quality attributes.

At the start of the section a definition of public space relevant to this thesis and types of public spaces to be studied within this thesis are provided. The reviewed literature is organized according to three research focus areas that lay within the scope of this thesis, namely: environment behaviour studies, place studies, and space morphology studies. The chapter concludes with the summary of reviewed publications and implications for this research. Chapter 3 then clearly defines the scope of the present study and formulates the hypothesis and associated research questions.

2.1 PUBLIC SPACE IN HISTORY

It is reasonable to assume that spatial practice, representations of space and representational spaces contribute in different ways to the production of space according to their qualities and attributes, according to the society or mode of production in question, and according to the historical period (Goonewardena, 2008)

Many types of public spaces in Western Europe originated in Roman and Greek cities (Carmona, Magalhães, and Hammond, 2008). The Greek and Roman public spaces were public in their essence. According to Sitte (Sitte and Stewart, 1945) they were stages for public life to unfold. Various social activities had originally taken place in public spaces, including education, public speeches, commerce or even legal proceedings. The role of public spaces in social life of Greeks and Romans was also reflected in their aesthetic appearance.
2.1 Public Space in History

2.1.1 Roman and Greek Cities

In Roman cities public spaces were planned and integrated within the city fabric (Carmona, Magalhães, and Hammond, 2008). There were social spaces, cultural spaces, shopping and spiritual spaces. The strong symbol of state and religion was reflected in the organization of public spaces. Consequently, senate and temple buildings surrounded the space with statues and monuments placed at the centre. Such organizational structures can still be found in contemporary European cities.

In Greek cities organic growth eventually was replaced with planned urban development. As a result, public space design increasingly reflected the fact that space aesthetics would impact the experience and the spirit of space users, e.g. applying non-axial design to public space to emphasize the space three-dimensional qualities. One of the most prominent examples of Greek public spaces is the Agora of Athens. Its literal translation is a "gathering place" (Orum and Neal, 2010).

2.1.2 Medieval Cities

The crisis of the slave-owning mode of production, continuous revolts and intrusions by foreign tribes (Slavic and Germanic) lead to the fall of the Roman Empire and to a partial abandonment of the Roman city building principles. A number of new “barbarian” settlements have been established which developed in the conditions of new productive relationships based on the feudal land ownership and labour of peasants exploited by feudal and were more bound to the rural way of living (Kolly et al., 1966).

Churches and monasteries played an important role in all the domains of medieval social/public life and served as a supporting element for the feudal system. Subsequently, church buildings were the organizing elements in urban structures of local settlements as well as in the overall process of medieval architectural development. The Church also became a centre of public life. Religious festivals and processions were meant to bring people together. Compared to its ancient predecessors, medieval cities were classless. “For the first time the majority of inhabitants were free men… city dwellers and citizens were synonymous terms” (Howard and L. Mumford, 1966; Carmona, Magalhães, and Hammond, 2008). This fact was reflected in lack of restrictions to use public spaces. The street systems that emerged were vibrant public spaces (Orum and Neal, 2010). Market places became another dominant/important type of public space of that period.
Monasteries, growing in numbers, required craftsmen, artisans, cattlemen who settled in the areas close by and provided the required services. The spatial structure of towns, thus, was a self-organizing product of these conditions of social organization. Having monasteries or fortresses as starting points, cities grew organically around, usually in the concentric manner following natural landscape (Broadbent, 1996).

The essence of the feudal system with its endless war of everyone against everyone and cruel exploitation of peasants, which resulted in many revolts from the side peasants, yielded a new architectural typology – the feudal castle (Kolly et al., 1966). Later, as a result of contact with the East in the time period of crusades the architecture of castles reached a very high level of sophistication in the strategic, as well as in the structural sense. Such castles with the adjacent public spaces are still present in European cities and are attractive destinations for people.

The history of architecture between 5th and 15th century can be divided into three periods. The typological and stylistic specificities that distinguished each of the periods had strictly historical grounds, changing in parallel to main shifts in social, political and cultural-historic structures of Medieval Europe (Kolly et al., 1966).

Pre-Romanesque period, which lasted from the 5th to the 10th century, is a period when construction was carried out sporadically initiated by the episcopes of monasteries and nobles who were largely from “barbarian” states. With Italy being an exception, this was a period in Europe of deep “barbarization” of the Roman building tradition, the time of empirical search of compositional and structural solutions for church buildings, mostly basilicas, constructed in a form of rough stony structures with wooden partitions.

The Roman period eleventh, which lasted during the 11th and 12th century is marked by a rapid acceleration of the form-generating process in the conditions of the feudal state and with the emergence of the established typology for the construction of churches. In the period of the consolidation of the feudal system, the Roman castle emerged as a distinct fortification building typology that also served as a dwelling of a feudal.

With the re-emergence of trade in this period, markets that were formed at the intersection of the major trading routes became starting points for the development of new cities. Houses were built on the plots allocated by landowners following the feudal structures. Those houses that were facing market places directly had the highest rent prices, the ones that were closer to city gates took a second best position. The rest of the plots were used for housing. As commercial activity took pace, more and more people headed to the cities.
The Gothic period lasted between the 13th and 15th century, and was the time of flourishing of the medieval towns. In the conditions of further strengthening of the feudal state and central power, the development of crafts and trade caused the increased in growth of the towns all over Europe. Due to increased wealth, the love of freedom and the energy of its population, they became centres of the medieval culture gradually displacing monasteries.

The architecture of the medieval Europe carried a civic character. It was created by groups of craftsmen largely empirically and in response to the ever complicating spatial and architectural tasks and with respect to the available social and material environment (Broadbent, 1996; Kolly et al., 1966).

The organization of medieval cities can still be traced in the historic centres of cities such as Zürich, Bern, Prague, Paris and others. For example, current locations of markets in Zürich can be dated back to this period. It has been underlined in a number of urban studies such as (Sitte and Stewart, 1945; Cullen, 2007; Rapoport, 1990; J. Jacobs, 1962) that the human scale of medieval city structures significantly adds to the experience and perception of space and is favoured by people who stroll in the city (Carmona, Magalhães, and Hammond, 2008). It is underlined in (Rapoport, 1990) that learning from urban spaces that were created when walking was the main mode of transportation may enhance understanding of preconditions for pedestrian use by designers.

2.1.3 The Renaissance

The Renaissance started in Italy in 14th century and later spread around the rest of Europe. Italy was and still remains the cultural centre, as many Greek scholars seeking security moved there from Constantinople in the period from 320 until 1450 AD. As a result of the feudal conquests and the expanding overseas trade at that time, the new wealthy merchant class had emerged. The new rich patronized many artists and intellectuals. During the Renaissance period, arts in particular thrived in Italy and were aimed to please the noble class.

Overall aesthetics, scale and proportion came to play key roles in the design of urban space. Some Italian piazzas were beautified and rebuilt from older structures while others were created anew (Carmona, Magalhães, and Hammond, 2008). Often, markets and traffic were banned from city centres to give place to monumental architecture and sculptures. As opposed to the incremental growth of Medieval Cities, during the Renaissance period a city was considered to be a product of rational planning. Geometric elements such as squares, the
star-shaped plans and regular street grids became the main elements of the city structure. The revival of ideas from Greek and Roman culture during Renaissance led to the design of public spaces that resembled shapes and functions of classical Greek public space such as Agora (Orum and Neal, 2010).

From the 16th century onwards, the pedestrian scale of streets of medieval towns gave way to new street types designed to accommodate with respect to the needs of a new mode of transportation – the carriage, which implied higher speeds of movement along the streets, as well as a different way of space perception. Streets were divided into traffic lines and footpaths. They became longer and straighter to accommodate higher speeds. Rows of buildings along the streets implied transitional movement and focused the view at the end of the path (Gabrichevskiy et al., 1967).

It is regarded in the literature that during this period, the nature of public spaces has changed. Their design was mainly governed by aesthetics and preferences of the noble class. They took a form of “geometric arrangements and avenues designed for royal processions and marching armies”, rather than places for vibrant social and economic activities. The fine-grained organic structures of medieval cities have been reconstituted. Lennard Crowhurst and H. L. Lennard (1995) write the following regarding public space in this period:

“The etoiles created at major junctions were not “places” for social life, but neither were the symmetrical geometric spaces in front of a palace or other monumental government buildings.”

2.1.4 Industrial Revolution

Transformation of the medieval towns that started already in the Renaissance period was brought forward by the needs of new industrial cities around Europe. Large influx of people from rural areas seeking jobs at emerging industries resulted in overpopulation and consequent deterioration of living conditions, as well as in disease outbreaks. The solution to remedy the problems associated with increased human influx was sought in new building/planning schemes. New regulations were aimed at improving living conditions, as well as erasing meandering slums that could potentially become focal points of unrest and opposition.

In order to educate and increase the overall cultural level of the new urban working class, formerly private squares and parks such as, for example, Georgian residential squares in London, were opened to the public (Orum and Neal, 2010). Creation of parks was also
In this period, the two major schools of thought in city planning could be identified (Gehl and Svarre, 2013). The first school, led by Ebenezer Howards, was the Garden City movement. It suggested a clear separation of functions expressed in a form of the house settlement schemes (Howard and L. Mumford, 1966). Ebenezer Howard and his proponents suggested that there was a strong correlation between unpleasant living conditions and human social and psychological behaviours. Consequently, by changing the environment, one could expect that people living there would also change their behaviour.

Ideas of the second school of thought take their roots in the work of Camillo Sitte (Sitte and Stewart, 1945). They are summarized in his book “The Art of Building Cities: City Building According to its Artistic Fundamentals” that encouraged design of cities from an intuitive and aesthetic perspective. His theory emphasizes the importance of learning from traditional ways of building. Camillo Sitte glorified the quality of medieval streets with their meandering nature that brought life and intricacy. He also referred to classical Greek and Roman examples of public space. According to him, the interconnection and harmony between different parts of the city were more important than the quality of an individual object (building, piazza etc.) According to Gehl and Svarre (2013), his writing created the foundation for future studies on public life and public space, respectively. Moreover, his writing focused on the design of "people places", rather than on rigid building form regulations.

The ideas of Ebenezer Howard were brought forward by modernists in the first half of the 20th century. The work of Camillo Sitte found its followers later, in 1950-1960 with one of them being Gordon Cullen and his work “Townscape” (Cullen, 2007). The next part of the chapter reviews the modernists’ planning, followed by the review of the period when public space and public life studies emerged in 1960s.

2.1.5 Modernism

According to Jane Jacobs, the modernist movement builds upon the image of the Garden City movement; however, the modernists realize the concept of Garden City for higher densities in a form of high rises standing in the prairies (J. Jacobs, 1962). Modernists planning principles dominated urban design discipline until the mid 1900s. According to Gehl and Svarre (2013), the major writing in urban planning in the period from 1880 until 1933 include the works by Camillo Sitte "City Planning according to Artistic Principles" (1889), Ebenezer Howard
"Garden Cities of To-Morrow" (1902), and Le Corbusier "Towards Architecture 1923 and the Charter of Athens" (1933).

Le Corbusier regarded the qualities of medieval towns that were admired by Sitte as the maladies of contemporary cities. Generally, modernists rejected traditional high-density city structures of the medieval cities. In 1923, Le Corbusier published a number of essays, which made a case for building rational and functional cities with straight lines, green areas and high-rise buildings and highways. Consequently, in 1943, Le Corbusier published a heavily edited version of conclusions from the fourth CIAM meeting held in 1933. Based on the analysis of 33 cities, CIAM proposed that problems faced by cities could be resolved by strict functional segregation, with population being distributed into apartment blocks at widely spaced intervals (E. P. Mumford, 2000; Gehl and Svarre, 2013). These changes generally meant that open green areas intended for recreational use between tall standalone buildings replaced traditional public spaces used for social activities. Functional segregation was at the core of the modernists’ plans, which was meant to accommodate a growing number of cars. Accordingly to the modernist perspective, people and cars were each meant to have their own territory and not to intermingle.

The previously described reconstitution of the interrelation between the various functions in a city affected social life in public spaces. Large parcels of land between buildings were left empty, which was sought to bring “more light and air” and to allow people the ability to freely stroll in “healthy” urban green spaces; however, this never manifested into reality due to a loss of human scale and a loss of place-based character.

In addition to new strategies in urban development, various groups of specialists handled aspects of urban development individually due to the demands of industrialization: engineers and planners handled large-scale aspects of designs such as overall infrastructure, architects were in charge of mid-scale aspects such as site plans and building designs, and the small-scale aspects were handled by landscape architects who were in charge of green elements and recreational zones (Gehl and Svarre, 2013; Lang, 1987). Such a mechanistic approach to city development excluded the realities of social life. The disconnected systems of pedestrian and traffic roads that were not meant to intermingle were adopted differently by people in the reality of everyday life. The traffic lanes were crossed by people for convenience and in order to shorten their journeys at spots where drivers would not expect to see them which lead to multiple accidents. Thus, engineering plans were not always practical for the everyday life of local residents.

Finally, in the 1960s, a number of researches began to focus on the social life of public spaces.
2.1.6 Urban Design and Public Life Studies

Continuous technological advances coupled with the invention of cars that became cheaper to produce in 1950s meant that more people could afford to buy them. As has been mentioned in the previous sections, the car dominance in cities started to interfere with pedestrian life. More cars also meant higher mobility which resulted in people leaving cities for new suburban neighbourhoods. In the middle of the 20th century, cities began to grow rapidly beyond old boundaries and into new extended suburbs. However, social life of public spaces did not follow into suburbia. It became clear in the 1960s that public space and public life do not happen automatically but require certain conditions to develop, such as the appropriate population density, a variety of potential activities and proper physical setups (Carr et al., 1992). Around the same time, the interaction between public life and public space was identified as a specialized field that needs to be studied more carefully, which gave rise to the emergence of a new discipline of urban design (Moudon, 1992; Krieger and Saunders, 2009; Broadbent, 1996).

It is described in (Gehl and Svarre, 2013) that there are two studies which are generally considered to be basic for the discipline of urban design. The first study is William H Whyte’s “Securing Open Space for Urban America” (1959) and, second is Jane Jacob’s “The Death and Life of Great American Cities” (1962). In the following decades, there were three other works produced which are often perceived as a turning point in understanding of an urban space nature and its complexity: Lefebvre’s “The Production of Space” (2008) and Relph’s “Place and Placeness” (1976).

Later on, in 1980-90s city inhabitants and visitors made more and more demands regarding liveable and attractive city environments that would incorporate public life. City planners and politicians recognized these demands and utilized them as points of differentiation between cities. In 2000s, the desire to find solutions to the challenges posed by the environment, health and safety was added to the list (Varna, 2014).

2.2 The Scope of Research Study

The motivation for the present research is an enhanced understanding of interaction between public space and people, with the subsequent goal to identify space attributes that provide for its better use. Consequently, this work focuses on the period from 1960s until today, when urban design was formed as an independent discipline that had a particular focus on the creation of good urban spaces for people.
2.2 THE SCOPE OF RESEARCH STUDY

To get a more systematic overview of the areas of concentration within the discipline of urban design, this thesis refers to the epistemological study by Anne Vernez Moudon (Moudon, 1992). She has identified the following nine areas of concentration in urban design discipline: urban history studies, picturesque studies, image studies, environment-behaviour studies, place studies, space – morphology studies, typology – morphology studies, material – culture studies and nature-ecology studies.

The urban history studies are concerned with how and why certain urban form came into being. Picturesque studies accentuate the pictorial element of urban settings and its quality, and are largely formed by personal judgments based on personal experiences. Image studies investigate the way people conceptualize and understand urban settings. Environmental - behaviour studies research how people interact with urban environments and in particular, the way they use it or behave within it. Here, the emphasis is more on the subject (people), rather than on the object (the physical setting). They take their roots in social sciences and result from the multidisciplinary studies. The latter was, in turn, a product of systems sciences that emerged from the military needs during the WWII. The methods suggested within the area of environment- behaviour studies were regarded as more reliable than highly subjective ones of the picturesque studies, for example, due to the fact that they were based on scientific evidence. Under the influence of the systems approach, the group of Leslie Martin and Lionel March emerged at the University of Cambridge. Their studies laid the foundation for another area of research – the space morphology studies. Space morphology studies focus on the underlying structure of space and explain it by employing mathematical logic and computational means (Kropf, 2009; Hillier and Hanson, 1993; Marshall, 2005; Laskari, 2014). Place studies, as well as environment behaviour studies, look at the relationship between people and setting but focus on the object as a main outcome of a design process. The description of the three latter areas of inquiry is omitted due to their irrelevance to this research study.

This thesis examines environment-behaviour studies in order to understand ways of studying human behaviour in public spaces. To identify the set of public space descriptive attributes that foster activity this work refers to place studies. Finally, to learn about the analysis of underlying physical structure of public space, this work employs the methods best presented within space – morphology studies. In order to proceed with the review of the analysis methods, the term "public space" has to be defined for the purpose of this study.
2.3 PUBLIC SPACE DEFINITION AND SCOPE

The definition of public space should be viewed within the two broader concepts: public life and public realm. Public life is associated with social processes that occur in public spaces. Carmona (2010) identifies two types of public life – “formal” and “informal”. Formal public life in public spaces is governed by formal institutions, while the informal one takes places naturally as a result of people’s conscious, individual choice. For example, a transportation hub is a place where people have to go to in order to get from point A to point B. On the other hand, an urban park is a place which people choose to come to only if they want to.

Public realm is a broader definition of a setting where public life takes place. It serves a number of important purposes, one of many being a place for social exchange, personal development and physical well-being. It ranges from cyber space to a physical one (Sennett, 1977; S. H. C. Lennard and H. L. Lennard, 1984; Carmona, 2010). According to Carr et al. (1992), physical public spaces can be categorized as follows: external public space (river banks, streets, squares, parks etc.); internal public space (public libraries, town hall); external and internal quasi-“public” spaces (e.g. privatized external public spaces). Authors provide the following categories of the external public spaces: public parks, square and plazas, memorials, markets, streets, playgrounds, community open spaces, greenways and parkways and waterfronts.

It is suggested in the literature that a good public space is the one where “informal” public life takes place, and which supports a high degree of “optional” and “social” activities as defined (Gehl, 2011). Gehl suggests classification of public spaces by the following activities: necessary, optional and social (Figure 3). The necessary activities (e.g. walking to school, work) happen independently of public space quality. The optional activities take place only if conditions are pleasant and mostly take form of lingering and wondering - something people do when not in a rush and with pleasure and enjoyment. And, consequently, if people feel good, this makes them predisposed to further social activities, e.g. occasional conversation with a stranger, a game between kids, etc.

The focus of the present work is on the physical external public spaces where the “informal” public life takes place, specifically, on spaces which people choose for optional and social activities such as urban squares and urban parks. These two types of public spaces are also most representative elements of public realm in European cities. The following text is the translation from German of Magnago Lampugnani (2014) where definitions and explanation of a park and a square as distinct public space types are provided.
The term park comes from the mit-lattin parricus and identifies an enclosed area within a space that is differentiated in terms of functionality, appearance and meaning. With a variety of park types such as parks of castles, natural parks, urban central parks, theme parks, and others, different perceptions and meanings for different individuals are expected, which imply different relations between nature and culture.

The square typically has an open and public character. Historically, it used to fulfill the purpose for people to meet and socialize within a city or a village. The square’s appearance constantly changed over time, trying to adapt to new social requirements of usage.

The quality of spaces such as urban squares and urban parks may be estimated based on the number of people using space for informal and optional activities. This view on public space quality necessitates its study (its attributes) in conjunction with human behaviour and use, and with regards to the way space “fits” human capabilities and needs (Carr et al., 1992; Gehl, 2011; Lynch, 2012). The next section reviews the literature which suggests ways to study human behaviour in public spaces, which in turn induces a deeper insight into interrelations between human use (driven by their needs, capabilities etc.) and public space attributes.

### 2.3.1 Public Space Quality Regarded through Liveliness

In the literature, there exist a number of interchangeable terms that are used to describe successful urban settings such as vitality, liveability, viability and liveliness (J. Jacobs, 1962; Montgomery, 1998; Lynch, 2012; Whyte, 1980). John Montgomery underlines that vitality is what distinguishes successful public spaces from others. He suggests that vitality:
“...refers to the numbers of people in and around the street (pedestrian flows) across different times of the day and night, the uptake of facilities, the number of cultural events and celebrations over the year, the presence of an active street life, and generally the extent to which a place feels alive or lively.” (Montgomery, 1998)

Jan Gehl accentuates the interrelationship between the quality of public life and vitality, and observations by Jane Jacobs suggest that activity produces the quality in the urban environment and vice versa. Kevin Lynch defines vitality as follows:

“...degree to which the form of place supports functions, biological requirements and capabilities of human beings.” (Lynch, 2012)

Thus, vitality refers to the number and variety of activities (social, economic etc.) and the degree of interaction between their various types that occur in urban space.

Viability, on the other hand, is defined in the Urban Design Dictionary as the ability of urban space to attract investment for further development. In other words it is a measure of urban space feasibility (Cowan, 2005).

Liveability is a characteristic of cities that offer a good quality of life. There exist a number of indicators that measure liveability (or life quality) in cities such as for example the level of unemployment, crime rates, access to free education, etc. (R. W. Marans and Stimson, 2011). The types of indicators vary for different countries.

Essentially, people are at the core of any stipulations regarding vitality or liveability of cities. The term liveliness can be considered within these two broader concepts. In general, when urban spaces are described in literature as lively, it is most often referred to the level of perceived activity produced by the number of people using space (Montgomery, 1998). However, as precise definitions of the term “liveliness” vary in research literature (Cilliers et al., 2015), it will be defined as a number of people using public space for transit and stationary activities for the purpose of this thesis. In the course of the present research work this definition has been developed and first introduced in Beirão and Koltsova (2015). This publication presents a method to measure permeability as an urban quality that impacts liveliness. This study has been brought forward within this thesis where liveliness is explored in conjunction with a larger set of public space quality attributes (Koltsova, Kunze, and Schmitt, 2012).

There is a number of tools and techniques, in particularly within the environment behaviour research and place studies, to explore the reasons why certain public spaces are livelier than others.
People in Public Space: Behavioural Studies

“Implicit in every design process are conjectures about the functions to be housed, about the requirements of the “physical system” required to meet these needs, about the approaches to design that fulfil these needs, about how these different designs work, and about the future physical and social environments in which they will have to work.” (Lang, 1987)

The observation of environmental behaviour is well established and widely applied in urban design research and practice. Behavioural studies contribute to design theory by providing deeper insights into the relationship between built environments and people (Moore and R. Marans, 1997). One of the most applied techniques to the study interaction of people and built environment is a direct observation, in which neither of the two is manipulated. Such studies imply structured documentation of the observed facts, as well as careful consideration of the time spans during which the observations are conducted. William Whyte specifically underlines the importance of direct observations which should be supported by other means of analysis, such as photographs, video recordings, time-lapse cameras and others. (Whyte, 1980; Gehl and Svarre, 2013).

Methods for environment behaviour research are well described in Porteous (1977) and Zeisel (1986). According to Porteous (1977), behaviour of people within a built setting is influenced by several factors: genetic capabilities, experience and familiarity with a setting, and the setting itself. Cultural habits cause variations in the behaviour of people, which is reflected in the traditions of space use.

Zeisel (1986) suggests the two following observation techniques: observation of physical traces and observation of environmental behaviour. The first one is focused on physical traces of behaviour, i.e.: by products of use, adaptations for use, displays of self, and public messages. Observing physical traces can provide an initial idea about the possible activities that take place, and also provide a hint to their sequence, cause and effects. However, a researcher would always have to verify the initial intent by looking directly at the way people act in a setting. The second technique implies unobtrusive systematic watching of people exploiting public space. Typically, the researcher takes the role of a participant and sets out to answer the three following questions:

• What do people do in public space?

• How do their activities interrelate with the physical structures of the space?

• And how, in turn, do spatial relations influence human behaviour?
One example of such interrelationship is the visual link between the parent and the child in a public space. While child is actively engaged inside the space by playing with others or interacting with some physical objects (e.g. fountain, art object, play/sport element), it is important for the parent to see the child. Any (physical) obstruction of this view would make it difficult for the parent to make sure their child is safe. Thus, when designing, spaces that are intended to be used by families, aspects such as the view need to be considered in the organization of elements. Physical components that impact the use of space include but are not limited to walls, fences, art objects, and symbolic elements. The design of these elements in general, i.e. dimensions, orientation and allocation in space, has certain effects on the behaviour and navigation of people in the space.

Having on site observation at its core, Mehta (2007) suggests a set of tools to assess the responsiveness and diversity of public space which, according to the author, are prerequisites for lively urban spaces. Specifically, the author suggests that the number of people staying and the length of their stay are important for space liveliness and vice versa. In short, “people attract people”. To be lively and animated during large span of the daytime, the space should provide possibilities for people of diverse social groups (age, income or biological capabilities). Consequently:

“The variety of activities and the diversity in age and gender of the users indicate how responsive the space is for different users and purposes.”

Mehta (2007) suggests six measures that indicate space responsiveness and diversity which are presented in Table 1.

<table>
<thead>
<tr>
<th>Measures indicating space responsiveness</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity of use</td>
<td>Determined by calculating the number of people engaged in some stationary and sustained activity at the block-segment</td>
</tr>
<tr>
<td>Intensity of social use</td>
<td>Determined by calculating the number of people in groups of two or more engaged in some stationary and sustained social activity</td>
</tr>
<tr>
<td>People’s duration of stay</td>
<td>Calculated by studying how much time people spent in stationary activities at the block segment</td>
</tr>
<tr>
<td>Temporal diversity of use</td>
<td>Determined by calculating the use of the space over the duration of the day</td>
</tr>
<tr>
<td>Variety of use</td>
<td>Determined by calculating the number of types of activities at the block-segment</td>
</tr>
<tr>
<td>Diversity of users</td>
<td>Determined by calculating the variety in the gender and age of the people at each block segment</td>
</tr>
</tbody>
</table>

Table 1: Six measures that indicate space responsiveness. (Source: Mehta 2007)

General on site observations, as well as the tools presented in Mehta (2007) employ methods to count the number of people using the space.
Stationary activities can be recorded in the form of dots mapped on the drawn plan of public space, while transitional activities can be recorded using such method as “gate counts”. The detailed description of this method can be found in the “Space Syntax Observation Manual” (Syntax, 2013). This method implies selection of a point - a “gate” in space. Number of people passing through the gate within a certain time period is recorded. In order to get a result that would reflect the real situation such counts should be conducted several times on different days and times of the week.

The presented methods and tools distinguish the following important questions regarding the utilization of space: who uses the space, how many users are there, as well as the types and length of activities the individuals who use the space are involved in. All of it is factual information. To understand the triggers for what happens in the space, it is necessary to understand the driving factors for space use, one of them being the human sensory perception which is especially relevant to the micro scale analysis of public spaces, also referred to as the scale of an individual public space.

2.3.3 Consideration of Human Scale in Public Space

One of the most notable works on behaviour of species regarded through physiological capabilities is the study conducted by Edward Hall (E. T. Hall, 1966). His studies are largely based on behavioural observations. He writes about the way people become aware of the world through physical forces acting on their sensory receptors. E. T. Hall (1966) identifies the following categories: the distance receptors and the immediate receptors. Each of these implies specific distance of perception. Through distance receptors, people get information about the objects and subjects that are located at a certain distance, and these receptors are the eyes, the ears, and the nose. Through the immediate receptors, i.e. skin, membranes and muscles, people are able to understand the world through the immediate body contact. Distance receptors are able to act within certain distances, or as they are called by Edward Hall, “spaces”. He identifies the two following types of spaces: visual and auditory space.

These two concepts of visual and auditory space are very different. Visual information is more focused, while auditory information is more vague. E. T. Hall (1966) provides specific dimensions of these spaces. For hearing, it is approximately six meters for a two-way conversation, 30 meters allow a one-way communication, and beyond 30 meters, the human ability to hear reduces drastically. The visual field of a human is much broader. At 30 meters, an eye can perceive and differentiate
rather large amount of information. Hall distinguishes between the following types of vision:

- **Foveal vision** – the smallest area of vision, something that a person can see in front of him without moving eyes at all
- **Macular vision** – the visual angle of 3 degrees in the vertical plane and 12-15 degrees in the horizontal plane
- **Peripheral vision** – the attention to the details of an image, such as colour, is reduced, and attention to movement becomes dominant. The limitations for the peripheral vision are the following: the 90 degree angle from the line virtually drawn from the middle of the skull

Connecting the design of space and its perception through the peripheral vision, Hall provides an example of trees planted at an even distance that would amplify the sense of movement. This way, objects in space (e.g. historic buildings) can be seen as a whole from a distance of twice its height.

People come to public space alone, with family, close friends or with acquaintance. Consequently, the modes of communication and the distances at which communication occurs between these different groups of people vary. Thus, spaces should accommodate the possibilities for interaction at various visual and sensory distances. E. T. Hall (1966) brings several examples of visual and sensory distances; intimate distance (contact behaviour), personal distance (non contact behaviour, people at the bus stop), social distance (e.g. colleagues in business) and public distance (person giving speech to audience). These distances were identified by Hall in the course of an experiment, in which he counted the number of the so called “vocal shifts” between the two people speaking. The term “vocal shifts” refers to the shifts of voice level in relation to distance between people. The following four categories emerged from this experiment:

- **Intimate distance** – varies from the direct physical contact to 15-20 cm
- **Personal distance** – spans between 45 cm and 120 cm
- **Social distance** – ranges between 120 cm and 365 cm
- **Public distance** – spans between 365 cm to a meter and above

Ergonomics of space should consider the ways in which people perceive the space using their senses. Various spaces imply varying uses. Some spaces should be observed from afar, while others should be sensed and touched. The smaller the space, the more tactile experiences it encourages. For example, in a room people mostly sit and lie down, the ergonomics should be such that it accommodates these activities. On the other hand, if a room is too crowded, it feels oppressive.
2.3.4 Public Space Descriptive Attributes

The previous section reviewed a number of analysis methods for human behaviour in public spaces, where as the current section will focus on the attributes of public space itself. The literature review carried out encompasses the period from 1960s, which marked the point when urban design emerged as a stand-alone discipline, until present day (Figure 4). In this period a number of works that suggest attributes of successful public spaces have been developed. These works include design studies, with resulting recommendations, direct design guidelines, theoretical frameworks and design and analysis tools (J. Jacobs, 1962; Whyte, 1980; Montgomery, 1998; Varna, 2014; Mehta, 2014). The goal of this review is to identify a set of attributes that are most representative of public space quality to be studied in conjunction with space liveliness in order to identify the underlying interrelationship.

Figure 4: The reviewed writings organized as a timeline
2.3.4.1 Jane Jacobs: Modernism under Attack

One of the first and foremost messages at the beginning of Jane Jacob’s book "The Life and Death of Great American Cities" (J. Jacobs, 1962), states that it is only through observations of real city life that it is possible to understand what stimulates social and economic vitality in cities. She writes that:

“Cities are an immense laboratory of trial and error, failure and success, in city building and city design. This is the laboratory in which city planning should have been learning and forming and testing its theories” (J. Jacobs, 1962)

According to Jane Jacobs, a good city must be, first and foremost, diverse. In particular, spaces (open and built ones) and businesses should all be diverse. However, the prerequisite for vitality in cities is a mutual support between these elements.

There should be enough people working or living nearby who use space for it to be socially diverse. The economic diversity is based on a large number of various enterprises of varying sizes with high proportion of smaller elements that should functionally complement one another. Finally, building form should vary to provide pedestrians with intriguing experience of space variation (e.g. visual interruptions of the urban scene, the combination of clear and understandable grid street system with sudden interruptions by irregular winding streets etc.). Table 2 provides a summary of attributes of diversity suggested by Jane Jacobs. These should be regarded within the three urban scales: entire city; district and neighbourhood (Figure 5).

![Figure 5](image_url)

Figure 5: According to Jane Jacobs the attributes presented in Table 2 should be regarded at the following three urban scales: entire city, district and neighbourhood (Source: Jacobs 1962)
### Social
- Dense concentration of people working/living in the district
- Presence of people with varying time schedules
- Vitality: people staying/passing
- Presence of social contacts
- Possibilities for children for “city play”

### Economic
- At district scale – more than one primary function
- Buildings of varying age and condition
- Diversity of businesses of various scales
- Large number of small businesses supporting one another

### Environmental
- Availability of sun
- Sun protection
- Intricacy (change in rise of ground, grouping trees)
- Centring (e.g. small parks as centres)
- Enclosure
- Interesting views, visual interruptions, visual dominants, attractive views
- Parks at dead-ended streets
- Uninterrupted distant views to water

### Physical
- Sidewalk width 30-35 feet
- Sidewalk niches
- Irregularities in building line
- Short blocks
- Frequent street intersections
- Presence of landmarks: for navigation and diversity
- No physical obstructions
- Combination of a clear grid system cut by irregular winding streets
- A square as an interruption to a street that is too long

Table 2: The List of urban space attributes and qualities suggested by Jane Jacobs (Source: Jacobs 1962)

#### 2.3.4.2 Cullen: Urban Environment as an Experience

The study by Gordon Cullen presented in his book “The Concise Townscape” focuses on a “serial vision” experienced by an individual walking through an urban setting (Cullen, 2007). The aim of this book is to teach design practitioners and students the ways and techniques to observe and create rich and harmonious urban settings.

“...the whole city becomes a plastic experience, a journey through pressures and vacuums, a sequence of exposures and enclosures, of constraint and relief”

Cullen (2007) suggests three ways through which urban designers may understand the manner in which an urban environment creates an emotional reaction. They are categorized as follows: optics, place and content.

One way is to consider it through the optical/visual perception. More specifically, it is the impression about an urban environment that is gained through a series of revelations. Gordon Cullen names it a serial vision (Cullen, 2007). He proposes an analysis technique (of the serial vision) which uses a series of sketches in conjunction with an urban space plan. As an illustration, he shows a path within the urban setting with a number of points marked along it, for which he then provides a series of sketches to give an idea of the third dimension at these
locations. These sketches attempt to capture experience of a person who walks down the path.

Here, the author accentuates the importance of space analysis in two and three-dimensions, adding a forth dimension in the form of visual-temporal progression of urban space scenes. Gordon Cullen writes the following:

“…the slightest deviation in alignment and quite small variations in projections or setbacks on plan have a dis-proportionally powerful effect in the third dimension.” (Cullen, 2007)

Another way to examine urban space is to look at the characteristics of a place. This implies the analysis of people’s response to the positions that their bodies take in an urban setting. Particularly, Gordan Cullen emphasizes the influence of exposure (being outside) and enclosure (being inside, within space). When discussing the concept of places, Gordan Cullen considers such elements and notions as occupied territory, advantage enclosure, focal point, indoor landscape etc.

“Since it is an instinctive and continuous habit of the body to relate itself to the environment, this sense of position cannot be ignored; it becomes a factor in the design of the environment – the major impacts of exposure and enclosure.” (Cullen, 2007)

The third category, content, refers to the study of the urban fabric, specifically, colours, scales, textures and similar characteristics. These are important properties of the urban form that can have an impact on the way place is experienced by people.

Within the three categories, Gordon Cullen suggests a number of attributes of urban settings that contribute to the coherent and harmonious experience associated with using the space. The list is vast; thus, within this thesis, only the attributes relevant to the focus of the study will be considered as well as the two public space types considered here: namely, the urban square and the urban park. Also, some attributes are omitted since when they are applied to a specific public space type, they appear to be redundant. These attributes are summarized in Table 3

The study by Kevin Lynch, which will be discussed next in the text, also puts an emphasis on the physical components of the urban environment and the relationship between them, but also explores them from the perspective of human perception. Both authors emphasize the importance of a clear structure. In the case of Cullen (2007) he underlines that only cities which have a “working” structure that it developed gradually, following the evolving and ever changing social life.
### 2.3 Public Space Definition and Scope

#### 2.3.4.3 Imageability and Urban Space

For Kevin Lynch, a "good" city has a clear structure which can easily be grasped by people. He does not analyse physical form of a city per se, but examines it through human perception. After the evaluation of a number of city paths and their elements (i.e. everyday routes people take to work or elsewhere) drawn by people, he created a generalized mental image of parts of a city and its elements – the environmental image. It is composed out of the following elements: identity, structure and meaning. They are defined in Lynch (2012) as follows:

- **Identity**: determination of object identification based on key characteristics related to the surrounding setting.

#### Elements of Possession

<table>
<thead>
<tr>
<th>Places</th>
<th>Elements of Possession</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupied territory</td>
<td>The most common motives of possession are shade, shelter, comfort and facilities because they represent a fixed and occupied setting.</td>
</tr>
<tr>
<td>Advantage</td>
<td>Among the examples of the advantage lines are the embankment lines which people favour due to the opening views.</td>
</tr>
<tr>
<td>Viscosity</td>
<td>A mix of static and dynamic properties of space is called viscosity, with the examples being the gathering of people in groups to chat, people lingering along shopping windows, news paper stands, etc.</td>
</tr>
<tr>
<td>Enclaves</td>
<td>The examples of enclaves are internal spaces that open up to exterior ones and provide a sense of safety and possession.</td>
</tr>
<tr>
<td>Enclosure</td>
<td>A small enclosed square, such as a courtyard, is congruent with human scale and create a special ambience with its quietness and intimacy.</td>
</tr>
<tr>
<td>Focal Point</td>
<td>A central element in space, a focal point that brings it identity and the perceived feeling of being “here” to pedestrians.</td>
</tr>
<tr>
<td>Defining space</td>
<td>Among the elements that define space may be lines of trees or more explicit borders such as fences and barriers.</td>
</tr>
<tr>
<td>Change of level</td>
<td>Lower levels of urban spaces impose the feeling of intimacy and enclosure while high-er ones suggest superiority and delight.</td>
</tr>
<tr>
<td>Division of space</td>
<td>A way to divide optical space into “here” and “there” is to bisect the angle of vision into two approx. equivalent parts.</td>
</tr>
<tr>
<td>Linking and joining: the floor</td>
<td>Use of various surface materials such as cobbles or tiles to indicate different urban functions. Cullen suggests that “floor signage” could potentially replace the third dimensions – standing signs.</td>
</tr>
<tr>
<td>Hazards</td>
<td>The most common examples of hazards are railing and fences as well as landscape undulation, water bodies or raws of plants.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content</th>
<th>Attributes and urban space qualities suggested in Cullen (2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intricacy</td>
<td>Building form in particular</td>
</tr>
<tr>
<td>Multiple use</td>
<td>In a form of joint activities (play, retail, conversations etc.) and uses</td>
</tr>
</tbody>
</table>

Table 3: Attributes and urban space qualities suggested in Cullen (2007)
- **Structure**: key traits of an image that define its relationship with the observer or other objects. Can be pattern or space related.

- **Meaning**: a component of an object that signifies the object’s meaning for the observer. Can be related to emotions or practical usage.

Kevin Lynch underlines that the focus of his work is on the physical environment and, thus, he identifies physical qualities that correspond to the features of identity and structure with respect to human perception. He provides the five following elements of the city that are fundamental: *path, landmark, edge, node, and district*.

The allocation, arrangement, proportion, colour and, most importantly, the relation between these elements that create a clear and powerful image, as well as an understanding of an environment are the preconditions for imageability. With this respect, Lynch (2012) provides a number of urban space form properties that designers should consider when designing anew (Table 4).

<table>
<thead>
<tr>
<th>Urban Form Properties</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singularity</td>
<td>Implies a certain degree of contrast between urban form and its surrounding and clarity of a form definition, e.g. the boundary of an enclosed square, noticeable contrast in size, colour or urban form complexity.</td>
</tr>
<tr>
<td>Form simplicity</td>
<td>Simplicity in terms of geometry, e.g. few parts of simple understandable shapes such as a grid, rectangle. Those can be combined into larger and more complex urban environments but can always be mentally decomposed by pedestrians into simpler and understandable elements.</td>
</tr>
<tr>
<td>Continuity</td>
<td>Continuity can be applied to form or use, e.g. continuity of surface in a street corridor, clustering of elements (e.g. buildings, trees etc.), repetition of street turns, similarity of building material along the street (or a district).</td>
</tr>
<tr>
<td>Dominance</td>
<td>In any terms, let it be size, concentration or significance.</td>
</tr>
<tr>
<td>Clarity of joint</td>
<td>Clarity in terms of visibility and relation to other elements (e.g. street).</td>
</tr>
<tr>
<td>Directional differentiation</td>
<td>The variation of form between ends of a path, e.g. asymmetry, gradient, rising/fading intensity, landscape undulation, etc.</td>
</tr>
<tr>
<td>Visual scope</td>
<td>E.g. building façade transparencies, views opening towards wider spaces, cityscape or background natural landscape.</td>
</tr>
<tr>
<td>Motion awareness</td>
<td>Elements and qualities of an urban setting that provide awareness of ones movement through urban setting.</td>
</tr>
<tr>
<td>Time series</td>
<td>Links between urban elements that are perceived through time.</td>
</tr>
<tr>
<td>Names and meanings</td>
<td>Names are important for place distinctiveness.</td>
</tr>
</tbody>
</table>

Table 4: Properties of urban form that are regarded as important for space quality (Source: Lynch 2012)

In addition, Kevin Lynch provides the five following qualities, or “performance dimensions” of a successful urban environment, as termed in Carmona (2010):

- **Vitality** - the extent to which the urban space responds to requirements and capabilities of people;
- **Sense** - the extent to which the place can be clearly understood in space and time by people;

- **Fit** - the extent to which the space matches the behaviour of people;

- **Access** - the possibility to easily reach other people, spaces or activity plus the number and variation in types of activities that can be reached;

- **Control** - the possibility of people to influence the activities in urban spaces around their place of work or residence;

The above attributes and qualities of urban space suggested by Kevin Lynch are synthesized in Table 5.

The main contribution of Kevin Lynch’s work is in the synthetic analysis of physical properties of urban form and their perception (behaviour). Another contribution is the identification of a group of physical elements that play an organizing role in urban setting, i.e. path, node, landmark, edge and district. This categorization helps to reduce the complexity of urban settings to a finite number of elements.
Following the “Patterns” of Christopher Alexander

This section reviews one of the most notable works in the area of urban design research, the book written by Christopher Alexander, “A Pattern Language” (Alexander et al., 1977). The book describes 253 design patterns that correspond to different city scales, i.e. from a town to a room, which cumulatively form a pattern language. It is a condensed summary of findings and efforts from the author’s own design experience, which makes this work largely empirical. The components of this language are named patterns. Each pattern represents a problem which is repeatedly encountered in urban settings and at the same time provides a solution to it. The solutions are formulated in a way that when applied and adapted to different design contexts, they result in visually distinct urban spaces. Christopher Alexander specifically underlines the importance of context consideration when settling in a new design. The range of patterns varies from construc-
tion material (e.g. adoption of concrete by modern technologies) to social processes in urban space.

All patterns have the same format. A picture that illustrates an architectural case of this pattern is followed by the description of its context and its relation to other “larger” patterns. Subsequently, the problem is summarized and explained in thorough detail. This is followed by an instruction for a solution to this problem. At the end, it is recaptured in the form of a diagram illustrating its main components. This thesis will regard a set of patterns from the 253 suggested patterns in the book, which are related to the types of public spaces considered in this study, namely, the urban square and urban park.

In particular, with regards to the *meso* urban scale, Christopher Alexander emphasizes the importance of centres or nodes (Figure 6). According to Alexander et al. (1977), nodes are one of the main organizing elements in cities and should be distributed at a distance of 273 meters. This is sufficiently dense concentration to generate activity. Additionally, there should be as many paths going through the nodes to bring pedestrians in them. A square can be a centre point of the node, while surrounding buildings should accommodate functions/businesses that would mutually support each other to create vibrancy.

![Figure 6: Image that explains the role of nodes as organizing elements of an urban setting and pedestrian paths connecting them (Source: Alexander et. al 1977, p. 167)](image)

The dimensions of the square should not be vast in order to keep activities concentrated. The authors explain these dimensional limitations through specific characteristics and human body physics (Figure 7). The most convenient distance for communication for people, according to Christopher Alexander, is up to 23 meters, which allows talking the recognition of facial expressions. From 23 to 30 meters, communication becomes challenging and at any distance above 30 meters, verbal communication is no longer possible.

Linking the existing local nodes or centres can form promenades where locals can be seen and see others who live in the neighbourhood. Promenades are the types of public spaces that support well the local social interactions (Figure 8).
Christopher Alexander writes that large number of small parks, or as he calls them – open green, are better then a single large park (Figure 9). He suggests that smaller parks should be distributed within three minutes walk from local places of residence or work. Their dimension should be approximately 45 meters across and 5’500 square meters in area.

The water bodies with which the public and especially children can interact, are important elements of squares and parks. Water has positive psychological effects through the sound it produces and it is also pleasant and calming to look at. Christopher Alexander states that in each neighbourhood, there should be an easily accessible body of water (e.g. a pool or a pond). In addition, the body of water should not be dangerous for small children. The water level should deepen gradually, and children should be able to enter it from the shallow side (Figure 10).
2.3 PUBLIC SPACE DEFINITION AND SCOPE

2.3.4.5 Life in Small Public Spaces Explained by William Whyte

In the first part of his book “The Social Life of Small Urban Space”, William Whyte explains a way to recognize a good public space (Whyte, 1980). He writes that good places have a higher percentage of couples, as well as of people who come there in groups. He names this concept an “index of selectivity”, which implies that if people come to a place in groups, they most probably took a conscious decision to do so. In turn, people in groups attract single people. The single people, especially elderly ones, like to come to public spaces and watch other people’s activities, such as children playing, people doing sports, or just someone chatting and laughing. William Whyte concludes that what appeals to people most about in public spaces is the presence of other people. Another indicator of place quality is the high number of women present. According to William Whyte, women are generally more selective and if they prefer to stay in a place it must be a good one.

In order to organize a short “catch-up” talk with a colleague or a longer stay for lunch or a coffee with a friend, people choose well-defined areas of public spaces, such as staircases, perimeters of a fountain or a fence. As observed, women and men prefer to occupy different spots. Women like more secluded areas, while men prefer “front rows”.

In terms of major elements of good public spaces, William Whyte distinguishes the following: movable sitting, presence of trees/loans/water, availability of sun as well as protection from it, and protection from wind. For example, by designing a place with respect to the sun pattern during different seasons, designers can make the place much more comfortable for staying activities. In winter times, there should be areas that have more sun and sittings should be provided at these spots, while during hot summer days, there should be possibilities for shadow also with the possibilities for sitting in the shade. For optional activities, people generally choose comfortable places (Gehl, 2011). An
<table>
<thead>
<tr>
<th>Social</th>
<th>Economic</th>
<th>Environmental</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Many couples and people in groups</td>
<td>• Presence of food stalls</td>
<td>• Opportunity for sun</td>
<td>• Provision of secluded places to rest</td>
</tr>
<tr>
<td>• High proportion of women</td>
<td>• Presence of retail: stores, windows with displays</td>
<td>• Protection from wind, e.g. small parks surrounded from three sides by the green</td>
<td>• Provision of active spots</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Presence of trees</td>
<td>• Movable sitting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Best location for squares, plazas are at the corners, these are the decision/turning points</td>
<td>• Amount of seating</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Presence of vegetation (trees, loans)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Trees aligned to sitting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Interaction with water</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Accessible loans</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• No fences</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Windows and displays add to visual diversity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Many doors facing a street</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Curved sitting ledges</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Design of node-street junctions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Presence of statue, performance or artefact creates triangulation effect</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>


An important condition for people to like and to use a place is that there should be an opportunity for interaction between people and design elements in public space (Whyte, 1980). One should be able to lay down and relax on the grass and read a book. Children love splashing in the water; thus, there should be access to water. Therefore, it is the continuous interchange between the place and people that keeps places alive. The summary of space qualities and attributes suggested by William Whyte are presented in Table 6.

### 2.3.4.6 Amos Rapoport: Elements of Traditional Public Spaces

Rapoport (1990) focuses on vernacular architecture and is a historic study in its essence. More specifically, he analyses pre-industrial urban environments with the goal to identify space attributes that can be applied for new designs. His work is based on observations of a large amount of pedestrian settings in various contexts from which he derives a number of attributes for a good pedestrian space. Amos Rapoport argues for the importance of historic studies for valid generalizations in environmental design theory. He suggests a way of studying built environments based on the historic data (i.e. historic evidence) which should be as broad as possible in scope. It should
include a vast range of built environment examples at different scales regarded through the use and behaviour of people. It can be argued, that attributes of built environments are formed by human activity or by the intended adaptation by humans through time. In this regard, he writes that:

“In cultural landscapes can then be treated as manifestations of cognitive schemata, ideas held in common by the makers (and users) of these cultural landscapes, which design as a choice process tries to express...”

Cultural landscape is a one part of material culture that refers to physical elements of built environment that are transformed by people following the specifics of cultural behaviour. In particular, Rapoport (1990) concentrates on such elements as settlements, buildings and various furnishings.

Amos Rapoport suggests that some (long term) persistency can be found within various cultures with regards to behaviour, as well as with regards to the material world. The described persistency leads to the premise that if certain models of behaviour or types of buildings structure, for example, are repeated in the long term, this should mean it is a good solution for this context and its inhabitants. These repetitive actions are called patterns:

“If any patterns and regularities occur in otherwise very different cultures and persist over long periods of time, it is likely that they are basic or, at least, important and significant.” (Rapoport, 1990)

The author proposes a way of studying built environments and demonstrates it on a case study, i.e. pedestrian space. He states that the mechanism of walking did not changed over time, as it is an intrinsic human ability. Thus, studying pedestrian spaces present a relevant topic for current historical and cross-cultural studies. Moreover, Amos Rapoport suggests that if the persistence in the form and organization of such settings across environments can be observed, it implies that they are probably congruent to the needs of local people. He also suggests that it is best to consider such type of spaces (i.e. pedestrian space) in the historic periods when walking was a major mode of transportation; thus, streets were designed with respect to it. It may be expected that physical properties or attributes of such streets should be best for walking activities. Consequently, in his work, he focuses on the pre-industrial cities, the time before cars became popular among and affordable to the masses. The focus of Rapoport’s work is therefore on the vernacular settings.

“The cultural variability of actual activities and settings combined with the fact that they are all largely pedestrian provides the best combination; this is further reinforced by the range of cultures, periods, climates, and so on.” (Rapoport, 1990)
The interrelation between people and the built environment is analysed in Rapoport (1990) within the framework of Environmental Behavior Studies. The author emphasizes that physical characteristics of built settings alone do not play a determining role in their use. The motivation for walking, which is largely a matter of cultural habits, is a driving force in the use of pedestrian settings. Subsequently, the author frames the question in the following way:

“Given the motivation or predisposition to walk... which environmental characteristics have which effects on which groups; under which sets of conditions and in what ways.”

The use of a particular environment is an individual’s conscious choice. Consequently, various individuals and groups seek to use different settings based on their capabilities and needs. The question that results is what would be the preferred setting that people would select for their activities?

Rapoport (1990) distinguishes between the following two types of pedestrian activities: dynamic activities such as walking or promenading, and static activities, e.g. sitting and relaxing. The two types of activities imply varying characteristics or attributes. Dynamic spaces are mostly linear and should possess such qualities as hidden or emerging views, intricacy that stimulates for continuous experience. According to Rapoport, static spaces should be wider and they should have greenery, as well as possibilities for sitting. There should be interesting views, e.g. to other people’s activities, and spots available to observe those. Although Rapoport’s study is concerned with dynamic spaces, there is a number of attributes that are important when one investigates the relation between dynamic and static spaces.

Referring to the Environmental Behaviour Studies perspective, Amos Rapoport writes that the interrelation between people and environment originates from a complexity of cultural, perceptual, as well as environmental parameters/components. In case of walking activity, there are several characteristics that should be regarded: the speed of walking, the nature of perception, the information processing and necessary level of environmental complexity and cultural predispositions. The stimulus for walking thus is based on the appropriate cultural, perceptual and physical characteristics of a setting. The consequent question that should govern the study of a setting is the following:

“Under what conditions would one expect the maximum pedestrian use of streets?”

Rapoport derives a number of factors that would be influential with this respect. These are summarized in (Table 7).
Factors that influence the use of a built setting

| Technology | Urban form/structure that evolved at the time when walking was the main means of transportation (with minor exceptions) can be very in-formative for the study of qualities and attributes congruent to walking |
| Safety | Safety refers to the feeling of “being secure” as perceived by people, also the interrelation between the size of a town and children’s mobility that is impacted by parent’s perceived sense of safety |
| Environmental variables | Level of noise, exhaust, congestion, type and maintenance of paving etc. |
| Climate and weather | The impact and perception of weather conditions to pedestrian use at different times of the year such as sun, rain or snow. This includes possibilities for sun as well as protection from sun/wind/rain and snow |
| Topography | Perceived landscape undulation which positively impacts space perception providing for picturesque views, urban form differentiation etc. Among the negative impacts are restrictions created for people with reduced mobility |
| Distance to a given goal | Conceived, subjectively determined distance |
| Presence and availability of services | Retail, seating, dining, toilets, seating etc. |
| Culture | Specifics of space use, behaviours and setting types |
| Certain physical, perceptual characteristics | Intricacy of form, changing vistas, etc. that stimulate further interest of pedestrians to explore space |

Table 7: Factors influencing the use of an urban setting

To summarize, Amos Rapoport suggests that people’s use of streets is culturally based (Table 8). An active use is driven by a number of perceptual characteristics. In order to discover the latter characteristics for a particular context, it is necessary to understand the local cultural specifics, as well as perceptual qualities. In order to reduce the complexity of the task (in his study), Amos Rapoport deals solely with settings designed for walking. He analyses the form of a broad sample of pedestrian spaces through history, while looking for repetitive characteristics which were earlier defined in the text as patterns.

<table>
<thead>
<tr>
<th>Cultural Variables</th>
<th>Activity/Behaviour</th>
<th>Physical/Perceptual Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Values</td>
<td>• Walking</td>
<td>• Dimensional characteristics (such as: Width)</td>
</tr>
<tr>
<td>• Lifestyle</td>
<td>• Standing</td>
<td>• Enclosure</td>
</tr>
<tr>
<td>• Meaning</td>
<td>• Sitting</td>
<td>• Turns</td>
</tr>
<tr>
<td>• Unwritten rules</td>
<td>• Eating</td>
<td>• Texture</td>
</tr>
<tr>
<td>• Etc.</td>
<td>• Socializing</td>
<td>• Etc.</td>
</tr>
</tbody>
</table>

Table 8: Culture, walking and setting relationships (Source: Rapoport 1990)

With regards to perceptual characteristics of space, Rapoport (1990) underlines the importance of safety, convenience and others as well as less tangible characteristics such as pleasure, delight and interest that the particular place evokes. When people select certain environments for walking, it indicates that the characteristics of the places chosen
coincide with people’s expectations and needs. The next question that is posed by Rapoport is the following:

“What are the invariant human characteristics associated with walking and which attributes of settings are congruent with these?”

The first condition for human use of urban space according to Rapoport is a certain level of complexity. It can be achieved through the following means:

- “Through ambiguity... using allusive and open-ended design...”
- “Through the use of varied and rich environments and those that are not visible from a single view but unfold and reveal themselves and thus have an element of surprisingness, unexpectedness, mystery...”

The arcades (of Paris) is one example that, according to (Rapoport, 1990), exhibits an appropriate level of complexity, which is created by the difference between “inside” and “outside” activities. The “inside” is characterized by enclosed spaces featuring shopping and restaurants, which all imply a slow pace of movement and lingering. The “outside” domain is predominantly for a fast-paced movement, such as the movement produced by cars. While contrasting each other, these spaces coexist in the immediate vicinity and create the necessary perceptual complexity. The same principle applies to the raised sidewalks of Paris.

With respect to the perception of different places by people, Amos Rapoport distinguishes between static and dynamic spaces. He states that “liking” is the main condition for static spaces, while dynamic spaces should evoke people’s interest. According to the author, these spaces might possess varying desirable characteristics. Static spaces entail associations, while dynamic spaces are more perceptual. The presence of people already entails a high complexity level in static spaces, so they serve as a background. The static spaces pose a different (changing, varying) level of enclosure, and are wider and invite for a stay. These spaces require such elements as greenery and memorable elements such as art objects, water bodies, etc. On the other hand, dynamic spaces are narrow, winding and long. These differences in space characteristics can be explained through the differences in activity types that they imply.

Although the study of Amos Rapoport is focused on dynamic spaces, certain suggested characteristics may be applied to static spaces such as the types considered in this thesis, namely the urban park and urban square. Figure 11 presents a summary table of these attributes.
To understand the quality of public spaces one has to know the reasons people choose to come there. These, in turn, reflect the characteristics of urban life. The following text reviews one chapter from the book “Public Space” by Stephen Carr and Mark Francis that focuses on the needs of people in public space (Carr et al., 1992). The use of public spaces may be planned or spontaneous, such as taking a break at a plaza on the way to a destination, which are accidental uses and constitute the minority of activities in the public space. As stated in Carr et al. (1992), most of the people have reasons to go to a public space. Based on the review of a number of case studies, a number of purposes that govern people’s use of spaces have been identified.

The first and the most basic human need in public space, is the need for comfort. It is rather difficult for people to enjoy any urban setting
without being comfortable. The prerequisites for that is the presence of food/drinks, places to seat, the feeling of safety and others described in Table 2:10. Urban parks should be planned so that people could relax there. In big cities it is important to have a possibility to escape from the hustle and bustle of the city and relax. When staying in public spaces and relaxing, people still want (at least passively) to be involved in the social life around them. The authors use an example of the act of watching other people. An open café situated in a park or at the side of a street would be a good setting for such an activity.

Apart from passive engagement with public life, there should be other possibilities for a direct social contact, such as spaces for children to play, as well as spaces for adults to do some sports or just to have a conversation. Finally, people are willing to discover new things and public spaces should provide them with such possibilities. This human desire for space intricacy can be satisfied through the use of interesting unexpected design elements or changing/opening views.

The above stated needs of people and corresponding public space properties are presented in Table 9.
Comfort | Relaxation | Passive engagement | Active engagement | Discovery
--- | --- | --- | --- | ---
• Accessible food, drinks | • Quiet atmosphere | • People watching (from sidewalk cafes) | • Presence of statue, performance or artefact creates triangulation effect | • Non obvious elements that people can discover when moving through space
• Relief/access to sun | • Places set up in green (parks, loans etc.) | • Observation of scheduled performances, programmed events | • Small square or plazas with concentrated activities | • Can be enhanced through design
• Comfortable and sufficient sitting | • Separation from vehicular traffic | • Steps is a good observation spot | • Streets and sidewalk for human/children activities | • Diversity in the physical design
• Policing of space for safety reasons | • Presence of water | • Landscape undulation that provides views to attraction points | • Control of traffic to provide safety for activities to take place | • Changing vistas
• Visual access from surrounding streets to provide safety | • Presence of trees, greenery | • Observation of natural elements, water, city line | • Areas for active use of place (sport, play) | • Non obvious elements that people can discover when moving through space
• Presence of toilets (well maintained) | | | • Elements supporting activities, fountains, sitting spots, playgrounds | • Control of traffic to provide safety for activities to take place
Table 9: Human needs in public spaces and space properties that support them (Source: Carr et al. 1992)

2.3.4.8 The Good Streets of Allan Jacobs

Allan Jacobs in “Great Streets” describes physical characteristics of streets that in his opinion could serve as inspirations for designers, (design) decision makers and students (A. B. Jacobs, 1993). Thus, this book is a reference guide to the examples of great public spaces.

He admits the importance of nonphysical economic and social variables; however, public spaces (streets, squares etc.) still have to be designed. Thus, study of physical form of public spaces is important to provide a point of reference and to build the knowledge about the way public spaces should or should not be created. Allan Jacobs asks the following question: “What is it that a great street should do?”. He then continues to provide a list of characteristics that a great street or a public space should have. These are summarized in Table 10.
Social Accessible Safe

• Facilitates human interactions
• Seeing/meeting people and be seen
• People stop to talk, sit and watch

• Easy to find
• Easy to access (all social groups)
• Support various physical capabilities of people
• Entry to streets at every 90 meters
• Accessible by transit
• Parking well-integrated (visually) into scene

• Traffic calming measures - same pace of vehicles and pedestrians
• Physical separation between traffic and pedestrians - curbs

Comfortable (incl. climatic cond.) Defined (have clear boundaries) Visually and Sensory Complex

• Various walkways to accommodate varying paces of pedestrian movement
• Availability of sun (on cooler days)
• Protection from sun (on hot days)
• Alteration of wind flows/protection from strong winds
• Good lighting conditions
• Presence of trees

• Vertically: height of the adjacent buildings, walls or trees to width of a street; 1:2 - strong def., from 1:5 – weak def.
• Obelisks, fountains, statues as ending or focal points are important for space definition
• Buildings of 4-6 floors
• Horizontally: length and spacing between objects along the street/place
• Tight spacing is better for street definition
• Clear beginnings and endings

• Many different surfaces over which light moves
• Surface changes
• Contrast of shapes, regularities in built forms
• Transparency of ground level (many windows and doors going into street)
• Complementarity – buildings support each other in style and theme or function (materials, colour, cornice lines, buildings sizes, entrances, porches etc.)
• Maintenance – cleanliness, smoothness, no potholes
• Quality of construction and design
• Long streets interrupted by a focal point, turn or curve.

Diverse Dense

• Physical: many buildings rather than few (with various uses)
• Social: various social groups
• Diverse uses
• Smaller building plots
• Different building ages

• Land use: many people living in the same area

Table 10: Properties of “good” urban spaces (Source: Jacobs 1995)

2.3.4.9 Public Space Design Principles by Lennard and Lennard

Lennard Crowhurst and H. L. Lennard (1995) present a set of principles for design of lively and social public spaces that are derived from traditional urban design theory and observations of a number of suc-
cessful examples of urban spaces in Europe (Mehta, 2015). According to the authors:

“The design of a space defines the kinds of behaviours, activities, and social contacts most appropriate to that place.” (Mehta, 2015)

Based on the analysis of a number of lively public spaces in Europe, the authors formulated a list of social functions and experiences that these places can allow for, which are summarized in Table 11.

<table>
<thead>
<tr>
<th>Social functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• To encourage safe and easy access by all local residents, including children and people with reduced mobility</td>
</tr>
<tr>
<td>• To induce recurrent use by community members</td>
</tr>
<tr>
<td>• To support a sense of significance and self-esteem in people</td>
</tr>
<tr>
<td>• To strengthen a sense of belonging to a particular community</td>
</tr>
<tr>
<td>• To arouse cognizance and sense of pleasure of the current moment</td>
</tr>
<tr>
<td>• To provoke interest in the urban setting</td>
</tr>
<tr>
<td>• To induce meaningful and notable experiences</td>
</tr>
<tr>
<td>• To direct people and provide for various activities</td>
</tr>
<tr>
<td>• To induce the sense of being at home in the space in various individuals</td>
</tr>
<tr>
<td>• To strengthen channels for direct interpersonal social exchange such as eye contact or facial recognition</td>
</tr>
</tbody>
</table>

Table 11: Public space social functions (Source: Lennard and Lennard 1995)

In order to achieve the identified social functions, the authors developed a set of principles for public space design. These are presented in Table 12. The authors define the design of public spaces as a process of integrating “physical evidence of the pattern of social life” into urban fabric.

Lennard Crowhurst and H. L. Lennard (1995) advocate the creation of continuous city-wide networks of pedestrian spaces that can be used safely especially by population groups such as children and elderly people. They praise the structure of traditional (here, authors refer to the medieval period) European cities where streets were designed for walking and possessed human scale. A similar point was stressed in the work of Amos Rapoport which was described earlier in this thesis (Rapoport, 1990).

In order for a place to be actively used it has to be centrally located and accessible to all. Activity in a public space should be supported by a variety of adjacent cultural, commercial and residential functions, which should be concentrated directly next to or within a walking proximity from the public space. The authors emphasize the idea that lively public spaces are never mono-functional. The diversity and mix of uses are essential.

Referring to the work of Camillo Sitte, authors write that enclosure of space is important for people’s perception (Sitte and Stewart, 1945). When a public space has clearly defined boundaries, it is easier for
### Traffic free
- Network of continuous, interconnected footways independent from traffic ways

### Location and size
- Central location of places through which many routes pass
- Accommodate many of the facilities required on a daily or regular basis by all in the neighbourhood
- Never single function places
- Belong to identifiable community
- Setting should be appropriately dimensioned to the social needs

### Threshold and enclosure
- Space is surrounded by buildings or other barriers forming the walls which seem to support the sky. This quality of visual enclosure focuses attention on the people and events within the space

### Architectural frame
- Intricacy and variety of surrounding buildings, unpredictable changes in views, and hidden architectural treasures stimulate curiosity and interest in the setting and encourage exploration.
- Examples: richness of facade details, varied textures and colours of building materials
- Various shape and building year of adjacent buildings
- Variety of historic building forms
- Architectural backdrops, level changes, floor textures and focal points orient people in the space and facilitate differentiated use of space.

### Walls, Railings
- Floorscape can also be a work of art that increases the pedestrian enjoyment and awareness of the experience of walking; steps offer opportunities for sitting or loitering, and may be designed in combination with trees, planters and walls to create tables, back and arm rests; an amphitheatre of tiered seating for an audience to watch the activity below

### Seating, building ledges
- Maximum variety in the type of seating – ergonomics and variation in seating possibilities to support social activities, talking, watching others, resting etc.
- Orientation of benches, their alignment

<table>
<thead>
<tr>
<th>Traffic free</th>
<th>Location and size</th>
<th>Threshold and enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Network of continuous, interconnected footways independent from traffic ways</td>
<td>• Central location of places through which many routes pass</td>
<td>• Space is surrounded by buildings or other barriers forming the walls which seem to support the sky. This quality of visual enclosure focuses attention on the people and events within the space</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Architectural frame</th>
<th>Complexity, backdrop</th>
<th>Paving, steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The architectural scale and proportions of the facades of surrounding buildings, their overall height, vertical and horizontal dimensions must be scaled to human proportions and human use.</td>
<td>• Intricacy and variety of surrounding buildings, unpredictable changes in views, and hidden architectural treasures stimulate curiosity and interest in the setting and encourage exploration.</td>
<td>• Floorscape can also be a work of art that increases the pedestrian enjoyment and awareness of the experience of walking; steps offer opportunities for sitting or loitering, and may be designed in combination with trees, planters and walls to create tables, back and arm rests; an amphitheatre of tiered seating for an audience to watch the activity below</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Walls, Railings</th>
<th>Nature, planters</th>
<th>Focal points, fountains</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low walls define boundaries, but are also used as a temporary resting place, a support to lean on, or a surface for sitting and reclining</td>
<td>• Trees protect, hide, separate and bring a feeling of pleasure and enjoyment to space; water offers pleasant experience from its sound, changing character and coolness it brings.</td>
<td>• Focal points to provide memorable and distinct points around which they meet and cluster</td>
</tr>
<tr>
<td></td>
<td>• Arrangement of plants to divert pedestrian traffic, and create quite enclaves</td>
<td>• Typically provide places to seat, ledges to lean on, shelters from the sun and rain</td>
</tr>
<tr>
<td></td>
<td>• Plants designed in connection to seating</td>
<td>• The historic significance of buildings and monuments intensifies the experience of the present.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A fountain provides a focal point that orients people in the public space.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Posts, columns and bollards may be installed for limiting traffic but could also be used to lean on or sit on.</td>
</tr>
</tbody>
</table>

### Table 12: Space attributes supporting social activity (Source: Lennard and Lennard 1995)
an individual to focus attention on the activities within this particular space. The sense of enclosure is created through articulation of façade surfaces around a public space. This leads to the next property identified by authors, which is the architectural frame. In this case, the human scale of facades and their elements is of particular importance. They should be designed in a way that the interaction between the inside and the outside is possible and active. The use of cafés (going in and out), window-shopping and lingering are the prerequisites of activity in public spaces, which are supported by qualities such as façade transparency and permeability.

Apart from the human scale, architectural form should be interesting and complex. The intricacy of façade elements, changing/hidden views and dominant elements encourage curiosity and will to explore space.

Other design elements such as steps, paving, greenery and well-designed seating areas and others add to the list of design properties. All the described properties should always be considered together with human activities. Most importantly, the interrelations of public space properties and people should be of particular importance to provide for lively and popular public spaces.

2.3.4.10 Urban Space Topologic Dimension by N. John Habraken

In his publication, "The Structure of the Ordinary", John Habraken examines the ways that the built environment is formed through its interaction with people who inhabit it (Habraken and Teicher, 1998). He names three key elements that form urban settings:

- **Agents** – people, governments or administrative organizations;
- **Built Environment** – the physical environment created by agents;
- **Control** – changes that occur in urban settings due to agents in control.

He identifies the three following major components for the analysis of an urban setting:

- **Physical order = Form**
- **Territorial order = Place**
- **Cultural order = Understanding**

In this case the term form represents the built environment as a part of all physical matter; the notion of place embraces the control of space and reflects upon the territorial behaviour which is observed among all living species, and thus, connects environment to biological realm. The notion of understanding primarily refers to social processes.
John Habraken names three main concepts for understanding of built form: patterns, types and systems. Systems, in turn, are defined through configuration and structure.

Humans tend to reduce the complexity of a matter by conceptualizations, which can be expressed in the form of a variety of groupings or combinations and, according to Habraken and Teicher (1998), can be called configurations. Configurations of the same system relate similar parts in analogous ways exhibiting system variants. The commonalities between variants are defined by rules of selection and relation which constitutes the system’s structure.

The change in the form and structure of an urban environment is triggered by the so-called “live configurations”. Those are social forces (individuals in control) that control the built form and cause its change.

John Habraken underlines that configurations exist on a variety of levels (e.g. network, building, partitioning, and furniture). At each respective level they exhibit control and undergo change. The concept of levels is central in the discussion regarding the organization of built environments, as in their combination they (levels) represent a structure that can observed and analysed.

One particular instance of urban configuration which Habraken describes in the course of his work is territorial depth. Specifically, the author introduces a notion which can be used to analyse the relation between private and public domains in urban environment. He defines it as follows:

“Territorial depth is measured by the number of boundary crossings needed to move from the outer space to the innermost territory.” (Habraken and Teicher, 1998)

John Habraken discusses various relationships between the street (public space) and private space that may be created by different configurations of entrances in buildings or building groups, which is shown through the increase of territorial depth between public and private spaces. He demonstrates such relationships on a set of examples from various cultural contexts that employ different design elements that are used to increase the territorial depth, such as front gardens, courtyards, raised terraces and arcades. The degree of territorial depth can produce different effects. On one hand, they preserve privacy. On the other hand, too many boundaries in the built setting can produce a disintegrative effect. Namely, it can produce blank facades that do not induce any social activity on the streets, which in turn affects the feeling of safety and the feeling of liveliness, a concern that has been previously raised by Jane Jacobs (J. Jacobs, 1962).
In the course of this thesis, the interrelationship between territorial depth and urban space permeability was explored in relation to space liveliness for a number of distinctive contexts, namely, Portugal, Russia and Switzerland. This study is described in Beirão and Koltsova (2015), and its results from this study point to possible interrelationships between these properties.

2.3.4.11 The “Ingredients” of Good Urban Design by Cliff Moughtin

In his book "Urban Design: Street and Square", Cliff Moughtin provides a systematic overview of the discipline of urban design, as well as its theoretical and practical underpinnings (Moughtin, 2003). Based on his examination, he identifies, as he calls them, “the ingredients that comprise good urban design”. Several of the concepts described by Cliff Moughtin in his publication that apply to the design of urban squares and fall within the scope of this thesis will be reviewed in more detail.

The author states that a plaza and a square are important components of city design. They represent a setting for human activities as well as settings for commercial buildings, monuments and landmarks, places of worship and others.

The organization of elements in space, form design and subsequent use by people are context-dependent. However, some general principles for European context can be identified. First of all, in a city there should be as many squares as possible that have different functions. Some examples of public squares include a square in front of a university building where students gather for lunch and chat, or a square at a shopping street. There should also be semi-public squares in residential areas that are less active and provide for relaxation and play (in case there are many children living in the area). There are also squares that have a symbolic meaning, which they have acquired through history. Well known squares such as Time Square or Red Square, serve as points of reference for people who are not familiar with a city, and thus, play an important organizational role within an urban setting.

Cliff Moughtin underlines the importance of a centre or a point of reference also from a philosophical standpoint. Here, he refers to the concept of human centre or “home” formulated by Norberg-Schulz (1980). Regarding the role of squares in planning and design, he signifies the works of Kevin Lynch and Christopher Alexander (Alexander et al., 1977; Lynch, 2012). In contrast to Christopher Alexander, who considered the formation of a centre to be an inevitable process in any urban setting, Kevin Lynch argues for the centre to be an organizing element that helps to achieve the urban structure’s identity. The latter
idea of Lynch can be exemplified in the design of a centre through the arrangement of surfaces, the use of various degrees of enclosure, and the exploitation or alteration of topography.

Another interesting idea, brought forward by Cliff Moughtin, is that in order for a city to be structurally viable, it has to have a hierarchy of centres. He then brings the following quote from Sitte and Stewart (1945):

“... in each town a few major squares are, as a group, decidedly the largest, the rest having to content themselves with a minimum expense.”

Referring to Zucker (1970), Cliff Moughtin identifies the following types of squares:

- **Dominant Square** - has a central organizing element such as a building, or group of buildings to which the rest of the setting is oriented. Referring to several sources Moughtin identifies the optimal dimension of this square type, which ideally has a width (of a square) to a height (of surrounding buildings) ratio of 4:1. This dimension is based on the maximum angle at which a human can see building as a whole. Figure 12 illustrates the derived dimensions for perception of a building detail, an entire building and a group of buildings.

![Figure 12](image)

Figure 12: a) A – max building height, B – distance from building façade to viewing point, B = A, α = 45°; b) B = 2A, α = 27°, width/height ration = 4/1, example: for a 3-storey buildings square height should be 35 to 45 metres; c) B = 3A, α = 18°, width/height ration = 6/1, example: for a 3-storey buildings square height should be 73 to 91 meter (Source: Moughtin, 2003)
• **Closed Square** - is built up along its perimeter, especially in the corners *(Figure 13).*

![Figure 13: A closed square (Source: Moughtin 2003)](image)

• **Nuclear Square** - is built up around a central point *(Figure 14).*

![Figure 14: From A=B to A=2B (Source: Moughtin 2003)](image)

• **Grouped Squares** - combination of several joint squares (e.g. linked by archways, *(Figure 15).*

![Figure 15: Examples of grouped squares (Source: Moughtin 2003)](image)

Departing from the previous studies conducted by Kevin Lynch, Jane Jacobs, Christopher Alexander and others, Cliff Moughtin suggests a number of properties for urban settings in general, and for squares and plazas in particular. The latter should be characterized by a varying degree of enclosure that should be appropriate to the design context. Urban environments should possess a high degree of legibility. It reflects the degree to which people understand and, consequently,
interact with the urban setting, and it relates to properties that give urban space an identity. Permeability is another quality which indicates the number of potential movement paths per unit of an urban setting. It is suggested in the literature that permeable environments provide for a higher degree of social activity or place liveliness (Beirão and Koltsova, 2015). Vitality is associated in Moughtin (2003) with diversity and a mix of uses that should stimulate social and economic activity.

The book of Cliff Moughting is a cumulative study that summarizes findings from the most notable contributors to urban design theory and practice. Table 13 summarizes the qualities of urban space that crystalized from his explorations.

<table>
<thead>
<tr>
<th>Economic</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Diversity of uses</td>
<td>• Central location of places through which many routes pass</td>
</tr>
<tr>
<td>• Mix of uses</td>
<td>• Accommodate many of the facilities required on a daily or regular basis by all in the neighbourhood</td>
</tr>
<tr>
<td></td>
<td>• Permeability – number of potential route choices</td>
</tr>
<tr>
<td></td>
<td>• Enclosure (of a square) – built surface area around a place</td>
</tr>
<tr>
<td></td>
<td>• Legibility – presence of elements that give place an identity</td>
</tr>
</tbody>
</table>

Table 13: Qualities of urban space (Source: Moughtin 2003)

2.3.4.12  Jan Gehl on the Life between Buildings

The research studies of Jan Gehl focus on the relationship between patterns of use and the components and form of public spaces. His work is based on the extensive systematic observations of public spaces’ performance, from which he derives a number of factors that are influential to place quality and degree of use. Human dimension is central to his study. He looks at public spaces through the prism of human needs, senses and biological capabilities. Levels of pedestrian flow, both static and dynamic, serve as criteria for public space success.

In the first part of the book “Life Between Buildings”, Jan Gehl suggests the concepts of necessary, optional and social activities (Gehl, 2011). These serve as a base point for further analysis of public space quality. Specifically, place is regarded as successful if it accommodates many optional and (resultant) social activities, which normally occur when people choose to go to a public space. In the case with necessary activities, the use of place is governed by necessity such as, for example, the need to commute from the public space of residence to work.
Jan Gehl analyses the perception of public space through senses such as touch, smell or vision, referring to the studies of Edward Hall (E. T. Hall, 1966). The design of space has a direct impact on the way people feel in space and, consequently, on the way they use it. With this respect, Jan Gehl identifies a number of components of public space, as well as its properties that increase or decrease its use. These are summarized in Table 14.

<table>
<thead>
<tr>
<th>Traffic</th>
<th>Security</th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Protection against traffic accidents</td>
<td>• Street life occurrence</td>
<td>• Room for walking comfortably</td>
</tr>
<tr>
<td>• Absence of pollution/fumes</td>
<td>• Presence of street watchers</td>
<td>• Interesting layouts of streets, facades and</td>
</tr>
<tr>
<td>• Low level of noise</td>
<td>• Overlapping of functions in space and time</td>
<td>good pathway surfaces</td>
</tr>
<tr>
<td>• Low visibility of traffic</td>
<td></td>
<td>• Few footway interruptions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Accessibility to key points</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Convenient crossings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Staying/Activities/Interaction</th>
<th>Climate</th>
<th>Seeing/Hearing/Aesthetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Seating areas available</td>
<td>• Protection against wind, rain, cold, heat</td>
<td>• Unobstructed long vistas</td>
</tr>
<tr>
<td>• Many interesting views</td>
<td>• Possibility for sun/shade, warmth/coolness,</td>
<td>• Bench arrangement in “talk spaces”</td>
</tr>
<tr>
<td>• Presence of people to watch</td>
<td>breeze</td>
<td>• Good design and use of good materials</td>
</tr>
<tr>
<td>• Invitation to physical activities</td>
<td></td>
<td>(consideration of human dimensions, ergonomics of space)</td>
</tr>
</tbody>
</table>

Table 14: Prerequisites of a successful public space (Source: Gehl 2011)

Another important finding in the work of Gehl (2011) is that "good" places should combine stationary and dynamic activities, which makes places lively and attractive. Activity in public spaces attracts more people and generates liveliness.

2.3.4.13 Public Space Quality Evaluation in Ewing and Handy (2009)

The work by Ewing and Handy (2009) makes an attempt to operationalize public space quality through the analysis of an urban physical setup, namely, commercial streets, and was performed in collaboration with ten design experts (Ewing and Handy, 2009). The premise here is that walking behaviour depends on the perception of the physical environment by people. The following perceptual qualities of public spaces were derived from the literature: imageability, human scale, transparency, complexity, legibility, linkage and enclosure. However, only the first five were made operational. Each of the case studies, i.e. the commercial street, has been evaluated based on the range of identified space qualities during the expert panel. The study uses space quality concepts that the general public might not be familiar with, such as
legibility, imageability and others. Thus, only design experts who are familiar with these notions were invited to join the panel.

The study uses a mixed-method research, and the analysis was conducted on video clips created using the consistent filming techniques. Subsequently, a statistical model was developed based on the results of the panel ratings, and served as the dependent variable; features of the urban environment served as independent variables. The resultant models triggered a better understanding of the following matters:

- Physical properties statistically associated with every perceptual quality;
- The nature of association – positive or negative;
- The degree to which ratings vary for a particular perceptual quality across cases regarded with respect to physical features in the model;
- The degree of overall variation in ratings clarified by the model.

The attributes associated with each of the perceptual qualities are presented in Table 15.

<table>
<thead>
<tr>
<th>Imageability</th>
<th>Enclosure</th>
<th>Human scale</th>
<th>Transparency</th>
<th>Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Nr of people</td>
<td>• Proportion street wall – same</td>
<td>• Nr of long sight lines</td>
<td>• Proportion first floor with windows</td>
<td>• Nr of people</td>
</tr>
<tr>
<td>• Proportion of historic buildings</td>
<td>side</td>
<td>• Nr of all the street furniture and other</td>
<td>• Proportion active uses</td>
<td>• Nr of buildings</td>
</tr>
<tr>
<td>• Nr of courtyards, plazas and parks</td>
<td>• Proportion street wall –</td>
<td>street items</td>
<td>• Proportion street wall - same side</td>
<td>• Nr of dominant building colours</td>
</tr>
<tr>
<td>• Presence of outdoor dining (yes/no)</td>
<td>opposite side</td>
<td>Building height same side</td>
<td>• Nr of long sight lines</td>
<td>• Nr of accent colours</td>
</tr>
<tr>
<td>• Nr of buildings with non-rectangular silhouettes</td>
<td>• Proportion sky across</td>
<td>• Nr of small planters</td>
<td>• Urban designer</td>
<td>• Nr of public art</td>
</tr>
<tr>
<td>• Noise level</td>
<td>• Nr of long sight lines</td>
<td>• Building height same side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Nr of major landscape features</td>
<td>• Proportion sky ahead</td>
<td>• Nr of all the street furniture and other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Nr of buildings with identifiers</td>
<td>• Proportion street wall - same</td>
<td>street items</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>side</td>
<td>Building height same side</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 15: Measurable public space quality attributes (Source: Ewing and Handy 2009)
Components of Contemporary Public Space by Matthew Carmona

The current interest in the sensible development of urban design from the side of the private sector, as well as the renewed focus of the political sector on public space design, create a fertile basis for public space and public life to flourish. Matthew Carmona calls it “a narrative of renewal”, which praises the comeback of a public space paradigm (Carmona, 2015).

The tendency in urban design has changed from the search of an idealised public space concept that would fit all purposes and contexts. According to Matthew Carmona, there is now an understanding of the fact that people are different and they have different needs, physical abilities and cultural habits. Thus, there should be various spaces in cities for activities such as commerce, business, entertainment, social gatherings (e.g. festivities) or relaxation. Diversity and mix of uses are the necessary prerequisites of successful public realm and lively public spaces. Carmona also underlines that narratives such as the one presented in his work were derived on the basis of studies conducted within the context of London. Consequently, it would fit other UK cities and should be relevant to the cities in the rest of Europe.

Based on his narrative, Matthew Carmona develops a set of properties of a successful urban space within a Western context. A good public space, thus, should be: diverse, delineated, social, free, engaging, meaningful, comfortable and robust. Table 16 provides further details on the prerequisites for these properties.

Public Space Integrative Frameworks and Assessment Tools

The following section presents a number of frameworks and tools that were developed with the aim to make the concept of public space quality operational within the discipline of urban design. These are largely based on the preceding empirical studies, such as the studies by Jane Jacobs, Kevin Lynch, Gordon Cullen and others reviewed in this thesis.

One of such frameworks is presented in Canter (1977). The author suggests the following three components of public space: physical attributes, conceptions and activity (Figure 16). This framework brings together previous studies concentrated on physical attributes of space (e.g. Cullen, 2007) with studies on perceptual attributes (e.g. Lynch, 2012) and the studies focused on the activity patterns.

Another, more elaborated framework suggested in Punter (1991), outlines specific attributes for each of the proposed components (Figure 17).
A good public space is...

<table>
<thead>
<tr>
<th>Diverse</th>
<th>Delineated</th>
<th>Social</th>
</tr>
</thead>
</table>
| • Addressing multiplicity of needs  
• Equality of use and access | • Appropriate division of public and private (beyond just buildings)  
• Presence of both private places for relaxation and shared public | • Various types of social activities: large scale/-gregarious to the intimate, quiet and insular  
• Support public discourse, collective experience, and social interaction |

<table>
<thead>
<tr>
<th>Free</th>
<th>Engaging</th>
<th>Meaningful</th>
</tr>
</thead>
</table>
| • Free (open, unrestricted and free of charge) for all social groups and for all reasonable activities | • Opportunity for exchange of goods and services  
• Social interactions  
• Right not to consume while being in space | • Place should encourage users to engage with it and make them choose to return again and again |

<table>
<thead>
<tr>
<th>Comfortable</th>
<th>Robust</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ability to use space in a stress-free and convenient manner</td>
<td>• Ability of a place to adapt and change over time</td>
</tr>
</tbody>
</table>

Table 16: Suggested properties of a good public space (Source: Carmona 2014)

The next framework will be discussed in more detail and was developed in Montgomery (1998). The author claims that “the city is a phenomenon of structured complexity”. To disentangle this complexity he provides a framework to make preceding theories of practical use. He suggests that by following a logical flow similar to the one outlined in Canter (1977) and Punter (1991) it is possible to make use of space components in order to develop a range of principles for the design of good public spaces. Based on these two studies, as well as on the work by Kevin Lynch, Jane Jacobs and others, John Montgomery suggests his own framework that has three following components: image, form and activity (Figure 18).

![Figure 16: Public space framework adopted from Canter 1977](image-url)
Montgomery underlines that it is possible to achieve high urban quality by combining in the right way certain physical elements such as buildings, landmarks, and open space plants in the right way. However, this alone is not enough. The elements described must always be considered together with the underlying social processes and cultural habits. It is stated in Montgomery (1998) that a good city should have a comprehensible form with many opportunities for social transactions. Thus, activity is one of the main components for successful urban setting.

*Activity* is the resultant of vitality and diversity. Vitality refers to the number of people using the place, the number of activities, events, and so on. Vitality is generated through various opportunities that an urban setting has to offer. The variety and mix of uses are prerequisites for diversity.

*Image* describes the way people perceive space. People have memories, feelings or impressions about certain places that they like which are context specific and culturally grounded. The image is in turn influenced by the clarity of city structure, which implies that public
realm should be regarded as system of spaces of changeable sizes, dimensions and meanings.

*Form* is described by Montgomery with regards to the way built space “fits” the needs and activities of people. He underlines that in good cities there should be many types of public space forms to accommodate various needs and uses. Thus, there should be many possible patterns for movement, clear structure in allocation of its elements (nodes, landmarks, focal points etc.), a small-grained economy, etc. In Table 17, the preconditions for physical form derived from Montgomery (1998) are provided.
## The Physical Conditions for Making a City

<table>
<thead>
<tr>
<th>Development Intensity</th>
<th>Mixed Use</th>
<th>Fine Grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>• High (enough) residential densities</td>
<td>• More then two primary functions</td>
<td>• Large number of small businesses</td>
</tr>
<tr>
<td>• High level of ground coverage</td>
<td>• Variety of “secondary uses” supporting primary ones</td>
<td>• Small businesses vary in skills and serve space specific markets</td>
</tr>
<tr>
<td>• High level of plot coverage</td>
<td>• Activities distributed in time during the day</td>
<td>• In small companies face to face interaction with clients (more intimate)</td>
</tr>
<tr>
<td>• High level of building form density</td>
<td>• Conscious vertical and horizontal zoning</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adaptability</th>
<th>Human Scale</th>
<th>City Blocks, Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Form of buildings, plans that can accommodate different uses (e.g. lofts)</td>
<td>• Easily reachable (within 10 min walking)</td>
<td>• Short city blocks</td>
</tr>
<tr>
<td>• Streets and open space last longer than buildings</td>
<td>• Many intersections around (smaller walkable human scale blocks)</td>
<td>• Buildings built around a courtyard</td>
</tr>
<tr>
<td></td>
<td>• Activities at turn points of the blocks to generate people flows</td>
<td>• Buildings define place rather then being set in it</td>
</tr>
<tr>
<td></td>
<td>• Proportion between building height and street width</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Street Contact, Visibility</th>
<th>Public Realm</th>
<th>Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Active frontages at every 20-30 feet</td>
<td>• Dedicated places for people to meet, gather, see and be seen</td>
<td>• Unrestricted pedestrian movement</td>
</tr>
<tr>
<td>• Wide pavements (sidewalk cafés)</td>
<td>• Squares, meeting places, promenades</td>
<td>• Restricted car movement in core areas</td>
</tr>
<tr>
<td>• Network of streets rather than vast roads</td>
<td>• Good lighting system (safety)</td>
<td>• Parking out of the view</td>
</tr>
<tr>
<td>• Small intimate scale squares and plazas</td>
<td>• Surveillance (safety)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Landmarks, Visual Stimulation</th>
<th>Green, water space</th>
<th>Architectural style</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Provide legibility, points of orientation</td>
<td>• Provide conditions for: recreation, health</td>
<td>• Variation in style, façade surfaces and materials that create memorable image</td>
</tr>
<tr>
<td>• Provide individual features and points of interest</td>
<td>• Provide views and landscape image</td>
<td></td>
</tr>
<tr>
<td>• General sense of interest</td>
<td>• Places for cultural events</td>
<td></td>
</tr>
</tbody>
</table>

Table 17: Physical conditions that are prerequisites for “good” urban spaces (Source: Montgomery 1998)

### 2.3.5.1 Vitor Oliveira and his Method for the Assessment of Urban Form

*Morpho* is a method developed by Vitor Oliveira for quantitative assessment of physical properties of an urban setting (Oliveira, 2013). The method is built upon the following principles:

• Focuses utterly on the physical characteristics of urban environment
• Uses a reduced number of physical elements to depict cities’ morphological characteristics
• Quantitatively evaluates urban setting with the criteria being the degree of urbanity (from urban to rural)
• Offers a basis for an integrative research with the implications into practice

The method comprises four steps. In the first step, the objective, criteria, tools and data sources to be used for evaluation of an area are set. The next step involves the evaluation of the following properties of an urban setting: accessibility of street system, accessibility of plots, age of buildings, dimensions of street blocks and plot series, alignment of buildings, ratio of building height to street width, and building use. The results of the evaluation are then documented in a form of a matrix. These results are then compared against the two sets: local/context specific set and a general set. The final step involves the result of the interpretation and suggestion for further use. The following three urban elements are basic in the analysis process:

Accessibility of the street system is measured using Space Syntax methodology (DepthmapX, 2014). The global and local integrations are measured and results are normalized with the scale ranging from 0 – segregation, to 1 – integration.

Accessibility of plots is measured by counting the number of plots that are accessible within a specified radius and at a predefined number of topologic steps.

Age of buildings implies categorization of buildings according to the year of their construction. However, in order to simplify the process the range was divided only into two periods (i.e. before and after the WW II). Consideration of buildings construction periods is an important part of morphologic studies as it reveals some important facts about the typology and intended use of buildings.

Dimensions of street blocks are measured in a straightforward way. The smaller the blocks, the greater is the diversity of an area (J. Jacobs, 1962)

Alignment of buildings - this variable is measured in two steps. At first, the prevailing alignment for each side of the street is defined. Then, the total number of buildings is calculated and compared against those that follow the dominant alignment and expressed as a percentage.

Ratio of building height to street width– this variable measures the degree of enclosure in the street (from 0 – little sense of enclosure to more than 1:1, which means that building height is larger than the width of a street).
Building use – the ratio between residential and non-residential use is calculated (0 being only residential use, 0.5 being the same amount of residential and non-residential and 1 being non residential only).

The prerequisites for high urbanity are: high accessibility, high density, high diversity and high continuity (Table 18).

<table>
<thead>
<tr>
<th>Prerequisites for High Urbanity</th>
</tr>
</thead>
<tbody>
<tr>
<td>High accessibility</td>
</tr>
</tbody>
</table>

Table 18: Conditions for high urbanity (Source: Oliveira 2013)

2.3.5.2 Vikas Mehta: Method for the Evaluation of Public Space

Mehta (2014) underlines the importance of public space for the social well-being. He names three major components of a successful public space. It should be responsive, democratic and meaningful. The author makes a strong case for the need for new comprehensive tools to assess public space quality.

The two basic writings that Mehta’s framework is built upon are Carr et al. (1992) and Gehl (2011). Based on the review of the extensive number of preceding writings on urban design in general and on public space quality in particular, as well as based on the empirical studies of public spaces, Mehta develops a framework for the evaluation of public space. His framework uses the Public Space Index as a measure of public space quality. He identifies five dimensions (Figure 19) that define the quality of public space and should be evaluated using the public space index, and they are:

- **Inclusiveness** – evaluates the range of activities and users behaviours which the place accommodates, as well as the ability to access and use the space. These, in turn, imply the analysis of such properties as the distribution of public spaces, and the proximity and connectivity to other elements within an urban setting.

- **Meaningful** activities – evaluates whether place supports activities that are symbolically and culturally significant, this implies verification whether place supports “any community – gathering third places”, evaluation of the way form of places and its elements support activities and behaviour, diversity of businesses around, including cafés, restaurants and food stalls.

- **Safety** – evaluates such aspects as the “eyes on the street” (J. Jacobs, 1962), control by police and CCTV, safety from traffic through space design, presence of many ”third places” such as bars and restaurants.
- **Comfort** – evaluates microclimate conditions, as well as the availability of sun/shade, depending on the season.
- **Pleasurability** – this implies the evaluation of factors such as imageability (Lynch, 2012), the level of spatial quality associated with sensory complexity and shape/colour arrangements.

![Public space dimensions](source: Mehta 2014)

For each of the five aspects of public space suggested in Mehta (2014), there is a number of attributes derived that are used to evaluate public space (Table 19). This method is applied to a number of case studies, which resulted in a set of diagrams showing a varying degree of inclusiveness, meaningful activities, safety, comfort and pleasurability for each of them.
### 2.3 Public Space Definition and Scope

<table>
<thead>
<tr>
<th>Inclusiveness</th>
<th>Meaningful Activities</th>
<th>Safety</th>
<th>Comfort</th>
<th>Pleasurability</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Range, variety of activities in public spaces supports</td>
<td>• Prior familiarity</td>
<td>• Eyes on the street</td>
<td>• In terms of physical and environmental impacts</td>
<td>• Imagoability</td>
</tr>
<tr>
<td>• Social groups that can use space</td>
<td>• Historic &amp; political events that occurred at a place</td>
<td>• Good physical condition and maintenance</td>
<td>• Comfortable micro climate conditions</td>
<td>• High level of spatial quality</td>
</tr>
<tr>
<td>• Behaviours a place supports</td>
<td>• Support of community gathering third places</td>
<td>• Configuration of spaces</td>
<td>• Moderate temperatures</td>
<td>• Sensory complexity</td>
</tr>
<tr>
<td>• Distribution of public space in urban area</td>
<td>• Design and layout that supports activities and behaviours</td>
<td>• Types of land uses</td>
<td>• Availability of sun</td>
<td>• Colour, shape and arrangement</td>
</tr>
<tr>
<td>• Proximity of place to other city areas</td>
<td>• Number of businesses that offer food and drinks</td>
<td>• Presence of people</td>
<td>• Possibility for shade</td>
<td></td>
</tr>
<tr>
<td>• Connectivity to other city areas</td>
<td>• Diversity of uses and businesses</td>
<td>• Type of people</td>
<td>• Protection from wind</td>
<td></td>
</tr>
<tr>
<td>• Accessibility to various social groups</td>
<td>• Personalization of property</td>
<td>• More non residential uses</td>
<td>• Diversity of activities</td>
<td></td>
</tr>
<tr>
<td>• How well the activities and behaviours of the latter are supported</td>
<td>• Presence of street-lights</td>
<td>• Yards decorations and private plantings make place appear safer</td>
<td>• Standing patterns of behaviour</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Stores, bars as basic components of surveillance and safety</td>
<td>• Yard decorations and private plantings make place appear safer</td>
<td>• Ergonomically sensitive design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safety from traffic</td>
<td>• More non residential uses</td>
<td>• Sitting space</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• How safe people feel in space at different times of the day</td>
<td>• Broad sidewalks</td>
<td>• Shade &amp; shelter</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Yards decorations and private plantings make place appear safer</td>
<td>• High degree of built form articulation</td>
<td></td>
</tr>
</tbody>
</table>

Table 19: Public space attributes to be measured for quality evaluation (Source: Mehta 2014)

#### 2.3.5.3 Measure of Space Publicness by Varna

In order to grasp the complex nature of public space, Varna (2014) suggests a measure of space “publicness” that comprises the following five dimensions: ownership, control, civility, physical configuration, and visual access (Figure 20).

- **Ownership** defines the legal status of a place. Place may be owned and managed by public authority and used for public activities, or, on the other hand, it may be owned by a private person and solely used for individual’s needs.
Control refers to a place’s modes of control, either through explicit control - surveillance and policing (which is less public) or, on the other extreme, the absence of such measures, and the freedom of the people to use space in the way they want to. The in-between case is when the “atmosphere” of the public space bans undesirable behaviours.

Civility refers to the regard and awareness of others in public space. The ideal situations are the ones in which the place is managed in a moderate way, imposing (but not overusing) spatial regulations, defining the time spans when the place may be used or permitting/restricting certain activities. However, those places that are “over-managed” or “under-managed” are less public.

Physical configuration is a “design-oriented dimension”. Varna (2014) defines two respective design scales: macro-design and micro-design. Macro-design defines the way place is integrated within surrounding urban setting (its connectivity, accessibility etc.). Micro design is the arrangement of parts within a space boundary. The author defines three major qualities of physical configuration:

- Centrality and connectivity – how well the place is connected to the rest of the city fabric
- Visual access refers to the possibility to look into the place
- Thresholds and gateways define physical access to places (walls, gates, fences etc.)

With respect to the physical configuration, the “more public” places are those that are well connected within the city fabric, have high visual permeability and have no obstructing elements at the entry points.

Animation refers to the activities that take place in space and to the way the physical configuration of the public space supports...
those activities and meets the needs of people. There are several
types of people’s interaction with space:

- Passive engagement (e.g. people watching)
- Active engagement (e.g. direct contact between people)
- Discover and display (e.g. a will for new discoveries)

The “more public” places in terms of animation are those that ade-
quately support and stimulate various kinds of human activities. Based
on the five dimensions presented, the author builds an interactive-
integrative “star model” (Figure 20). To turn this model into the tool
for objective measurement of space “publicness” a set of indicators
was derived and is illustrated in Table 20.

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Control</th>
<th>Civility</th>
<th>Physical Configuration</th>
<th>Animation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ownership (from public to private)</td>
<td>• Intent of control</td>
<td>• Physical maintenance and cleansing regime</td>
<td>• Centrality and connectedness</td>
<td>• Possibilities for passive engagement</td>
</tr>
<tr>
<td>• “Headline” function (from public such as street/access or route to private such as residence)</td>
<td>• Control regulation</td>
<td>• Visual permeability</td>
<td>• Possibilities for active engagement</td>
<td></td>
</tr>
<tr>
<td>• Control presence</td>
<td>• Control provision of facilities</td>
<td>• Physical thresholds and gateways</td>
<td>• Possibilities for exploration and display</td>
<td></td>
</tr>
<tr>
<td>• Control technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 20: Indicators for each of the five dimensions (Source: Varna 2014)

2.3.6 Computational Methods for Public Space Analysis

The previous section presented theoretical frameworks and tools for
public space quality evaluation, whereas the present section concen-
trates on computational tools developed for the analysis of various
aspects (i.e. indicators and attributes) of urban form in general and
public spaces in particular.

Current computational tools are used for a range of urban analysis
tasks, which span between topologic and configuration analysis of
urban form and the use of data mining methods for detecting urban
typologies. As a consequence, exploration of patterns, systems and types
of spaces in urban environments has reached yet another level. The
multiplicity of associated data can be gathered using tools such as
the GIS database, mobile data sensing and analysed by employing a
variety of methods such as, data mining (Fayyad, Piatetsky-Shapiro,
and Smyth, 1996; Batty, 2013).
The works described in this part of the thesis are considered to be within the domain of the space morphology studies (Moudon, 1992). Leslie Martin and Lionel March of the University of Cambridge where some of the first authors to exploit mathematical logic for urban and architectural form studies (Martin and Lionel, 1972). At large, space morphology studies focus on the underlying structure of urban space and explain it by employing mathematical logic and computational means.

2.3.6.1 Space Syntax: Urban Grid Configuration Analysis

The methodology of Space Syntax originates from empirical research conducted by Bill Hillier and his colleagues (Hillier, 1996; Hillier, Burdett, et al., 1987; Hillier and Hanson, 1993). He advocates the idea that movement activity can be forecasted through the analysing of urban grid configuration. In this case, factors that make the space more attractive, or certain land being used, play a secondary role as activity multipliers. In particular, the effect of spatial configuration on visual permeability impacts movement densities (Carmona, 2010).

The methodology employs a set of mathematical procedures that are used for the analysis of a number of geometric/topologic properties of urban grid configuration. Specifically, urban grid is represented as an axial map constructed from “convex” spaces connected by “axial” lines. The latter are defined in Carmona (2010) as “the longest and fewest set of lines of sight passing through all the convex (open) spaces in the area”. There are many syntactical properties (or attributes) that can be measured for every line in a grid such as:

- **Connectivity** – calculates the number of lines that directly join the line.
- **Integration** – calculates the number of lines it takes to reach every line from any other line in the grid.
- **Choice** – measures the probability with which a line would be traversed on all shortest paths from all spaces to all other spaces within the whole grid or otherwise, within a predefined radius from every segment (Klarqvist, 1993).

This method grasps well the pedestrian movement within the traditional urban settings (old historic centres, etc.). However, the modes of transportation evolved and new city grids were created from scratch. The processes of functional allocation followed these changes. For the improved understanding of contemporary city grids, it is necessary to consider more factors that influence the way people use and appropriate urban spaces. In Stähle, Marcus, and Karlström (2007), it is suggests to combine methods from space syntax with methods from
accessibility analysis (geographic data as additional weights) for an improved understanding of pedestrian behaviour.

### 2.3.6.2 Place Syntax

It is argued in Ståhle, Marcus, and Karlström (2007) that Space Syntax methodology, the axial map in particular, is able to capture the “natural movement”, which is defined by the author as “the proportion of movement that is determined by the configuration of space itself, rather than by the presence of specific attractors or magnets”. This type of analysis is relevant to urban setting that developed organically through time. The author goes on to state that the distribution of population followed by the spread of “attractions and magnets” (e.g. retail or transport hubs) went along with this development process and is rather even. Thus, the two patterns movement and attractors’ distribution went in parallel. However, such method may not capture the movement patterns within the newly created suburban developments. These did not evolve gradually, but were created from scratch and within short time spans. Thus, accompanying processes, e.g. distribution of attractors, did not follow the gradual change of space configuration. This is due to the fact that population distribution is not even, and the distribution of attractors does not follow the configuration of space.

In response to this challenge, Ståhle, Marcus, and Karlström (2007) suggests a new way of analysing urban space which combines axial descriptions from Space Syntax, with geographic accessibility measures. This, in the author’s opinion, would allow to improve the predictions regarding movement patterns in Space Syntax, as well as to add a finer grain (i.e. information on human perception) to the accessibility analysis which is traditionally done for vast geographic areas (e.g. “the linear, rather than for example the metric, accessibility to any asset or service we find in a city”).

### 2.3.6.3 Spacematrix: Density and Urban Form

Berghauser Pont and Haupt (2010) explore the role of density measures in urban design and their book analyses in detail the implications and inconsistencies in the use of a variety of density indicators, and further suggest a more accurate model for calculating the density measures. The variables that are used in the model for density measurements are the following: *Floor Space Index*, *Gross Space Index* and *Spaciousness*. The basic parameters for the calculation of the indicators are:

- **Base Land Area (A)** – When comparing densities for different urban areas, it is crucial to maintain the consistency in the way
boundaries of an area are identified. Spacematrix presents the three following ways to define the boundary:

- Administrative boundaries (e.g. cadastral boundaries or municipal boundaries)
- Projected boundaries (e.g. random grid of pixel in GIS applications)
- Generated boundaries (extracted from morphological features)

- *Network length* \((l)\) – is measured as the total length of the network inside an analyzed area plus half the length of the borderline coincident parts which are mutual with adjoining areas (Berghauser Pont and Haupt, 2010).

- *Gross floor area* \((F)\) – is the sum of all of the floors’ areas of the building measured along the perimeter of the walls that surround the building. This includes the underground floor, as well as a the space under the roof (Berghauser Pont and Haupt, 2010).

- *Built up area, or footprint* \((B)\) – is a floor area calculated at the ground level. It does not include any overhanging elements or underground spaces (Berghauser Pont and Haupt, 2010).

The awareness of density differences at various urban scales is important. Berghauser Pont and Haupt (2010) distinguish between the following urban scales: building lot, island and district.

*Floor Space Index* (FSI) – built intensity of an area (Figure 21). \(FSI = \frac{\text{Gross Floor Area}}{\text{plan area}}\) (Berghauser Pont and Haupt, 2010).

*Gross Space Index* (GSI) – coverage. \(GSI = \frac{\text{footprint (square m)}}{\text{area of aggregation (square m)}}\) (Figure 22) (Berghauser Pont and Haupt, 2010).

*Spaciousness* (OSR) – the amount of non-built space at ground level. If the proportion of built space in relation to non-built territory is higher,
more people should supposing use open space. OSR = (1-GSI) / FSI 
(Figure 23)(Berghauser Pont and Haupt, 2010).

Figure 23: Spaciousness (Source: Berghauser Pont and Haupt 2010)

2.3.6.4 Urban Analysis and Data Mining

The preceding examples of computational analysis tools are focused on particular attributes of urban space, such as configuration characteristics of the urban grid (Hillier, Burdett, et al., 1987; Hillier and Hanson, 1993) or density indicators (Berghauser Pont and Haupt, 2010). Ståhle, Marcus, and Karlström (2007) suggests a way to refine the methodology of Space Syntax by supplementing it with accessibility analysis measures (to load geographic data for better forecasting of pedestrian movement). However, public spaces are complex matters and require a comprehensive view, in which a much larger set of attributes should be considered to grasp such complexity. The following text presents a number of examples of public space multivariable analysis.

The main aim of the work presented in Sokmenoglu, Çağdaş, and Sariyildiz (2010) is to create an urban database containing micro-scale urban data. This work is not based on any existing theoretical body of work but suggests the use of data mining methods for data-driven and context-specific urban analysis. The type of data that constitutes the database includes attributes such as: density, land-use, land value, ownership, material, physical conditions, and mobility infrastructure. Thirty urban space attributes in total formed the basis for data mining, allowed to identify the relationships between attributes, as well as their patterns within urban fabric. The resulting knowledge of the attributes’ relationships can lead to a better understanding of context-specific features by designers. The database is open-ended and can be extended further by incorporating additional attributes. Such dynamic tools for urban analysis allow for a much higher complexity in the study of urban spaces in general and in the study of public spaces in particular. The knowledge acquired from the developed method of Sokmenoglu, Çağdaş, and Sariyildiz (2010) may help to avoid the discrepancies between design projects and design context through the understanding of the nature of the relations between components of an urban setting. Consequently, the better fit of design projects into existing interrelations of an urban setting may be achieved through the knowledge that can be generated through data mining.
“The conflict of design projects with the existing interrelations of an urban environment can be minimized within the light of relational knowledge that will be gathered from this particular environment.” (Beirão, Chaszar, and Čavić, 2015)

Beirão, Chaszar, and Čavić (2015) describe a method for the analysis and classification of three-dimensional representations of open urban spaces – solid voids. According to the authors, solid voids consist of aggregated “convex voids” constructed from 2D plans and 3D information which includes topography undulation, as well as the adjacent buildings’ heights. The aggregation of convex voids into solid voids is based on the continuity of the visual field, which in turn assures uninterrupted spatial experience. The number of convex voids that forms solid voids in conjunction with angular deviation reveal “the grain” and linearity of an urban setting.

The work by Beirão, Chaszar, and Čavić (2015) demonstrated the joint use of the GIS database, CAD and VPI (visual programming interface). A set of codes, or the so-called “design patterns”, was used to generate 3D representations of solid voids in Grasshopper, which is the visual programming interface. Geometric characteristics are then measured, and they include the degrees of symmetry and patterns of variation and repetitions – regular, partially irregular and irregular. Based on results, the following space typologies are formulated: canyon-like spaces, valley–like spaces, steam-like spaces, room-like spaces and corridor-like spaces.

The authors of the study suggest further that the derivatives from these basic geometric characteristics are qualitative properties of space such as enclosure, openness, granularity and connectivity. These characteristics bridge the geometric properties to the use and perception by people. Such representation of an open space allows for a completely different perspective on the study of open space. Observing open space as a three-dimensional entity allows for a better understanding of its potential impacts on human perception by designers. For example, a space that is bigger in size provides for a higher sensation of spaciousness in a human. The sense of enclosure, in turn, stimulates more or less a secluded feeling while being in space. People may feel oppressed or excited and relieved. Connectivity indicates how many routes lead from one solid-void towards other urban spaces. The property of connectivity may be considered with regards to the (higher or lesser) number of people that these routes may potentially bring to a space. All these properties can be quantitatively measured and correlated to the geometric attributes in order to grasp some qualitative characteristics of space which are in most of the literature linked to the use of people which has been already mentioned at the beginning of this literature review. It is stated in Beirão, Chaszar, and Čavić (2015) that:
“This taxonomy is useful in aiding thought about (1) which factors are directly or nearly directly measurable, versus being calculated, and (2) how the progression from characteristics to properties, or vice versa, might be extended.”

The methodology presented in another study by Lopes et al. (2015) is based upon multivariate statistical analysis and data mining for the study of urban morphology. This work identifies and establishes the relations between a vast number of space attributes spanning from geometric to more qualitative ones, such as visibility or permeability, and uses data mining methods to classify urban spaces using these attributes. The methodology suggested in this work combines concepts and tools from urban morphology studies, computational parametric urbanism and the data mining domain. The attribute set was collected from literature and feedback from experts. The following groups of attributes have been identified: void shape, vertical plane and permeability, urban indices and density, visibility and connectivity, urban system, use and appropriation, environment, and generic labels. As can be observed, the attributes vary in type and level of scale at which they are measured. The advantage of data mining methods for public space quality analysis is in the ability to reveal interrelations within large sets of heterogeneous space attributes that would not be comprehensible otherwise.

2.3.7 Summary of the Literature Review and Implications for Research Study

This part discusses the implications of the reviewed literature for this thesis. In the course of the literature review, an extensive set of public space descriptive attributes was studied and accumulated. Any discussion regarding space descriptive attributes in the literature is focused on the way they relate to the quality of urban space. Indeed, for urban designers who are mainly concerned with physical form of public spaces, it is important to understand which attributes influence the sense of space quality, and how they influence it (Beirão, Chaszar, and Čavić, 2015). However, it can be difficult to set quality criteria for such descriptive attributes as geometric dimensions, topologic properties or environmental ones such as visibility.

The definition and interpretations of public space quality (concept) vary in the literature of the field of urban design (Moulaert et al., 2013). However, many of the works reviewed in this thesis express one similar idea that the quality of space is related to its use by people. More specifically, the quality of space is related to the way space “fits” the needs and capabilities of people which, in turn is a context and culture specific issue.
Based on this finding from the literature, it may be assumed that number of people using the public space can serve as an indicator of public space quality. The term that is used in the literature with respect to the number of people in public space is *liveliness*. This term was repeatedly used in J. Jacobs (1962), Whyte (1980), Mehta (2014), Carmona (2010) and in other related writings. It should be underlined here again that liveliness indicates space quality, and it is implied that the particular space is used for “informal” or “optional and social” activities (Gehl, 2011; Carmona, 2010). In the case of a transportation hub or any other place that imposes “formal” use or “necessary” activities (e.g. going to work or school), the statement with regards to being able to measure public space quality through the number of people in it, would need major amendments.

Consequently, attributes from the reviewed literature were organized into two groups. One group of attributes characterize liveliness which was adopted as a performance measure and the indicator of space quality for the purpose of this thesis. It is measured through the number of stationary and transit activities in space based on methods from the Space Syntax Observation Manual (Syntax, 2013) and Zeisel (1986) described earlier in this chapter. The second group of attributes contains descriptive attributes that represent objective characteristics of existing public spaces such as physical form, position in the city fabric, associated statistical information on the potential user groups and services and others (Ewing and Handy, 2009; Lennard Crowhurst and H. L. Lennard, 1995; Carr et al., 1992; Montgomery, 1998; A. B. Jacobs, 1993). This is illustrated on Figure 24.

![Figure 24: First attribute classification into groups that describe public space and its performance](image)

While the measurement process for the first group of attributes (i.e. liveliness) is straightforward, attributes in the second group must be further classified according to the respective urban scale at which they must be measured, and to the methods of measurements (quantitative and qualitative).
The first thing that must be considered in public space quality analysis is that this space is a part of a larger urban environment – the neighbourhood, the district and even further, the city, as suggested in J. Jacobs (1962) Figure 5. There are many factors, both physical and non-physical, which affect the way the space is used. These factors are referred to as attributes in this thesis and operate at these distinct urban scales in an interrelated way.

Among the global attributes (i.e. city scale) are accessibility, connectivity and integration. They characterize how well space is integrated within a city fabric and, consequently, how easily it can be accessed by people (Klarqvist, 1993).

The liveliness of public space also depends on the activities within the immediate vicinity. It is emphasized in Alexander et al. (1977) that factors such as the number of people living or working, and the diversity of activities (sport, retail, playgrounds and others) or the density of built form within 10 minutes’ walking distance from the public space all have direct repercussions on the activity in that particular public space Figure 8. Thus, these are the examples of attributes that characterize public space at an intermediate urban scale.

Finally, the way space is designed and how safe and maintained it is are the attributes of an individual space and should be regarded in relation to the previous two groups.

The three levels of urban scale form the basis for the further analysis of attributes in this thesis Figure 25. Several attributes and the corresponding levels of scale are shown in the tabular overview of Figure 26.

The set of descriptive attributes that was compiled from the literature review is comprised of 45 attributes in total. It contains descriptive characteristics that a good space should have according to (mostly empirical) valuations of design researchers and practitioners. The types of attributes embrace geometric attributes such as width, adjacent buildings’ height, area, and others; topologic such as connectivity, choice
2.3 PUBLIC SPACE DEFINITION AND SCOPE

Figure 26: Selected attributes and their respective sources and scales of measurement

(Klarqvist, 1993), associated statistical information, design characteristics (e.g. presence of urban furniture, water and green) and others. These attributes work together in different combinations to support human activity. As can be observed, they are numerous and vary in type.

The tendency in current research and design literature is to zoom into certain attributes and analyse them with respect to space quality. A human reduces the amount of analysed information due to his or her natural limited capacity to process large amounts of data. Thus, the reduction of complexity of a researched artefact to a number of parts that can be analysed by a human mind has been a common practice in urban design research until recently. Khan et al. (2014) argues for an interdisciplinary, integrative approach to the study of urban space and outlines the main current problematic with this regard.

Indeed, such disintegrated approaches are found more and more limiting for the research on public space quality problems as they do not operate at the appropriate level of complexity. It is apparent that an absolute understanding of public space quality is elusive due
to the ambiguity of this concept (Beirão, Chaszar, and Čavić, 2015). Also, the term "quality" may mean different things for stakeholders, designers or general public (Moulaert et al., 2013). However, the application of modern computer technologies may provide for some valid methods to approach this problem at yet another, advanced level of complexity.

2.3.8 Multivariate Analysis of Public Spaces

The present research thesis explores the synergetic effects from interactions between various attributes as they define “good” public spaces. In conjunction with the research work presented in Lopes et al. (2015), Beirão, Chaszar, and Čavić (2015), Sokmenoglu, Çağdaş, and Sariyildiz (2010), this research thesis advocates the use of multivariable analysis for public space quality evaluation. The two groups of attributes thus set the basis for the analysis process within this study: a) the performance attribute of liveliness and; b) the descriptive attributes that include such characteristics as geometry, topology, and the associated statistical data etc. Several attributes suggested in Berghauser Pont and Haupt (2010) are integrated within the latter group, i.e. integration, connectivity – at the city scale and built density measures at the intermediate urban scale (namely, the catchment area of ten minutes walking distance).

The following quote from Henri Lefebvre is from his book “The Production of Space” in which he underlines the problems of fragmentation and disintegration between concepts with regards to the production of space:

“. . . what does it mean to speak of ‘producing space’? We are confronted by the problem of how to bring concepts that have already been worked out and formalized into conjunction with this new content without falling back on mere illustration and example — notorious occasions for sophistry.”

(Lefebvre, 2008)

The theory of Henri Lefebvre still remains basic to the discipline of urban design and considers (urban) space as a multivariate entity formed through dynamic social and productive processes that should be observed and interrelated through time (Goonewardena, 2008).

Earlier, the lack of basic data such as plans, 3D data of built settings, as well as associated statistical data, made the process of space analysis quite narrow in scope, an observation which is specifically underlined in Rapoport (1990). Today, computer technologies provide opportunities for yet another, more enhanced understanding of the problem of space production and, subsequently, its quality. Possibilities provided
by GIS, crowdsourcing, simulation and analysis tools, as well as by parametric-algorithmic modelling, allow for a much more complex review of the problem of urban space production in general and of public space quality in particular (Shin et al., 2012; Schumacher, 2016; Woodbury and Gün, 2010). The new possibilities of contemporary technologies have a potential to bring researchers closer to the understanding of the way space is produced that was once exposed in the work of Lefebvre (2008).
Chapter 1 discussed the importance of public spaces for social and economic life in cities today and outlined the main problems with respect to public space quality research and public space design. One of such a problem is that the design of public space in the situation of rapid city development fails to consider the social aspects specific to design context. The design process is largely driven by the interests of stakeholders who mostly focus on fast implementation periods and projects’ financial returns. In order to keep up with the pace and maintain control of such a rapid urban development, standardized solutions for public spaces are developed and supported by regulatory documents. Implementation of such projects without the regard of context-specific needs of people leads to discrepancies between human activity and space. In urban research and design literature, this process is termed "the loss of quality". The issue of public space quality is the main focus of urban design discipline. It is commonly addressed in urban design literature through the range of descriptive attributes of space that are represented by objective features of space such as geometry, topology, statistical and user-related information, and performance attributes such as imageability, liveliness, or others that are interrelated with descriptive attributes to estimate how well space complies with the needs and uses of local people. However, public space quality is not a formal problem; thus, there are no specific rules or unambiguous criteria to choose from (Khan et al., 2014). The choice of this criterion is usually subjective and is based on extensive empirical observations of many case studies by researchers/practitioners.

Chapter 2 presented an analytic review of such existing approaches to determining the quality of those elements of urban environment which characterize public space and support its social function. Also, current approaches to the description of public spaces through attribution of their “final” quality characteristics that are amenable to direct measurement were analysed. “Final” here refers to the state of public space that designer aims to achieve through (re) - design. This chapter presents the conclusions which are based on the current state of research in the field of urban design as reviewed in Chapter 2, as well as on the hypothesis with the associated research questions that should further provide solutions to the identified problematic in the course of the literature review.
The extensive set of public space attributes was formed in the course of the literature review and the main point for each attribute in the set was its descriptive relevance towards public space quality. The concept of quality is a historical category that is culture- and context-specific. As could be observed in the course of historic overview in Chapter 2, cities and societies change following political, economic, social and technological transformations through time. Different countries follow distinct trajectories and development paths, which impacts social organization and the ways people perceive public spaces in cities. Therefore, the application of any hypothesis based on the reviewed attributes must be done only with respect to the particular historical and cultural contexts. The study context of this research work is Western Europe.

3.1 Global Trends: Lively Public Spaces

The importance of context information for public space design is amplified by the fact that the range of people’s needs in the developed countries is drastically different to that of the people who live in developing countries (Arimah et al., 2009). Quality of city life and, consequently, of city space, is defined predominantly by these varying needs and public space has an important role with this respect. It has to accommodate and support a variety of activities, as well as to provide for social cohesion and a vibrant social life. Therefore, it is natural to assume that if public space has both, a wide range of activities going on and appears lively, than it complies well with its main function of supporting public life. Consequently, it is considered a good public space with respect to the criteria listed above.

High quality public spaces are important for sustainable city development. They contribute to urban life quality and shape sustainable development by leveraging its three pillars: economic, social and environmental (Figure 27). The following quote from UN-Habitat confirms this global tendency:

"The liveliness and continuous use of public space as a public good leads to urban environments that are well maintained and safe, making the city an attractive place in which to live and work. Having access to public spaces does not only improve the quality of life: it is also a first step toward civic empowerment and greater access to institutional and political spaces." (Garau, 2015)

According to these criteria, public space quality will be treated in the present thesis from the perspective of public space liveliness and analysed with respect to the objective features of existing public spaces. Thus, the study contributes to the public space quality research by testing and objectifying some of the previous well-established research
works on public space quality attributes for a particular context of Zürich, Switzerland.

3.2 ZOOMING IN: PERSPECTIVE ON PUBLIC SPACE QUALITY

According to Lang (1987) and Carmona (2010) behavioural settings in general and public spaces in particular have two major components: *pattern of behaviour and the milieu* – the physical/built setting, with the latter resulting from the terrestrial and from cultural environments. As stated in Lang (1987), the built environment consists of man-made structures where surfaces, materials and colours are combined in *specific patterns* to form physical setup for human behaviour. The way people configure the environment around them changes “*the patterns of heat and light, sound and odors, and the mechanical contacts a person experiences*” (Lang, 1987). According to Lang (1987), various configurations of built environment accommodate different types of human behaviour, and their choice depends on a number of factors, such as human motivations, values and goals. Thus, a particular urban context defines the fit between what the built environment affords and the human use. The quality of public space for a particular context should be regarded through this fit.

As reviewed in Chapter 2, vitality serves as an indicator of this fit and consequently can be treated as a public space quality (reference to
vitality). Vitality is a combination of various sorts of activities, mostly social and economic, that take place in a particular urban location. The degree of vitality depends on how well the particular location supports those activities. Within the thesis the term "liveliness" will be treated as one instance of vitality which corresponds to social activity, in particular to the number of people using public space for transit and stationary activities. The term has been defined in Beirão and Koltsova (2015).

Based on Gehl (2011), it may be suggested that if public space has no imposed function (e.g. transport hub) and is visited by many people for optional and social activities, this space is considered as a "good" one and its descriptive attributes (the milieu) support well people’s needs. The second set of attributes that is analysed with respect to the performance measure of liveliness characterizes objective features of existing public spaces such as geometry, typology, statistical information and user-related information (people who may potentially use public space). However, one must have in mind that this statement is only true for cities that provide a variety of public spaces to choose from. In the case of a small town where there are only few public spaces, this statement would be wrong because people may choose them as the only available option and not due to their intrinsic qualities.

This thesis explores the interrelation between space liveliness and public space descriptive attributes suggested in current research studies in the field as reviewed in Chapter 2. The hypothesis of this research study is, thus, the following:

**Liveliness interrelates with commonly used measures of public space quality attributes.**

![Figure 28: Hypothesis illustration](image)

What follows from the formulated hypothesis is that the existing public spaces already contain information on the quality of public space and the space descriptive attributes that are needed to support this quality.
By extracting both sets of attributes from the existing successful public spaces within design context and entangling the interrelationship between the two sets, it is possible to recreate a profile of successful public spaces for this particular context. Such profiles can then be used as a starting point to create new public spaces within the same context. Obviously, to make any generalizations about the profiles for design practice, a sufficient number of public spaces needs to be analysed in the present study.

In order to make any further conclusions, it is necessary to analyse if and how liveliness interrelates with descriptive attributes of public space. But foremost, it is important to test whether liveliness is an appropriate measure that can be used to differentiate between "good" and "bad" public spaces. Consequently, the main research question that originates from the hypothesis is the following:

**What is the interrelationship of the descriptive attributes of public space to liveliness?**

To be able to provide the answer to the above research question the following sub questions have been derived:

- What are the common measures of attributes of public spaces that reflect their quality?
- How does liveliness differentiate between public spaces?
- What individual attributes of existing good public spaces in Zürich can be identified and how are they interrelated with one another and to liveliness?

A list of attributes has been collected based on the review in Chapter 2 to answer the first sub question. The answers to the second and third questions were found in the course of the method development and its application on a set of cases studies, which are described in Chapter 4 and Chapter 5 respectively.

To summarize, according to the goals of the research formulated in Chapter 1, the hypothesis forms the basis for the development of methodology for public space quality evaluation, where the interrelation between space liveliness (as a space performance criteria) and space descriptive attributes are tested. This was accomplished by developing the inverse approach for public space attribute detection. The specific approach used is based on the analysis of information available for the target context combined with the review of literature in the research area with the aim to uncover a set of attributes most relevant to public space quality within the given context.
The main goal of this research is to define an approach to assess and estimate the quality of public space based on the thesis hypothesis formulated in Chapter 3. The latter implies the necessity to identify the objective features of public space which promote higher occupancy and better usability. The corresponding goals are to objectify public space qualities established by prior research (reviewed in Chapter 2) and provide recommendations for suitable space attributes within the analysed context. These goals are accomplished by developing the inverse method for the detection of public space attributes. The main differentiation of the inverse approach lies in its aim to achieve the best possible quality for its occupants based on existing objective features of public space. The approach encounters two main steps. In the first step, the liveliness of public space is measured, which for the purpose of this study was adopted as a quality criterion. In the second step, attributes of public spaces with high liveliness are analysed and compared to their counterparts, public spaces where liveliness is low. Such a comparative study allows to distinguish the difference in the objective features of spaces that support or eliminate their use by people.

It may be stated that the basis of the inverse approach is the analysis of information available for the target context combined with the review of literature within a specific research area, with the aim to uncover a set of attributes most relevant to urban form quality within the given context. This is different to a traditional design process, where public space is transformed to attain the best possible quality under the specifications of the stakeholders, which often do not reflect upon the needs and requirements of the people who will potentially use the space.

Chapter 2 reviewed a number of previous publications on urban/public space quality. Based on this review, as well as based on site observations and expert feedback, attributes were gathered and organized into the two following groups: performance attributes – liveliness, and descriptive attributes – objective features of existing public spaces.

This chapter presents the methodology that was developed in the present thesis based on the hypothesis to test the interrelation between the two identified groups of attributes through the inverse approach.
Strategically, this research takes a positivist approach toward the study of the interrelation between liveliness of public space and descriptive attributes. On site structured observations were employed to measure the number of people in a space (on different days/times of the week), as well as to document their behaviour and interaction with spatial and physical components. The mode of inquiry is empirical – deductive. The developed hypothesis is based on the existing theories on public space quality and information available for the target context (i.e. local design literature and expert feedback). To test the hypothesis, the attribute data was collected and measured using a combination of qualitative and quantitative methods.

Indeed, such a cumbersome problem to objectify as the quality of public space cannot always be measured using either a quantitative or a qualitative method. In order to study multi-dimensional attributes of public spaces in a more comprehensive way, these research techniques have to be applied in combination (Carmona, 2010; Groat and Wang, 2002; Creswell and Clark Piano, 2007). The interaction with public space elements and their perception by people can be analysed using qualitative research methods, such as empirical observations. At the same time, the geometric and topological properties of spaces, as well as their associated information, such as the number of households and businesses it contains, can be directly measured. The combination of both qualitative and quantitative methods for public space exploration provides for more robust and reliable results (Carmona, 2010). According to Creswell and Clark Piano (2007), mixed method research helps to gain more of an in-depth understanding of a research problem than any single approach. The use of different data collection and analytical techniques for studying public spaces provides a more holistic understanding of the studied space attributes (Groat and Wang, 2002).

Observations from the current research study confirm that to fully understand what makes a space “good” and what makes people use a space, the attributes’ measurements have to be carefully considered together with qualitative data, such as informal interviews/dialogues with locals, personal observations, historic literature reviews, and discussion with local design practitioners. Just one interview with a local sociology expert uncovered some processes that, in addition to good design, had a drastic influence on the use of public spaces in Zürich. His feedback and writings on the underlying historic and social transformations in Zürich became fundamental for this research thesis (Wolff, 1998).

One example, which offers a glimpse into the final research results and, demonstrates the importance of examining public space in a systematic way is Idaplatz in Zürich. It is an urban square in Zürich that is highly appreciated and used by locals. However, the interview
with the sociology expert revealed that this has not always been the case throughout the square’s history. The square was redesigned in 2007, and its surface was changed from hard to soft, since a mix of sand and gravel was added. In addition, more seating and café tables were provided, and are now extensively used during lunch breaks by the people who work close by. Also, more subtle interventions have also occurred beyond the control of the square’s designers. For instance, the generation of people living nearby gradually shifted from elderly to younger people. Thus, the square became a place for the younger demographic to spend time with their small children while socializing with other similar families. The place provides enough safety for children’s activities (e.g. an elevated floor level that separates the square from traffic), with enough area for various types of activities (ball games, riding scooters, etc.). At the same time, street cafés (some existing prior to the shift and others new cafés, three in total, which, serve the shifting demographic) are places for grownups to socialize. Thus, if compared to the previous state (before the redesign), attributes such as the level of the square have been adjusted in relation to the level of the road. In addition, the asphalt surface has been changed to a more natural material, such as the combination of sand and gravel, and the access of traffic has been closed on one side of the square. These correspond to the following attributes considered to be important for space quality: distance to traffic hazards, separation from traffic hazards, and the type of pavement. It may be well assumed here that the change of attributes leads to better use of space for the people it is intended to serve; however, it would not be as successful without the change of the generation for whom such modifications were a perfect fit. This leads us to the premise that considering only the attributes of physical form is not objective enough, since they should be always regarded in conjunction with human use.

4.1 Research Design

Chapter 2 encompasses several important publications from domains such as environmental behaviour studies, place studies, and space morphology studies. The focus of environmental behaviour studies and place studies is on people and their behaviour in public spaces. Also, within space morphology studies, numerous publications suggest methods for the computational analysis of urban form, in conjunction with movement patterns such as the ones formulated in Hillier (1996). The main problem identified in most of the writings in the field of urban design is the shortcomings of theoretical frameworks, as well as of computational design and analysis tools, to capture the synergetic relationship between space quality and space descriptive attributes at the necessary level of complexity (Khan et al., 2014; Marshall, 2012). In
particular, the interrelation between public space liveliness and public space descriptive attributes came into focus. Another problem is that theoretical works are based on findings from preceding empirical research conducted for a specific context (Marshall, 2012). However, the quality of space is a context-specific property and has to be regarded in parallel with the current social and economic activity (Carr et al., 1992). To address the above problems, the present research study was constructed around the following five steps (Figure 29):

- **Analysis** – involved extensive analysis of literature, interviews with local specialists, review of local public space design practice, and review of potential case studies.

- **Hypothesis** – developed based on the problems defined in the course of literature review, namely the problem between the interrelation of public space quality and public space descriptive attributes.

- **Development/Synthesis** – development of a setup for attribute measurement, which includes a theoretical framework and computational tools.

- **Implementation** – application of developed methods for case studies to test/verify the original hypothesis: attribute measurement for each case study and the exploration of interrelationships between different attributes, particularly liveliness, to descriptive attributes in a set.

- **Evaluation** – result interpretation based on measurement results.

![Figure 29: The five steps of the research study](image-url)
4.1.1 Analysis

During the analysis stage, an extensive literature review was conducted in order to identify the set of space quality attributes, as well as criteria and methods for their measurement. The review focused on the following topics: place studies, behavioural studies, environmental design, urban indicators and attributes, public space frameworks, design tools, design codes, parametric design, parametric urbanism, space syntax, geographic information systems (GIS), and knowledge discovery with data mining.

The representatives of the Tiefbauamt Stadt Zürich (TAZ) were consulted to identify case studies for the developed methodology (TAZ, 2016). Joint workshops were conducted together with the Tiefbauamt to understand the role of public space quality research in the planning process in Zürich and the associated problems. In addition, the information on common design attributes used in local practice in Switzerland was kindly provided in an interview by Professor Vittorio Magnago Lampugnani from the Chair for the History of Urban Design at ETH Zürich. As this thesis focuses on the social aspects of public space use, the possible case studies were discussed and analysed during several interviews with Professor Christian Schmid from the Department of Sociology at ETH Zürich.

The analysis stage encompasses the following steps:

1. Review of the theoretical body of work on the topic of public space quality.
2. Review of qualitative and quantitative methods for evaluation of public space quality, and review of frameworks and design tools (theoretical and computational) to measure space quality.
3. Capturing local design knowledge and culture of public space use from interviews, site visits, and from literature.

4.1.2 Hypothesis

The hypothesis was formulated based on the problem defined during the literature review. A large number of successful public space attributes was formulated in the literature, and methods for their measurement were suggested. In the literature, the discussion of the attributes is carried out mostly with regards to their relationship to space quality (Beirão, Chaszar, and Čavić, 2015). However, as can be gathered from the literature, the notion of space quality is context-specific; thus, it requires consideration of attribute measures taken together with the specifics of the design context. This means that for
each particular design context, the specific measures may vary, and therefore, finding context specific measures of attributes represents a major challenge.

Moreover, the search for measures for individual attributes may be feasible with the parallel use of traditional design methods. However, the complexity of public space quality requires the study of large sets of attributes and, most importantly, of the interrelations between them. Due to the high number of attributes and their heterogeneity, this becomes a challenging task.

The main idea driving the research contained within the present thesis is an attempt to understand the interrelation between space quality and its attributes. The implementation of the research hypotheses is therefore based on the premise that the problem of interrelation between space performance and space descriptive attributes can be explained through liveliness, measured as the number of people staying and passing through space. The hypothesis was formulated in a way that the methodology developed to test the hypothesis would help to solve the following problems: to establish (quantitative) quality criteria for attribute measures, to understand the interrelation between quality criteria (liveliness) and descriptive attributes, as well as to define a way to analyse large sets of attributes (their interrelations and patterns).

4.1.3 Synthesis – Method Development

To test the interrelationship between space liveliness and space attributes, the methodology was developed through several stages:

• Development of theoretical framework for attributes measurement.

• Data collection and preparation – digital representations of space (such as plans, maps represented as GIS data, photos, etc.), extracts from OpenStreetMap, and information provided by the Statistics Office of Zürich.

• Definition of onsite measurements for the attributes of liveliness.

• Development of computational tools for descriptive attributes measurement.

• Attribute measurement on an exemplary case study with the developed computational tool set to test its functionality.
4.1.4 Method Implementation

The main aim of the implementation phase was to test the methodology across several real case studies – nineteen in total. Attributes were measured and evaluated with regard to the degree of liveliness for each individual case study. A set of charts and graphs was built to illustrate and evaluate the interrelations of attribute measures between the case studies.

4.1.5 Result Evaluation

This phase comprised the discussion and conclusions on the achieved results during the method implementation phase across the nineteen case studies. The main findings that contribute to urban design research and practice were outlined. In particular, the main achievements of this study include:

- Recommendations for supporting design of lively public spaces as a necessary component of sustainable urban development.
- A toolkit that can be used for the analysis of public space quality, not only from the social use perspective, but also from the standpoint of the economic and environmental impact.

The next section focuses on the components of the developed method and describes them in detail.

4.2 Inverse Design Support Method

The two constructs that support the concept of public space quality under the inverse design paradigm were identified based on a literature review performed for the purpose of this thesis. The first construct is space liveliness, which serves as criteria of space quality, and second construct is a set of descriptive attributes of space. The attributes of the latter group are categorized according to their respective urban scales of measurement (Figure 31).
4.2 INVERSE DESIGN SUPPORT METHOD

It is important to recognize that urban space is a scalable category. J. Jacobs (1962) suggests three scales for exploration of urban spaces, which are: the street scale, the neighbourhood scale and the city scale. She also suggests attributes that are important for each of the scales and that should be mutually supportive to provide for diverse, lively and practical urban environments. The prerequisite for a good urban setting is, according to J. Jacobs (1962), the diversity of place. Diversity is a complex concept that involves variation of the physical form of place, as well as the social groups of its users, of the activities and uses that place supports. All of these form a complex and interrelated system.

Consequently, scale-based classification of performance and descriptive attributes for this research thesis was carried out based on Jane Jacobs with one exception, which concerns the neighbourhood scale. Instead, the present research study considers the catchment area of ten minutes’ walking distance from the analysed public space. Christopher Alexander states that actively used streets must have various uses within ten minutes’ walking distance to provide for the flow of people between destinations as well as for the diversity of activities that they can reach on foot. The same logic may be applied to an individual public space. The more activity in the area around the spot, the more people it may bring into it. Thus, attributes are categorized with respect to the three following scales: city scale, catchment area (ten minutes on foot), and the scale of an individual public space (Figure 31).

The boundary of an individual public space corresponds to the boundary defined by the cadastral plan of Zürich as shown on Figure 32 [33].

The intermediate urban scale is defined by a polygon that represents the area of ten minutes’ walking distance (Figure 33). This polygon is generated by a parametric tool developed in the course of the present study, which uses graph representation of street network to calculate the distance along the network that a human can walk in 10 minutes.
The accessibility is based on the velocity of 4.5 km/h. The functionality of the tool is explained in the following section.

Finally, the city scale is defined by the city administrative boundaries.

4.2.1 Space Quality Criteria - Liveliness

In order to measure the set of variables that relate to space description and, subsequently, have direct or indirect influence on the quality criteria of liveliness, it was necessary to conduct on site observations and count the people who stay or pass through the space.

The number of people staying in space was directly counted during on site visits. The number of people passing was calculated using gate counts method, which is described in the Space Syntax Observation Manual (Syntax, 2013). The method is used to record the number of people or vehicles moving through space. The resultant data can be represented graphically or statistically. To conduct the measurement, a number of “gates” are defined. An observer stands at the location of the gate and draws an imaginary line through the analysed space. The line should be at the right angle to the direction of movement. The duration of counting should be defined and should be consistent for all days and times of the week when the observation is conducted.
4.2 INVERSE DESIGN SUPPORT METHOD

Figure 34: Liveliness is measured through on site observations and calculated as a proportion between people passing and people staying in the space.

Although this method is mostly used to count the number of people in streets with minor adjustments it has been also adapted to count passers – by in public spaces such as squares and urban parks. Figure 35 shows one example of the location of “gates” on a case study plan.

Figure 35: “Gates” are represented on the image as short bold lines in red; dashed lines are the axis of human movement most actively used in/around public space.

For consistency, the observations were conducted on the same times of the day and on the same weekdays for all the cases. According to the Space Syntax Observation Manual (Syntax, 2013), the most representative days that have distinct patterns of use are the following:

- Monday, Tuesday, Wednesday and Thursday
- Friday (Fridays tend to have a distinctive pattern of movement as it is the day before weekend)
- Saturday and Sunday

Observations were conducted for each of the case studies on the following days/times: weekday 12:00 – 14:00 (Monday – Thursday); Friday after 16:00; and weekend 12:00 – 16:00. Air temperatures during site visits varied from +20 and +27 degrees Celsius. Observations were not carried out on rainy days or on the days when weather conditions were not pleasant which could affect the number of people being present in the space. However, it must be noted that an interesting
effect – the boost of activity, can be observed at the turn of the seasons when warm days interchange with colder ones. The activity is usually at its peak on the days when cold weather changes to warm and sunny. As soon as the days become generally warm, the “hype” lessens (Figure 36).

Figure 36: Activity in Sechseläutenplatz, Zürich on the first warm spring day of 2014; activity in the same spot on one of the regular summer days

The variables that are used to calculate place liveliness are the following:

- Number of people staying \((N_{ps})\), measured on three respective days of the week
- Number of people passing \((N_{pp})\), measured on three respective days of the week
- Number of people staying – average \((N_{avp})\)
- Number of people passing – average \((N_{avs})\)
- Area of place \((A_{pl})\)
- Liveliness index \((L)\)

In order to compare the index of liveliness between different public spaces, the proportion between the average number of people passing to the average number of people staying for each public space was calculated. Subsequently, the formula for the liveliness index calculation is the following:

\[
L = \frac{N_{avp}}{N_{avs}}
\]  

In order to conduct on site measures a template was developed based on the methodology described in Zeisel (1986). The information in the template is organized into rows with the following information: time of observation, Number of people staying in space, Number of people passing through space in fifteen minutes. The field at the top of the sheet is for the notes on weather conditions. Additional fields were provided to document the activities occurring in space (maximum
range of ten activities was defined based on Carr et al. (1992), A. B. Jacobs (1993) and Mehta (2014); the types of urban furniture; landscape elements such as water and greenery; perceived maintenance and the level of perceived noise. Areas for photos, the area plan and field notes were provided at the bottom of the template (Figure 37).

![Figure 37: An example of on site observation sheet](image)

### 4.2.2 Space Descriptive Attributes - Theoretical Framework

Similar types of public spaces, such as squares, for example, may play a varying role for people who use them, depending on where they are located in a city. According to Lynch, public spaces such as squares or piazzas are the “nodes” that serve as reference points that help people to navigate within the urban setting. They are also meeting points and serve as cores for different urban areas. Norberg - Schulz underlines the importance of establishing such centres for people, with the first and foremost centre being their home place. In addition, centre may take an abstract form and, generally, represent an anchor point in the life of a person (Norberg-Schulz, 1963). People need such points of
reference to orientate themselves mentally, as well as physically. Public spaces such as squares (or small urban parks) may take form of local centres that add to the character of a neighbourhood, give it an identity and evoke a sense of belonging to an area in the people who reside there. However, such spaces are only used by people who live/work in the immediate vicinity. Other public spaces (mostly those that are located in the historic city centres) that have national/international significance attract much larger audience consisting of people from other neighbourhoods, towns or countries (i.e. touristic destinations). The examples of the latter are the Times Square in New York City, the Red Square in Moscow or the Bahnhofstrasse and Bellevue in Zürich.

The types of activities and people who engage with a public space vary for the spots of local or national and international significance. The areas of national and international significance usually accommodate a greater variety and choice. While in the case with the areas of local significance, activities in public spaces should be more place-specific and they should respond to the needs of people residing and working in these areas. In particular, such factors as the meaning of the public space for the local community should be considered.

The location of a public space in a city provides a preliminary idea of its type, role and, consequently, of the associated activities in the space and space attributes. Consequently, the location of a public space represents a centre of the framework which this thesis uses to examine public space descriptive attributes. The framework encompasses the three following components: people, interaction and space. The location of public space is a pivot point in the current framework to which the rest of the attributes are associated with. They are grouped into three respective categories (Figure 39).

![Figure 39: Theoretical framework for public space descriptive attributes analysis.](image)

In practice, the number of attributes of a good public space is large and encompasses about several hundreds of attributes. To reduce the complexity of public space quality evaluation, some studies suggest to combine the vast existing list of attributes into graspable sets (Montgomery, 1998; Mehta, 2014; Varna, 2014). Naturally, this implies that
some amount of information will be lost. The research study conducted in this thesis begins by combining attributes from the literature into one extensive set. Similarly to the approaches in Varna (2014) and Mehta (2014), and in order to simplify the analysis, the set is organized into three categories described above. The reason for selection of such categories is the need for a certain homogeneity among the attributes, which is preferable while studying the cumulative effect of a particular category on public space quality. Such homogeneity is a prerequisite in the process of analysing the synergetic effects of multiple (but each of a small influence) range of factors.

"People" and "interaction" are attributes that operate at urban scales above the scale of individual public space (i.e. city and catchment area). They define the potential users of the place, and differentiate between locals living/working nearby or the people travelling from other places. For the spaces of local significance, it is important to know the prevailing age groups and their income to understand how well space attributes fit their needs (Figure 40).

Among the most commonly detected descriptive attributes of public spaces in the reviewed literature are: accessibility, diversity, safety, comfort, connectivity, permeability, transparency, visibility and continuity. Though, many of them are defined as distinct attributes of urban environment, they have one point in common – they define interaction between people and space. Thus, for the purpose of this study, they are defined as sub components of the interaction component.

Also, the interaction between people and space is influenced by how appropriate the scale of the built environment surrounding public space is to a human scale. The attributes such as façade transparency, area of “active” façade frontages, building heights or length of building blocks have an impact on the way space is perceived and used by
people (A. B. Jacobs, 1993; Mehta, 2014). Table 21 illustrates the derived attributes set to be measured for case studies.

<table>
<thead>
<tr>
<th>People</th>
<th>Interaction</th>
<th>Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Total N of residents</td>
<td>• N of transport nodes</td>
<td>• Building coverage</td>
</tr>
<tr>
<td>• Residents Age 0 to 19</td>
<td>• N of commerce</td>
<td>• Area</td>
</tr>
<tr>
<td>• Residents Age 20 to 39</td>
<td>• N of restaurants</td>
<td>• Space openness</td>
</tr>
<tr>
<td>• Residents Age 40 to 59</td>
<td>• N of museums</td>
<td>• N of trees</td>
</tr>
<tr>
<td>• Residents Age 60 to 79</td>
<td>• Interaction with water</td>
<td>• Alignment of trees to sitting</td>
</tr>
<tr>
<td>• Residents Age 80 plus</td>
<td>• Interaction with green (trees, loans)</td>
<td>• Presence of other greenery</td>
</tr>
<tr>
<td>• Workforce (N of employed)</td>
<td>• N of activities</td>
<td>• Presence of benches</td>
</tr>
<tr>
<td>• Taxable income (median basic rate)</td>
<td>• Connectivity</td>
<td>• Presence of other urban furniture</td>
</tr>
<tr>
<td>• Taxable income (median married rate)</td>
<td>• Choice</td>
<td>• Presence of water</td>
</tr>
<tr>
<td></td>
<td>• Proportion of the perimeter to active facade fronts</td>
<td>• Average distance between buildings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• N of embranchment streets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Main axis of pedestrian movement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Distance to traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Availability of sun</td>
</tr>
</tbody>
</table>

Table 21: Resultant attribute set from literature review to be measured

4.2.3 Attributes Measurement Setup

This section describes the process and the applied methods for attributes measurements (Figure 41). The first part of this section will identify space descriptive attributes and data sources. The next part will talk about the choice of technology to perform measurements and data treatment. The following part of the section will describe in detail the tool set that was developed in the course of this research study for specific attribute measures, such as space openness, visibility, and accessibility. The conclusion of this section will illustrate the tool set’s exemplary application in the course of the joint work with the local design practitioners. The associated codes for the tool set are provided in the Appendix, Section A.3.

Figure 41: Attributes measurement setup.
4.2.3.1 Data Collection and Preparation

In the first step of data collection and in the preparation process, space descriptive attributes were organized according to data types (Table 22). The following groups were identified:

- **Statistical** – the attributes that refer to social aspects, such as people living/working in the area of ten minutes’ walking distance; N of retail and restaurants; N of activities at public space,

- **Geometric** – the attributes that refer to geometry, such as length and width of a public space, height of the adjacent buildings, distance between buildings, and their derived measures such as total area, footprint areas of buildings, space openness and building coverage.

- **Topologic data** – the attributes that refer to topologic street network properties such as integration, choice (Space Syntax measures) measured for city scale, N of transportation hubs and N of embranchment streets measured for an individual space.

- **Design** – the attributes that mostly refer to the design of space and to the properties of elements found within it (ergonomics, interaction etc.)

Next, sources had to be identified to acquire the data. For the statistical data, the two sources used were the statistical data provided by the Statistics Office of Zürich, and OpenStreetMap (OpenStreetMap, 2004; S. O. o. Zürich, 2017).

The office of Geomatik & Vermessung of the City of Zürich (G. V. Zürich, 2017) kindly provided the data set containing the information pertaining to the city’s geometric and topologic properties. For visualization of the statistical data, the acquired GIS data (i.e. Shape Files) was converted into geometry within ArcGIS software and exported as .dxf into CAD software, namely Rhinoceros (Associates, n.d.; ArcGIS, 2016). This process is shown on Figure 42. The resultant CAD model required a thorough “cleaning” of geometry, in particular, the remodelling of block instances into Breps (boundary representations), which are the solids constructed from a set of connected surfaces.

![Figure 42: Geometric data retrieval from data sets](image)

The information on the location of the businesses such as shops, restaurants (incl. fast-food and cafés) and attractions such as museums, view-
4.2 Inverse Design Support Method

<table>
<thead>
<tr>
<th>Statistical (real, integer)</th>
<th>Geometric (real, integer)</th>
<th>Topological, structural (real)</th>
<th>Design (binary, integer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N of residents</td>
<td>Building coverage</td>
<td>Connectivity</td>
<td>Presence of water</td>
</tr>
<tr>
<td>Residents Age 0 to 19</td>
<td>Area</td>
<td>Choice</td>
<td>N of trees</td>
</tr>
<tr>
<td>Residents Age 20 to 39</td>
<td>Space openness</td>
<td>N of embankment streets</td>
<td>Alignment of trees to sitting</td>
</tr>
<tr>
<td>Residents Age 40 to 59</td>
<td>Average distance between buildings</td>
<td>N of transport nodes</td>
<td>Presence of other greenery (loans, flower beds, etc.)</td>
</tr>
<tr>
<td>Residents Age 60 to 79</td>
<td>Building height</td>
<td></td>
<td>Presence of benches</td>
</tr>
<tr>
<td>Residents Age 80 plus</td>
<td></td>
<td></td>
<td>Presence of other urban furniture</td>
</tr>
<tr>
<td>Workforce (N of employed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxable income (median basic rate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxable income (median married rate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of retail shops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of restaurants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of museums</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building coverage</td>
<td></td>
<td>Connectivity</td>
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</tr>
<tr>
<td>Area</td>
<td></td>
<td>Choice</td>
<td>N of trees</td>
</tr>
<tr>
<td>Space openness</td>
<td></td>
<td>N of embankment streets</td>
<td>Alignment of trees to sitting</td>
</tr>
<tr>
<td>Average distance between buildings</td>
<td></td>
<td>N of transport nodes</td>
<td>Presence of other greenery (loans, flower beds, etc.)</td>
</tr>
<tr>
<td>Building height</td>
<td></td>
<td></td>
<td>Presence of benches</td>
</tr>
<tr>
<td>Building coverage</td>
<td></td>
<td></td>
<td>Presence of other urban furniture</td>
</tr>
</tbody>
</table>

Table 22: Attributes organized according to data types

Points and other public spaces, was exported from OpenStreetMap and imported through the Elk component and through the graphical algorithm editor Grasshopper into Rhinoceros (Rutten, n.d.). Elk is a collection of tools developed by Timothy Logan for Grasshopper that makes it possible to import maps, as well as topographical information, into Rhinoceros using .osm data from OpenStreetMaps (Logan, 2013) (Figure 43).

Figure 43: Import of OpenStreetMap data

4.2.3.2 Attributes Measurement and Associated Design and Analysis Tools

The attributes are measured through the means of on site observations, statistical data and urban space digital representations (Figure 45). The latter include vector plan of Zürich, and the 3D model of Zürich at the level of detail one (LOD1 - extruded building footprints). To capture some additional features such as the relation between space and elements of building facades, public space photos were employed.
The following analysis methods were used to measure attributes at different levels of urban scale (Figure 46):

- Space syntax analysis methods in DepthmapX, UCL (city)
- Data retrieval from GIS data through data format conversion (city, catchment area)
- Parametric-algorithmic analysis in Rhino & Grasshopper (catchment area, individual public space)

Grasshopper is a visual programming interface (VPI) that provides additional possibilities for parametric modelling within the CAD platform called Rhinoceros (Associates, n.d.) Such a setup allows for direct and parametric modelling and therefore supports the (high) flexibility of data integration and manipulation. The attribute data can be combined, measured and stored within a single database in Grasshopper and exported for further multivariate analysis elsewhere. For the detailed explanation of parametric modelling methods and their possible applications, refer to Woodbury and Gün (2010).
The data on the number of people working or residing in a walking proximity to a public space has been received from the Statistics Office of Zürich (S. O. o. Zürich, 2017). A polygon representing the ten minute walking distance from the public space was calculated (Figure 47). By using point-in-polygon testing, statistical data for the respective public spaces was extracted from the polygons, resulting in an excel table containing the following data for each space: number of people employed within the polygon area, and the number of residents categorised by age group and income level (Figure 48).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Data type</th>
<th>Unit</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Total N of residents</td>
<td>Real</td>
<td>-</td>
<td>Catchment area</td>
</tr>
<tr>
<td>2 Residents Age 0 to 19</td>
<td>Real</td>
<td>-</td>
<td>Catchment area</td>
</tr>
<tr>
<td>3 Residents Age 20 to 59</td>
<td>Real</td>
<td>-</td>
<td>Catchment area</td>
</tr>
<tr>
<td>4 Residents Age 60 to 79</td>
<td>Real</td>
<td>-</td>
<td>Catchment area</td>
</tr>
<tr>
<td>5 Residents Age 80 plus</td>
<td>Real</td>
<td>-</td>
<td>Catchment area</td>
</tr>
<tr>
<td>6 Workforce (N of employed)</td>
<td>Real</td>
<td>-</td>
<td>Catchment area</td>
</tr>
<tr>
<td>7 Taxable income median basic rate</td>
<td>Integer</td>
<td>CHF, 1000</td>
<td>Catchment area</td>
</tr>
<tr>
<td>8 Taxable income median married rate</td>
<td>Integer</td>
<td>CHF, 1000</td>
<td>Catchment area</td>
</tr>
</tbody>
</table>

Figure 47: Creation process of the ten minute walking distance polygon: based on the accessibility analysis along street network (left) the polygon is constructed (middle) and exported as JSON (right)

Figure 48: Statistical data on potential public space users acquired from the Statistical Office of Zürich
4.2.3.3 Analytical Tools for City Scale: Space Syntax Measures

To get an understanding of how well public space is situated within the overall city system, the two attributes measures were analyzed in DepthmapX, Space Syntax (DepthmapX, 2014). The middle lines of the street system were used to run angular segment analysis. The analysis was performed for a 1500-meter radius (which corresponds to the walking distance of 10-15 minutes). The first measure illustrated on Figure 51 is integration, which indicates how far each segment is from others in a system in terms of topological distance (Klarqvist, 1993). The second one is the choice, which indicates network segments with the highest probability of being used, such as a bridge connecting two parts of a city fabric (Figure 50). In this thesis, each value (choice and integration) is calculated as an average between the road segments surrounding public space (Figure 49).

Figure 49: Choice value for one of the segments surrounding public space. The attribute is measured by taking an average of all the surrounding road segments

Figure 50: Analysis results for Zürich city centre: choice (red – high choice values, blue – low choice values)
4.2 INVERSE DESIGN SUPPORT METHOD

Analytical Tools for Intermediate and Small Scales: Parametric Tool Set

The attribute set forms the backbone of a set of the computational tools that were developed in Grasshopper visual programming interface (VPI), which is a parametric plug-in for Rhinoceros (Koltsova, Tuncer, Georgakopoulou, et al., 2012; Rutten, n.d.). In Grasshopper, it is possible to write your own code in the programming languages C#.NET or VB .NET and to create a custom tool (or component), which performs specific functions. A component is represented as a box that has inputs (usually on the left side) and outputs (on the right side). A component performs computations on the input, producing its output data. Figure 52 illustrates several custom and built-in components combined into a tool that performs accessibility analysis. This tool and others will be described further in the text.

Accessibility Analysis

This custom built accessibility analysis tool calculates a street network representing the area that can be reached by a walking person from one point in a certain time period (Figure 53). To perform this task, the street network is split into small segments, which are then used for

Figure 51: Analysis results for Zürich city centre: integration (red – high integration, blue – low)

Figure 52: Combination of custom and in-built components in Grasshopper to perform accessibility analysis
creating a formal graph structure. The street segments serve as edges in the graph representation and as vertices in the intersection. The formal graph representation is analysed using Dijkstra’s algorithm in order to calculate the shortest path between the point of origin and the mid point of every segment of the road network. Based on the two inputs – velocity (4.5 km) and time (10 min) the topological distance is calculated. The input parameters for the accessibility analysis component are:

- Maximum walking distance, or;
- The time and speed by car/walk/public transport (in which case the maximum walking distance is calculated based on these two parameters).

![Figure 53: Custom component for accessibility analysis. Input parameters: network topology (G), starting point of movement (P), speed (V = 4.5 km/h), duration/time of movement (T = 10 min), max walking distance (D – calculated based on two previous inputs). Colour gradient indicates accessible area on foot within 10 minutes (right)](image)

The accessibility analysis tool was used in this thesis to define the catchment area of ten minutes walking distance. It is a useful add on in the design process as it quickly allows to estimate how far one can reach into the city from a public space and what are elements that can be accessed within this distance. When designing a new public space, it is important to analyse it connections (and their nature) to the elements located within their immediate vicinity, such as other public spaces, historic attractions (or any other attractions, such as art objects), retail or dining facilities. All these elements contribute to the activity within the public space. Space function and configuration (design) should be considered in relation to the relationship to these surrounding elements to provide the best design of vibrant and actively used public spaces (Kostof, Castillo, and Tobias, 1992).

**Visibility Analysis**

The visibility analysis tool combines two possibilities: a) visibility analysis from a given point in an urban setting (e.g. as perceived by a person); b) visibility analysis of urban space elements, i.e. buildings and streets. The latter analysis can be applied to a building in an urban setting to determine parts of the street network from where it is visible (Koltsova, Tuncer, and Schmitt, 2013).
In order to perform the analysis, building geometry (Breps) is converted to meshes. The road network is split into segments at intersection points. The length of every segment can be defined according to the design scale. The smaller the segment, the more precise the analysis is. The mid points of segments serve as visibility nodes. The algorithm generates rays between mid points of the curves and centroid of mesh faces of the building/terrain geometry. Then, the algorithm returns intersection points between vectors and each face’s centroid, and checks if there is any obstruction between the viewing point and the façade surface. Depending on the number of rays hitting the face centroid, a colour is assigned: yellow depicts the best visible mesh faces, blue depicts the worst visible mesh faces and white non-visible mesh faces (Figure 54).

Performing calculations for every street segment and every mesh face is computationally expensive, especially in Rhino/Grasshopper, in which it is difficult to perform optimisations.

The first iteration is using only bounding boxes of building meshes to exclude impossible intersections. Only if a generated ray intersects a bounding box the algorithm proceeds to the analysis of the entire mesh. This helps to considerably reduce calculation time. The inputs for the tool are:

- The view distance from a view point to a façade surface
- The maximum visual angle (vertical and horizontal)
- The angle from the view point to a façade surface

Combining accessibility and visibility analysis methods provides the possibility to analyse how far one can go within a certain time span and what is visible while walking this route. Figure 55 (a) shows the accessibility analysis results and (b) shows what is visible while walking on a particular path. Rays are created between the road segment and building mesh faces. If a mesh face is visible from the road segment, then the algorithm increments a counter on the mesh
face. The value of the counter expresses how many segments “see” a certain mesh face. In the visualisation yellow depicts best visible, blue the worst visible and white non-visible mesh faces.

Specific parameters for different design tasks are retrieved by the tool which combines the accessibility and visibility analysis. For example, for the analysis of city dominants (tall buildings or city monuments), the tool solely checks if the object is visible or not from a certain point or path as shown in Figure 55 d). Considering factors such as the visibility of city dominants during the design of new public spaces can improve navigation within a city. For pedestrians, it is easier to choose the direction of movement if they see a dominant building and know the location of it. Visual connections in the city also help to create better-connected public spaces (networks instead of isolated spots). Moreover, introducing or intentionally framing certain “attractive views” in public space through design may considerably enhance its quality and boost its use. People like to enjoy nice vistas, such as in the case of Sechseläutenplatz illustrated in Figure 56 where the opening between the trees is “hinting” to the beautiful view to the hills and the lake of Zürich.
Figure 55: a) Accessibility analysis results; b,c) accessibility analysis combined with the visibility analysis; d) analysis of streets segments that “see” a certain building within an urban setting

The developed visibility analysis tool may assist designers in “designing” the visual aspects of public space form to add additional perceptual quality to the space.

Figure 56: Captured situation at Sechseläuten

**Analysis of Space Openness**

The analysis of space openness is performed between the tessellated mesh of building facades and mesh that represent the ground surface of public space. This method uses a ray-casting algorithm to analyse
the degree to which public space is surrounded by building fronts. The
distance between the surface of the public space and building facades
is a variable that can be adjusted based on the design scale. The degree
of openness is calculated within a range of 0 and 1. For visualization
purposes, the colour gradient is used, where red corresponds to closed
space and blue corresponds to completely open space.

The degree of space openness has a potential to influence the feeling
of being in a public space. More secluded spaces provide for intimacy
and relaxation, such as the case of small European cafés located in
the courtyards of buildings from the turn of 19th century, with the
most famous example being the MQ Courtyard in Vienna, or in small
winding streets that are inherited by Europe from the medieval
times such as Lindenhof area in Zürich.

Figure 57 illustrates the result of openness analysis of the new devel-
opment in Zürich. The varying degree of openness that is produced
by building geometry may be used to the benefit of the open public
space in-between buildings. The areas in red (more secluded) can be
used to allocate more calm activities such as dining. Also, the sudden
narrow effect that is produced by the close proximity of buildings in
the central part of the development is a point of concentration which
draws attention of people to the activities located there. Consequently,
some “important” functions can be allocated at this point too.

OpenStreetMap Data

OpenStreetMap served as a data source for transport nodes, retail and
other leisure and entertainment facilities within a catchment area. The
data was retrieved using Elk, a custom set of components developed
by Timothy Logan for Grasshopper (Logan, 2013).

The tool allows to retrieve the maps and their associated data (e.g.
location of transport nodes, retail and dining) from Openstreetmap
and import it into Rhino. The locations of transport nodes, retail and restaurants were represented as points.

The analysis of the described locations was used in combination with the accessibility analysis in order to understand the kind of functions that can be reached on foot from the analysed public spaces and how those may potentially contribute to the human activity within the spaces. For example, if public space is surrounded by many transport nodes, there is also a better accessibility to it, which makes it attractive for people who travel to/from their destinations to potentially stop there.

Figure 58: Number of transport nodes from which the place can be accessed within ten minutes walk

Figure 59: Measurement of the number of shops within a catchment area

**Geometric and Design Attributes**

Other geometric attributes such as average buildings heights, average distance between buildings, length of blocks, public space area and building coverage were calculated from the urban model using built in components in Grasshopper at the scale of the catchment area and individual public space. This detailed information regarding the properties of buildings and open space form allows for the understanding of the scale of urban grain and its relation to human scale. According to the reviewed writings, the intricacy of urban form at
these two levels of urban scale influences the human perception of public spaces and consequently, the use of public spaces (Cullen, 2007). More specifically, the interrelation between the area of public space and the height of adjacent buildings influence the level of enclosure. In turn, different degrees of enclosures suggest different viewing and sensory experiences, from a more intimate experience such as having coffee at a small piazza surrounded by historic buildings, to a more exposed one such as doing tricks on a BMX bikes in the middle of the square or dancing to Hip-Hop music (Figure 60).

Figure 60: Activities at Sechseläutenplatz (left) and Weinplatz (right) in Zürich. While Sechseläutenplatz is an vast open space, Weinplatz is more secluded and intimate.

Also, the length of blocks is related to the number of possible routes that bring people to the public space. The more permeable the area around the public space is, the more possibilities for movement there are, and thus, the public space appears lively (J. Jacobs, 1962; Montgomery, 1998).

Most of the design attributes were measured through on site observations using the templates developed for space liveliness measures (Figure 37). Their examples are presented in the table illustrated in Figure 61.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Data type</th>
<th>Unit</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 N of trees</td>
<td>integer</td>
<td>-</td>
<td>Space</td>
</tr>
<tr>
<td>2 N of benches</td>
<td>integer</td>
<td>-</td>
<td>Space</td>
</tr>
<tr>
<td>3 Presence of water (fountain, pool)</td>
<td>Binary</td>
<td>1, 0</td>
<td>Space</td>
</tr>
<tr>
<td>4 Interaction with water</td>
<td>Binary</td>
<td>1, 0</td>
<td>Space</td>
</tr>
<tr>
<td>5 Presence of trees/greener</td>
<td>Binary</td>
<td>1, 0</td>
<td>Space</td>
</tr>
<tr>
<td>6 Interaction with greener</td>
<td>Binary</td>
<td>1, 0</td>
<td>Space</td>
</tr>
<tr>
<td>7 Availability for sun</td>
<td>Binary</td>
<td>1, 0</td>
<td>Space</td>
</tr>
<tr>
<td>8 Protection from sun/wind</td>
<td>Binary</td>
<td>1, 0</td>
<td>Space</td>
</tr>
<tr>
<td>9 Presence of movable/other types of furniture (talk spaces)</td>
<td>Binary</td>
<td>1, 0</td>
<td>Space</td>
</tr>
</tbody>
</table>

Figure 61: Examples of design attributes
The Tool Set Exemplary Application in Design Practice

The developed tool set for visibility and accessibility analysis has been tested with local urban designers on the exemplary case studies. One example is an application of the visibility analysis tool for the evaluation of an urban design proposal submitted for a competition. The new development was created to become the new economic hub for the local neighbourhood area in Zürich. Consequently, its visual perception from major access points such as transportation stops or the highway was an important point of regard in the design process. The visibility of the new development provides for better accessibility and integration within the existing urban fabric. The studio architect suggested a number of important visibility points and the particular elements of the development site that should be visible from these points. This was documented in the form of the “target” matrix (Figure 62). The visibility analysis tool was used to evaluate each new design proposal. Based on the results, a new matrix was created. The new matrix was then compared to the target matrix, and if there were discrepancies between the two, building shapes were adjusted to provide a better visibility.

Figure 62: A target matrix defined by an architect. Cells in dark grey indicate design project elements (top row) that should be visible from a number of points within the surrounding urban setting (column left)
4.2.5 Conclusion

The combination of the described tools supports the public space design process in several ways. Firstly, it allows to quickly test perceptual properties of space such as visibility and accessibility in relation to the designed geometry. With regards to the former, such analysis enhances designer’s understanding of the way the new design may be perceived by people and how it could potentially influence their behaviour. Careful consideration of views that open up from and towards the public space may serve as an additional attractor for people to use space. The accessibility analysis tool reveals how far one can go on foot within a short time span of 10-15 minutes (this is the time that most people can/would agree to walk), as well as the easily reachable adjoining functions that create activity around the public space under analysis. The information regarding the latter can be gathered from resources such as Openstreetmap or the local statistical database. Consideration of this contextual information and the way it relates to the designed space is crucial to its proper integration and future use. According to J. Jacobs (1962), in order for urban space to be vibrant, it has to contain many mutually supportive functions. On the other hand, a public space such as for example a square, is just one part of an urban setting that interrelates to the activities and spaces around.

Secondly, combining such tools under the umbrella of a single computational platform that allows for both, direct and parametric modelling and provides possibilities for simultaneous analysis of many space attributes and their interrelationships. This systematic (multivariate) approach may potentially enhance the understanding of attributes that are influential to the quality of public space of various types such as parks, squares and streets.

Finally, availability of statistical data (such as population groups which may potentially use space, the type and number of adjacent functions like retail, restaurants or cultural venues) enhances the understanding of the role the future public space should serve within the design context.

It is suggested in this thesis that the design of good public spaces should be driven by the contextual information associated with it. Specifically, the attributes derived from the local context following the described procedure make it possible to define the function and, moreover, the geometry of newly created public spaces. Such approach “reverses” the flow of a traditional urban design process, which typically starts with a design brief that prescribes the desired uses, densities and sometimes design elements of a new project. These are then translated into the design form (with its attributes) and adjusted in order to fit the development site. Many architects find this rigidity of the traditional
design approach very constraining for their creative process. However, it is obvious that in order to maintain control over the urban development process in cities, the building regulations should still persist. Thus, in the future steps of this research study, the arising question regarding how to combine the developed approach with regulatory documents should be addressed with thorough attention.

To summarize, the method suggested in the present study is envisioned as a first step in the inverse design process. In particular, this work tests the validity of liveliness as a measure of quality and consequently, the potential to identify/detect good quality public spaces across the range of existing public spaces in Zürich with this particular measure. The set of descriptive attributes that is gathered in the course of the literature review (Chapter 2) and based on the feedback of design experts is not all-encompassing. Rather, it is an exemplary set that is used to test the way interrelationship between measured liveliness and objective features of existing spaces can be established and empirically validated. Thus, the developed inverse approach comprises two main steps. The first step implies the measurement of liveliness, which allows the identification of good quality public spaces. The second step entails the measurement of descriptive attributes of identified public spaces. Finally, the interrelation between the two sets is then empirically analysed.

In order to test the hypothesis formulated in Chapter 3, the method was applied across 19 case studies in Zürich and will be described in the following chapter.
After World War II, a steady economic increase was observed in Switzerland. With a gradual shift from industrialized economy after the world economic crisis in 1970 to a service economy, Switzerland employed most of its labour force within this sector by the year of 2010 (Schmid, 2012; Eidgenossenschaft, 2016). The economical shift in turn, led to an improved quality of living and working conditions, the enhanced sense of social security and an expanding diversity of consumer goods (Wolff, 1998). According to Wolff (1998), there are two major factors, which influenced the formation of Zürich as a global city identified in:

- "An upsurge of the headquarter economy"
- "Essential social and cultural permutations induced by urban social movements" (Wolff, 1998)

Urban development of Zürich after World War II was highly constrained by anti-urban policies, which were against the geographical expansion of city boundaries. Consequently, urbanization started to take place at the city fringes. This process was called “a process of diffuse suburbanization” (Wolff, 1998).

The totality of such urban policy penetrated not only urban development but also other domains such as the social life of the city. The lack of places for cultural venues as well as the lack of space where people could simply meet without the need to pay for goods or services, were felt in Zürich. Activities in public space were regulated and did not encourage vibrant and versatile social interactions. The deterioration of public space quality and social life was also the result of the modernisation process with its focus on the functional aspects of city fabric, which was regarded as “reproduction machines” (Wolff, 1998).

In response to these challenges, the protest movement was formed in Zürich in 1968, which demanded “a different city” (Wolff, 1998). In turn, the protest movement resulted in the abandonment of modernization strategies which “protected” the inner city structure of Zürich from being transformed into retail and office facilities and helped to preserve the character of the inner city core.

After the wave of the previously described protests around Europe in 1968, the social life of cities began to change. The buildings left empty
after the relocation of the working class into suburbia started to fill up with new types of residents, who were typically young, culturally dynamic, and open-minded people. The areas in districts four and five in Zürich became new kinds of urban enclaves with their associated social life that spilled into public spaces. At the same time, global businesses started the search for new locations at the periphery of the city or at the spots of the deactivated industries that had access to the local airport. All these processes resulted in the development of Zürich as a polycentric city with various districts having their distinct features and uses:

“A polycentric urban region emerged, representing a new configuration of the urban, characterised by the regionalisation of the urban economy and urban society” (Wolff, 1998)

The strong social protest, which was highly disadvantageous to the image of Zürich as a safe and peaceful city, forced the government to take action to stop further unrests. At that point, the cultural life of the city came into focus. A large number of cultural organizations were founded, such as the Rote Fabrik, international theatre festival, cinemas, clubs and others. Obviously, these heightened the vibrancy of the social life in the city.

The uses of public spaces changed following the previously described cultural transformations. During this time, public spaces transitioned from being places strictly designated for consumption and transport purposes, with highly regulated social functions, to places for social experiences, such as social encounters and leisure. Due to the increased number of “allowed” activities parks were no longer places for formal family Sunday walks as they once used to be (Wolff, 1998; Parish, 2008). Schmid et al. (1998) in Wolff (1998) specifically underlines that physical components of these places are still the same. However, their “meaning and social order”, as well as “spatial practices” of use, took a new form:

“What was once the clearly defined, monofunctional and isotopic space of a disciplinary society has now become the open, heterotopic and differential space of an urban society” (Wolff, 1998)

These historic aspects are especially important for understanding of the social role and function/use of public space in Zürich today. The varying character of city districts entails different uses and meanings of public spaces. The analysis of the current use and quality of public spaces has to be informed by these preceding processes.

The current tendencies and trends in the development of public space in Zürich and the role of space quality studies can be gathered from several documents: Zürich Public Spaces 2004 by Gehl Architects and Stadträume 2010 (S. Zürich, 2006). The first document was developed based on the quality analysis of 18 public spaces in Zürich by Gehl Ar-
chitects, with the goal to acquire an understanding and a vision of “an integrated urban spatial quality” for the city of Zürich (Reference).

The second document, Stadträume 2010, was developed by the city of Zürich based on the results from the studies described above (S. Zürich, 2006). It presents strategies that should be implemented for the (re-) design of public spaces in Zürich. It specifically underlines that the change in the mind set of citizens and globalized international character of social and economic development resulted in changes in the use of public space by local people. In particular, aspects such as growing mobility and commercial exchange have to be considered in the design of public spaces (S. Zürich, 2006) (Kocan, 2013). The growing welfare of cities results in greater expectations/demands of citizens in the use of public space.

In order to gain a better control of the distribution of public space types in the city and to ensure that they correspond to the character of an area where they are located, Stadträume 2010 suggests a hierarchy of public spaces. For each hierarchy, a set of goals/qualities is provided. Such an organized approach can help to avoid the accumulation of similar space types within the same district which, in turn, may have undesirable consequences for space liveliness. Consequently, it ensures overall diversity of public spaces in the city. Moreover, it is noted that the prescribed space types should be considered with regards to the specifics of their use by people and the related functions which would additionally provide for higher space liveliness.

The resultant strategies in the study published by Stadträume 2010 include: public space hierarchies, coherent design and quality of stay. To achieve the latter, a checklist with the following points is suggested: pleasant climatic conditions, noise protection, good accessibility, possibilities for seating, the sense of safety and others (Kocan, 2013). The full list is presented in table overview in Figure 63. For practical design purposes, these qualities are measured mainly through on site visits and people counts before and after the (re)-design of public spaces.

The plan outlined in the study by Stadträume 2010 distinguishes the following hierarchies of public spaces (based on the importance/public significance for the city): international; regional; districtwide; and neighbourhood (Figure 64).

Further, in Stadträume (2010), special attention is paid to the aesthetic and volumetric aspects of public spaces and their interrelation to surroundings. The design of spaces should regard and support their uses. For instance, they should be accessible by different social groups, and they should be safe and well-maintained. Furthermore, Stadträume (2010) provides a catalogue of design elements with respect to public space type based on the relevance plan shown in Figure 64.
Also, the document outlines a set of design guidelines for public space “sub-types” within the “relevance” plan in Stadträume 2010 (Figure 64). In particular, it suggests a number of such guidelines for public squares that are (Kocan, 2013):

- Recreational squares (Aufenthaltsplätze)
- Transit squares (Verkehrsplätze) and
- Junction squares (Einmündungsplätze)

These categories are based more on their function than on their meaning for the entire city. According to Gestaltungs-Standards, Stadträume: Plätze (2007), public squares have a special role that they play within the city fabric. They have to exemplify the city image, encouraging social exchange and encounters (TAZ, 2007). They should have clear boundaries defined by elements such as special pavements, greeneries, lighting and others. Squares that are important “nodes” (junctions, central points) in the city should be memorable and have certain accent elements such as art objects or water bodies. People should have possibilities to seat and enjoy space. It is also stated in Gestaltungs-Standards, Stadträume: Plätze (2007) that design of new public spaces has to be context-sensitive in order for squares to reflect the identity of the urban setting and evoke the image it.

Based on the historically evolved differentiation of public space types and their functionality identified by the recent documents, such as the Stadträume (2010) publication, the current research study proceeds to the method implementation for the 19 case studies in the city of Zürich. Several important questions have to be answered with this respect:
5.1 Case Studies: Method Implementation

There were 19 case studies selected for analysis in collaboration with Tiefbauamt Zürich (TAZ) and based on Stadträume (2010). The focus of the proposed research work is on regional, district-wide and neighbourhood public spaces as defined by the “relevance” plan (Figure 64). The places of international importance are mostly tourist destinations within the historic city centre. Typically visited by tourists, they don’t always reflect public uses, and consequently, the needs of the locals. However, the following public spaces (of international meaning) are still considered in the present study: Sechseläutenplatz, Bürkliplatz.

- Does the developed method capture different degrees of liveliness for the range of types distinguished in the Stadträume (2010)?
- Can liveliness be used as an effective measure of public space quality?
- What is the interrelation of the degree of liveliness to descriptive attributes of public spaces in Zürich?

**Figure 64: Public space relevance plan from Stadträume 2010 document; international (red), regional (orange), districtwide (yellow), neighbourhood (uncategorized)**
and Oerlikon Marktplatz. Sechseläutenplatz has been historically a place for local fests and celebrations, and it is frequented by locals on weekdays and weekends which became apparent in the course of the on site observations conducted as a part of this research. In turn, Bürkliplatz is a place for local food and flee markets also popular among locals. Also, Oerlikon Marktplatz seems to be a popular spot for people who work, study and live in the area. The plans, photos and basic information on the case studies are provided in the Appendix, Section A.1. Further, their location in the city is illustrated on Figure 65. Based on the “relevance” plan cases studies are classified according to the four suggested categories in Table 23.

<table>
<thead>
<tr>
<th>International</th>
<th>Regional</th>
<th>Districtwide</th>
<th>Neighbourhood</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bürkliplatz</td>
<td>• Bullingerplatz</td>
<td>• Anny Klawa Platz</td>
<td>• Max Bill Platz</td>
</tr>
<tr>
<td>• Sechseläutenplatz</td>
<td>• Kasernareal</td>
<td>• Brupbacherplatz</td>
<td></td>
</tr>
<tr>
<td>• Oerlikon Marktplatz</td>
<td>• Turbinenplatz</td>
<td>• Fritschiwiese</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Stadelhoferplatz</td>
<td>• Hallwylplatz</td>
<td></td>
</tr>
</tbody>
</table>

Table 23: Case studies classified according to the relevance plan outlined by Stadträume (2010)

The first part of this chapter presented a brief outlook of Zürich urban development since 1960s until now, as well as the current strategies for public space design. The observed trends in current design practice in Zürich confirm the fact that the interrelation between space design and its use depends on that particular space within the city. Thus, prior to any stipulations about space quality, it is necessary to review the context of study, which is suggested by the theoretical framework for descriptive attribute analysis and developed within the methodology in this thesis (Figure 40). This goes in line with the inverse approach described in Chapter 3 and in Chapter 4. The inverse approach underlines the context priority in the space design process as opposed to the traditional context transforming design process, which is commonly performed with accordance to customer/stakeholders views and the demands of space functions.

The location of a particular public space produces variations in its character, meaning and use. Zürich is divided into twelve districts (Figure 65). The selected case studies are located within the following five districts (Wikipedia, 2015):

- District 1 – was formed before 1893, 20–28% non Swiss residents
- District 4 – 1893, 33–46% non Swiss residents
- District 5 – 1983, 26-39% non Swiss residents
• District 10 – 1893, 31% non Swiss residents
• District 11 – 1934, 34% non Swiss residents

Each of the districts has its own distinct character, which is reflected in its public space qualities and attributes (Figure 66). District 1 is characterized by its central location, mostly high rent prices and a high number of leisure and entertainment facilities. District 4 is a local “red light district”, with many bars and fast food restaurants and is considered as an attractive spot for young artists to live in and spend their free time. District 5 and 10 are mostly residential, with facilities such as river promenades, parks, playgrounds and shops, with the picturesque riverbank being one of the strongest attractors in the area. Finally, District 11 has relatively new residential and business developments. Although, some well-designed areas are present here, the population of the district still remains relatively low.

5.1.1 Liveliness Measurement

From the results of liveliness measures it follows that this index should be examined with respect to the public space type and its relevance to the city overall. Liveliness was measured for each of the case studies through on site observations. The number of people passing through and staying in the public space were counted and results documented following the procedures described in Chapter 4. The measurements produced the following results:

• Number of people staying (measured on three days of the week)
5.1 Case Studies: Method Implementation

- Number of people passing in an interval of ten minutes (measured on three days of the week)

To calculate the density of people per square meter, which is necessary in order to compare between case studies, the measurement results were correlated to the area of each respective case study. The original assumption was that the sum of the average number of people passing and staying correlated to the square area would represent space liveliness. In the course of the study this original assumption went through a number of permutations.

The main complication with the original assumption was that the resulting indices for very small squares with very few people produced similar results to very large squares where there are usually many more people present and therefore, the feel of liveliness is much stronger. In order to overcome these discrepancies, the decision was made to not interrelate the activity of people in the public space to space area. The new calculation produced interesting and “positive” results. In particular, the proportion between people staying and passing indicates the degree of liveliness for a specific space type. There are two types of public spaces examined in this thesis: the urban square and the urban park. Within the last category, a sub category may be distinguished: die Wiese, which means a lawn in German. As has been confirmed by measurement results, the urban square and the urban park each imply different degrees of liveliness. Based on the graph

Figure 66: The locations of case studies and their associated attribute data. This image solely demonstrates the concept of application for the theoretical framework.
on Figure 67, it can be observed that each type of public space falls within a certain

![Figure 67: Liveliness ranges according to public space type](image)

The degree of liveliness, or the proportion between people staying and passing for “die Wiese”, which is the sub category of urban parks, is very high (Figure 68). Indeed, people come often to such places to stay and to relax or to socialize. This fact is confirmed by the types of detected activities in such spaces during on site visits, namely: sports, playing, relaxing (even sleeping on the lawn), chatting or dating. The described types of activities are usually planned in advance and take longer time to conduct. This finding is also supported by findings published by William Whyte, who states that one of the indicators of public space quality is people coming to spaces in groups. People visiting public spaces in groups imply that they agreed in advance to come there and it was a conscious choice rather than an accidental visit.

- Wiese Squares liveliness range 310% - 409%

![Figure 68: Activities in Josefswiese and Fritschiwiese in Zürich](image)

In parks, people have the opportunities for both strolling and for staying and relax. People use parks for walks or jogging, they lay down on the grass, have lunch or if the park is located at the river bank, they sit and enjoy the view or splash in water (Figure 69).

Thus, this type of public space has liveliness within the middle range. The MFO Park, although called a park, does not really possess the properties of a park in its traditional understanding, as for example described in Magnago Lampugnani (2014). It can be, thus, observed that its liveliness degree decreases compared to others parks.
• Parks liveliness range (−) 5% - 32%

Squares are usually the elements in urban settings which are situated on the paths. Thus, they don’t imply people staying there for long periods of time. People may be able to linger or stay in the square for a short period of time while they are on their way somewhere else, provided the quality of space is good (Figure 70). Squares are also used by people to stay while having their lunch or just to grab a bite. All these activities depend on the role or the “relevance” of a square in the city. In the case of touristic destinations and if the square has a certain attraction – historic monuments or buildings, an art object, etc., people may go there to see it.

If well designed, residential squares may be used for a variety of purposes, such as for neighbours to intermingle, for mothers to come to have a coffee while their kids jump around, or for teenagers to socialize.

• Square liveliness range (−) 90% - (−)32%

One important result of liveliness measurements, which were conducted on actual public spaces in Zürich, is detecting of dependence between the space type and its degree of liveliness. Subsequently, in order to be correct methodologically, spaces of different types should not be comparable in terms of liveliness. For each of the space types, measurement results lay within a certain range. If some results are significantly above or below the average range for a specific type, it may indicate a very high or a very low quality of the public space. Also, the degree of interaction between people and the space is related to the space type (Figure 71).
Among the analysed case studies in this thesis, the case study of Idaplatz stood out among the rest. While an average range for square measures for the spaces analysed spans between (-)90 and (-)32%, the indicator for Idaplatz shows the liveliness index value of 32% (Figure 73). Idaplatz is a neighbourhood square, and it is described in local urban design literature and design reports as a successful space in terms of its use by locals (Emmenegger, Litscher, and Gaeumann, 2013). Thus, the decision was taken to measure and to compare the descriptive attributes of Idaplatz to the attributes of the square that got the lowest liveliness index value, the Brupbacherplatz square (Figure 72), which received the liveliness index value of (-) 90% (Figure 73).

Surprisingly, Idaplatz and Brupbacherplatz are located within ten minutes’ walking distance from one an-other. Also, both squares have been recently renovated and according to Stadträume (2010), the two are of the neighbourhood relevance. However, the difference in use and liveliness becomes apparent from the measurement results, as well as from the empirical observations. The following text will provide some evidence on the possible reasons for this difference.
Generally, the people who visit neighbourhood squares tend to live close by. Thus, the activities provided in these public spaces should respond to their needs (Carmona, 2015). Indeed, Idaplatz supports well the needs of local residents through its design elements since it was redesigned in a joint effort between the Tiefbauamt Zürich, the local residents and the café owners. Idaplatz is a popular destination in the neighbourhood and it is frequented by local residents, as well as by the people who work in the area nearby. The latter are mostly young and creative urbanites who come to Idaplatz to spend time in cafés or just to chat and socialize at the provided seating area. The surrounding buildings constructed at the turn of the 19th century belong to a conservation zone which adds to the image of the space (Figure 74, Figure 75).

The area of Idaplatz is around 1300 square meters. It was redesigned in 2006 in several stages. The redesign of Idaplatz was a joint endeavour of the local community and the city of Zürich (Kocan, 2013). Local residents and restaurant owners were given an opportunity to decide on the allocation of design elements at Idaplatz. The original plan for the redevelopment of this public space was suggested by the Department of Civil Engineering (TAZ, 2016). The proposal was a standard solution, in which the trees were allocated in line with the building façades and the seating area was aligned with the trees. However, the proposal
was declined by the local population, and the process started from the beginning, this time with local residents’ and restaurant owners’ participation. The placement of the fountain, together with the organization of the seating area, was carefully designed to fit with the needs of the local residents, as well as with the events that took place there on a regular basis (e.g. open-air cinema, local festivals, etc.). Various sitting configurations that provide opportunities for different modes of communication were considered. The resulting design project was carried out and is now highly appreciated and actively used by local residents, as well as by the people visiting the area.

Observations conducted in the course of the present research study reveal certain appealing design characteristics. Idaplatz provides a “talk-space” around the fountain with the seating area surrounding it, forming a half circle (Gehl, 2011; Whyte, 1980). Usually, groups of mothers enjoy visiting this location and chatting together, while their kids run around the fountain. The row of benches in the middle of the square is frequently used by local residents and passers by for laying down and relaxing, or even for taking naps. In this way, the square is divided into several zones for various activities. Benches are aligned with the trees and get sufficient amount of shadow during hot summer days. These are some examples of important attributes of public spaces that make them more pleasant and useful.

It is not only the individual design elements that are important for public space quality, but also the interaction between those elements. In case of another case study, Turbinenplatz, there are only a few seating possibilities that are aligned with the trees. Thus, benches are exposed to direct sunlight during the midday hours in summer (Figure 76), which makes the stay in the seating area uncomfortable. Public space has to have both enough possibilities for the visitors to stay in the sun, as well as in the shade (Whyte, 1980; A. B. Jacobs, 1993).
Also, from the interview with the local sociology expert from ETH Zürich, it has been revealed that the entire area around Idaplatz went through a gentrification process. In particular, a change of generations of the residents took place in the area and more young families moved into the area, bringing some additional vibrancy along.

The area of Brupbachplatz is around 700 square meters. It is now recognized as a stand-alone public space which was redeveloped in 2012. Before the redevelopment took place, Brupbachplatz was a small island with green space surrounded by busy streets (Figure 77). There was only one bench in the area, and it had been rarely used.

During the redevelopment of Brupbachplatz, the pavement had been changed to gravel (similar to Idaplatz), trees had been planted and the traffic had been re-directed. The redesign of Brupbachplatz was performed using the basic design guidelines. The allocation of trees more or less follows the contours of the square, and benches also follow this alignment. Following the redevelopment process, restaurants could increase their outdoor space. However, as could be observed
during the on site visits and from the local design reports, these spots are not actively used despite their redevelopment (TAZ, 2014). Even though there are now more people present at Brupbacherplatz than in Anny-Klawa-Platz, this public space still has considerably less people than Bullingerplatz. Generally, it appears that there are more men than women, visiting Brupbacherplatz which might be due to the fact that the Restaurant “Habesha”, which is a meeting point for men from Ethiopia or Eritrea, is located there. The main users of Brupbacherplatz are between 24 and 64 years old. School-age children and teenagers make approximately 17% of all the visitors to Brupbacherplatz (TAZ, 2014).

The redesign of Brupbacherplatz became a part of a larger project, the redevelopment of the street Sihlfeldstrasse. The goal of this endeavour was to reduce the amount of traffic at this street, making it calmer and more congruent with the pace of the residential area. The former Westtangente in and around the Aussersihl and Wiedikon areas suffered from major traffic loads, making it inconvenient for pedestrians or cyclist to move alongside of the traffic. Figure 78 highlights the main traffic network in and around the city of Zürich.

![Figure 78: Location of Wessttangente, image shows the main traffic arteries in Zürich (Source: TAZ, Stadt Zürich)](image)

The transformation of the Westtangente started in May 2009, with a reduction from two to one-lane streets at the Seebahn- and Weststrasse. At the end of 2011, the Weststrasse has been fully redesigned to a pedestrian street within the residential area. After further modifications, the new concept successfully reduced the main traffic on the West-, Sihlfeld- and Bullingerstrasse by 80% and 90% (Figure 79).

Post measurements of pedestrian and cycling activity along the new Westtangente and its parallel and cross-roads indicated a strong increase in the number of pedestrians and cyclists (TAZ, 2014). The new
design made it more convenient to manoeuvre on foot and by bike along the streets while accessing near by places or the city centre. The reduction of traffic further increased the safety at the new Westtangente, with more pedestrians, mainly children, being able to cross the streets (Figure 80).

Compared to the statistics of pedestrian activity from 2008, leisure activities especially around Bullingerplatz, which lays on the same axis with Brupbacherplatz, have been raised by a factor of 7 by the year of 2013. From the different activities captured during the measurement, the most intensified increase is visible for people either sitting in cafés or remaining on benches.

5.1.2 Descriptive Attributes Measurement of Idaplatz and Brupbacherplatz

The descriptive attributes measurement follows the established framework described in Chapter 4 (Figure 81). Thus, after defining the location and deriving some basic characteristics and rudimentary
types of public spaces, the study proceeds to the measurement of user-related attributes such as number of people residing and employed in the area, as well as their age groups and income levels. Figure 82 – Figure 84 show measurement results of all public spaces in comparison to each other. For these attributes, variables for both squares are very similar, as they are located in the immediate vicinity of each other.

The first set of attributes that is measured to get information regarding the potential user groups is the number of people employed and residing in the area. This information allows to identify the character of the area, as well as the potential users’ needs. In predominantly residential areas, people use public spaces to walk with children, to encounter neighbours and also for other leisurely activities. Generally, people identify themselves with local public spaces and their elements. However, the people who are employed in the area but do not reside there have a different relationship with local public spaces. Their time schedules and needs are different from the ones of local residents. The people who work in the vicinity of the public spaces but do not live nearby mostly use the spaces to eat lunch, to do some shopping or to socialize after work with their colleagues. Also, they might want to remove themselves from the hustle and bustle of city business life and relax in tranquility (Alexander et al., 1977).

Both case studies of Idaplatz and Brupbacherplatz are predominantly focused on residential areas (Figure 82). However, as could be observed during the on site visits, Idaplatz seems to receive many people from the neighbouring offices during lunchtime. In addition, lunchtime is also the time when mothers with young children appear on the streets. Students from adjacent schools also join these two groups of people. The combination of different age groups present in Idaplatz creates vibrancy and diversity in the ways the space is used. Employees have lunch, mothers chat while watching their children play around the fountain or ride toddlers’ balance bikes or scooters; teenagers chat on benches, and so on. Also, the use of the square is supported by several cafés that provide tables and chairs, and the benches which are available in different setups support social interactions, as well as
provide opportunities for people to rest (and even to lay down and sleep or read on them).

The next attribute measure shows the number and age groups of people residing in the area (Figure 83). This information enhances further the understanding of the way elements of public space fit the needs of potential user groups. In places where mostly families with young kids reside, there might be a need for elements that support children’s activities. Older people would probably prefer to have places where they could sit and observe others. In residential areas, there should also be possibilities to spend time in a quiet and relaxing atmosphere, while reading a book or having a conversation with a friend. The population groups residing close to Idaplatz and Brupbacherplatz are similar. However, Idaplatz is used much more extensively by people of varying age groups than Brupbacherplatz.

The information regarding the level of income of local residents is necessary to understand whether commercial functions corresponds to the level of income of the local population (Figure 84). The importance of this information for the public space analysis was underlined by the sociology expert affiliated with ETH Zürich, during an interview in which he discussed the case of Josefwiese, another public space in Zürich, and one of the case studies examined in the present research thesis. Josefwiese is one of the most vibrant spots in the city and the preferred destination for many locals. Some time ago, Josefwiese was mainly used by the local residents (by the lower income groups in particular) for free leisure activities. People lounged in the grass, played sports, organized BBQs and socialized together. However, with the redevelopment of Viadukt, the local historic monument that runs through Josefwiese, the situation has changed. The appearance of high-end boutiques attracted other user groups that had different patterns.
of activities and leisure behaviours, which involved consumption of goods offered by cafés and boutiques. According to the sociology expert’s feedback, it is not yet clear whether such a mix of user groups is for the better or for the worse in terms of social interaction, and if one group will replace another, or if their co-existence will be possible.

As Idaplatz and Brupbacherplatz are located very close to each other, there is a small difference in the income level among the people living within ten minutes’ walking proximity.
The next set of measures relates to the interaction between the identified groups and public spaces (Figure 85). These measures were collected for the catchment area and for individual public space levels.

![Figure 85: The theoretical framework for descriptive attribute measurement](image)

In particular, two measures are analysed using Space Syntax techniques in DepthmapX – integration and choice. Integration illustrates how well the space is integrated within the urban grid, while the second one identifies the probability with which people would pass through a certain point in the city. Idaplatz and Brupbacherplatz have approximately the same level of integration and choice, with Brupbacherplatz scoring slightly higher values for both (Figure 86).
The next set of measurements is directed at identifying how diverse the spaces are in terms of the opportunities that are available within ten minutes’ walking distance. According to Alexander et al. (1977) and J. Jacobs (1962) the number and variety of functions, as well as their mutual support, can produce higher activity in urban spaces. The first attribute to be measured is the number of retail shops in the catchment area (Figure 87). The number of retail shops for both cases, with Brupbacherplatz having a slightly higher fraction of shops than Idaplatz.
The next chart on Figure 88 shows the number of cafés and restaurants available in the area of ten minutes’ walking distance from Brupbacherplatz and Idaplatz.

![Number of cafes and restaurants graph](image)

Figure 88: Number of cafes and restaurants graph

The following chart in Figure 89 illustrates the number of transportation nodes within ten minutes’ walking distance of the public spaces examined in the present study. The number of transport nodes defines how accessible the public space is from the rest of the city. This measure is not highly relevant for public spaces of the local significance, such as Idaplatz and Brupbacherplatz. However, when comparing between public spaces of regional and international significance (Stadträume 2010), it is important to understand where people could potentially come from and how many of such “generators” of activity are present around the analysed public space.

![Number of transport nodes](image)

Figure 89: Number of transport nodes
As it appears from the calculated measurement results, the attributes of Brupbacherplatz and Idaplatz at the city and the catchment area (urban) scales do not show substantial differences that could be regarded as significant influences to the quality of public spaces. In accordance with the defined theoretical framework, this study proceeds further to analyse the scale of an individual space in order to distinguish the reasons for differences in the attribute of liveliness (Figure 90).

The area of Idaplatz is approximately two times bigger than the one of Brupbacherplatz, with the former encompassing approximately 1400 square meters and the latter approximately 700 square meters. It must be noted here that it is the areas of squares’ usable space that are considered, and not the ones indicated in the cadastral plan of Zürich (Kanton Zürich, 2017). The reason for that is that the cadastre boundaries are significantly different from the actual boundaries of usable space of both Idaplatz and Brupbacherplatz (Figure 91 and Figure 92).
Figure 92 illustrates the contours of squares considered for this research study.

![Figure 92: Space boundaries of Idaplatz (left) and Brupbacherplatz (right)](image-url)

The first attribute that is measured and interrelated with a number of space properties is the perimeter of the public space examined. The length of the perimeter of Idaplatz is 149 meters, while the length of the perimeter of Brupbacherplatz is 114 meters. Both squares are embraced by streets with speed limitation of 30 km/h. In the case of Idaplatz, 50% of the perimeter is exposed to traffic; however, there is a so-called buffer zone between the square space and the traffic road formed by the pedestrian path that embraces the square. Additionally, objects such as bicycle parking and recycling bins on the two sides of the square create additional unimposed protection from traffic. In the case of Brupbacherplatz, 61% of the perimeter is exposed to the traffic road with no buffer zones being present between the public space and the traffic road (Figure 93). The distance from the geometric centre of Idaplatz to the road is approximately 20 meters, while in Brupbacherplatz it is 9 meters. Consequently, the perceived feeling of safety in Idaplatz is higher than in Brupbacherplatz (Gehl, 2011).
Arrangement of space similar to Idaplatz may be observed at another popular square in Zürich, the Sechseläutenplatz (Figure 94). There, the distance from the perceived centre of the public space to the traffic is between 50 to 70 meters. This spot is highly popular among parents with children learning to walk or to ride scooters or balance bikes. While parents may sit at the provided movable seating and have an unobstructed view of their children’s activities, the children themselves may safely enjoy the vastness of the space surface that is even and presents a perfect setup for biking or skating (E. T. Hall, 1966). Also, many teenagers on skates or BMX bikes favour this space.
Figure 94: Sufficient distance to traffic from the central point of Sechseläutenplatz allows for a higher range of activities and the feeling of safety.

The perceived sense of maintenance is higher in Idaplatz than in Brupbacherplatz. As can be observed in Figure 95, Brupbacherplatz is still undergoing the renovation process. Some of the surrounding buildings are covered with the construction net (Figure 95, d). There is much more wall space covered in graffiti as well, which creates the feeling that space is not well maintained.

Figure 95: Building frontages at Brupbacherplatz

Another important attribute for human activity in public space is the area of active façade frontage, which implies the presence of cafés, restaurants or shops that facilitate frequent interactions between indoor and outdoor space. In this study, the length of active façade frontages is correlated with the perimeter length for each square. In Brupbacherplatz, only 11% of the perimeter length is active (Figure 96). In case of Idaplatz 29% of the perimeter is active (Figure 96 (left)). It must be noted that only active façade frontages that have direct interaction with public space are considered. Thus, in the case of
Brupbacherplatz, cafés that are separated from space by a traffic road are excluded.

An important difference between active façade frontages in Brupbacherplatz and Idaplatz is their visual quality. For instance, in Brupbacherplatz, the Habesha restaurant offers Ethiopian national cuisine and has a large advertisement of Lycamobile covering almost the entire area of its windows which creates a mixed-impression of the restaurant’s original function (Figure 97). Is it a restaurant or a shop or something entirely different? In the front of the restaurant there is a pair of fixed-place benches and tables provided with accordance to the original design by the city. In addition, the restaurant owners leave a couple of plastic chairs that they use to sit on in the front of the restaurant entrance.

In Idaplatz, the visual qualities of cafés and restaurants are presented using signage and elements such as colourful sun umbrellas, café chairs and tables of varying configurations and setups (Figure 98). All of these objects bring additional intricacy and visual appeal to the public spaces.

The total amount of seating, including movable/adjustable seating, as well as the availability/interesting design of additional urban furniture provided in the space; all of these are important attributes of public space design that provoke the interaction between the public space and
people (Alexander et al., 1977; Whyte, 1980). In Idaplatz the amount of seating (excluding café and restaurants) per square meter is around 0.012, while in Brupbacherplatz this number is 0.013. However, in case of Idaplatz, cafes and restaurants provide for approximately 30% more additional seating (including movable seating) on the two sides of the square that is actively used by people.

The presence of additional attractions such as water or lawns that provide for interaction such as water splashing, drinking the water or just observing it may have positive impacts on the use of space. In Idaplatz, a fountain forms a centre point of one part of the square, around which the benches are arranged in a semi circle (Figure 99). This spot is highly appreciated by mothers with small children. While mothers sit and chat together, children run around and climb the fountain from time to time for entertainment or for a quick drink when thirsty. Also, people use this spot to lie down on benches and relax.

Figure 99: Children splashing, drinking or playing around the fountain in Idaplatz (Source: Vimeo “Amamer Vernissage & Performance”)

Figure 98: Façade visual qualities at Idaplatz
As it appears from observations conducted in the course of this research study, the possibilities for interaction with water add a considerable amount of vibrancy to a public space. Similar to idaplatz, interaction with water was also provided in a number of other public spaces in Zürich, such as in Josefswiese, Wahlenpark, Bullingerplatz, Sechseläutenplatz, Wipkingerpark and Fritschiwiese.

Figure 100: Activities around water elements in Wahlenpark and Bullingerplatz in Zürich

Figure 101: Children playing with water at Josefswiese and Sechseläutenplatz in Zürich

In terms of the availability of sun and shade at Idaplatz trees are mature there and provide sufficient amount of shade during hot summer days. Also, the trees there are properly aligned to the seating area, which is an important attribute of space design (Figure 102). At the same time, benches located in the middle provide the opportunity to enjoy the sun. In contrast the trees have yet to mature in Brupbacherplatz (Figure 103).

Figure 102: In Idaplatz the canopies are wider and provide shade and comfort during hot summer days
Overall, Idaplatz appears to have more activity going on also in terms of people who visit the space on foot and by bike. All the cross streets that go out of Idaplatz are active. In case of Brupbacherplatz, Sihlfeldstrasse appears the liveliest in terms of transit pedestrian movement and is indicated on Figure 104 and Figure 105 as the orange dashed line (bold).

The table illustrated in Figure 106 summarizes the set of descriptive attributes measured for Brupbacherplatz and Idaplatz at the three levels of urban scale: city, catchment area and individual space. The attribute values of Brupbacherplatz measured at the city and catchment urban
scales, such as connectivity, integration, number of retail shops, the number of restaurants exceed the values received for the attributes of Idaplatz.

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<th>Idaplatz</th>
<th>Brupbacherplatz</th>
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<td>N of retail</td>
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<td>N of dining</td>
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<tr>
<td></td>
<td>Shadow from tree canopies to seating (1=yes; 0.5—not enough; 0-no)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Presence of benches (1=yes; 0-no)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Amount of seating (benches) per square meter</td>
<td>0.020 (incl. 30% other urb. furniture)</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>Presence of other urban furniture</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Presence of water (fountain, artificial lake etc.)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Average distance between buildings</td>
<td>19.4 m</td>
<td>15 m</td>
</tr>
<tr>
<td></td>
<td>N of actively used paths going through</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>N of embourchement streets</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

Figure 106: Set of descriptive attributes
In contrast to Burpbacherplatz, Idaplatz scores higher attributes values at the scale of an individual space. The table illustrated in Figure 107 shows a heat map with descriptive attributes values at the scale of an individual public space for Idaplatz and Brupbacherplatz, where Idaplatz received 80% more attributes with higher values than Brupbacherplatz (Figure 108). Consequently, the high liveliness at Idaplatz may be attributed to the diversity of (design) elements and their arrangement, as well as to a greater feeling of safety and maintenance, and to the more comfortable micro climate conditions at the scale of an individual public space.

<table>
<thead>
<tr>
<th>Perimeter length (m)</th>
<th>Idaplatz</th>
<th>Brupbacherplatz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of imposed/unimposed protection from traffic</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Perimeter exposed to traffic (%)</td>
<td>50%</td>
<td>61%</td>
</tr>
<tr>
<td>Distance from traffic to green/perceived centre (m)</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>Building coverage (index value)</td>
<td>0.25</td>
<td>0.3</td>
</tr>
<tr>
<td>Area (square meters)</td>
<td>1400</td>
<td>700</td>
</tr>
<tr>
<td>Space openness (index value)</td>
<td>0.58</td>
<td>0.68</td>
</tr>
<tr>
<td>Presence of trees (1 - yes, 0 - no)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>N of trees</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Shadow from tree canopies to seating (1 - yes, 0.5 - not strong, 0 - no)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Presence of benches (1 - yes, 0 - no)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Amount of seating (benches) per square meter</td>
<td>0.02</td>
<td>0.013</td>
</tr>
<tr>
<td>Presence of other urban furniture</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Presence of water (fountains, artificial lake etc.)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Average distance between buildings</td>
<td>19.4</td>
<td>15</td>
</tr>
<tr>
<td>N of actively used paths going through</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>N of embranchment streets</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Active façade frontages to perimeter (%)</td>
<td>29%</td>
<td>11%</td>
</tr>
<tr>
<td>Interaction of people with water (yes - 1; no - 0)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>N of activities</td>
<td>9</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 107: Heat map with descriptive attributes

Figure 108: 80% more attributes with higher values for Idaplatz
Qualitative information such as the importance of social appropriation of public space should also be added to the above results of attribute measures. Idaplatz has a long history of use by the local residents and it is meaningful to them. It has been continuously used for events such as festivals and open-air cinema. Brupbacherplatz in its current form is relatively new. It has not yet been adopted by the local residents to the same extent as Idaplatz. Possibly, the gradual change of adjacent functions such as retail shops, cafes and restaurants would change the character of the area around Brupbacherplatz and may bring additional vibrancy to the space. For example, the new design shops that emerge at the Sihlfeldstrasse may bring in some additional activity. In addition, there is also some restoration work taking place around the square, which should improve the overall appearance of the surroundings.

5.2 CONCLUSION

The application of the developed inverse design support method across the nineteen case studies has revealed that liveliness is an effective criterion for public space quality evaluation. Using the measure of liveliness, it was possible to determine public spaces that are considered to be successful by the local design experts and lay public. The validity of the developed method may be further supported by the evidence from another research project that uses a different approach to estimate public space quality, as described in Griego et al. (2017). In particular, their study is based on the measured emotional response of people to public spaces. The results of this project demonstrate that people have a higher rating of appeal at Idaplatz than at other public spaces in the area.

Furthermore, the range of received liveliness measures could be clearly associated with particular public space types such as urban park and urban squares, as well as with one more context-specific category that was identified in the course of the study - die Wiese. The latter one has a similar meaning to an urban park, but implies more "staying" activities such as playing sports, making BBQ or catching up with a friend, and is a common type of public space in Zürich. Therefore, liveliness can be used for the stratification of public spaces based on their qualitative characteristics determined through social use.

The latter is an important finding with respect to the problem of public space quality analysis. Current claims in design and research literature for differentiated public spaces that would fit different processes and activities of varying population groups in the context of changing socio-dynamics in Western European cities raise further questions about the differentiated qualitative attributes of these spaces (Car-
This means that different types of public spaces should have different performance measures, which the measure of liveliness allows us to retrieve with respect to their social use.

The comparison of attributes between the same types of public spaces within a particular context should allow for more general statements about their qualitative attributes, which in turn would create a more solid base for subsequent design recommendations within the inverse design framework. In the course of the present study, this type of generalizations could be made based on public space stratification results and further analysis of public space objective features, the descriptive attributes.

For example, in Sechseläutenplatz, which has international relevance according to Stadträume (2010), factors such as accessibility, the number of transport nodes, visibility and exposure to the surrounding urban fabric, as well as choice and integration, are important and provide for additional vibrancy of the space. Sechseläutenplatz is located close to the bridge (Quaibrücke) that links the two sides of Zürich city. As an important connection, the bridge receives higher choice values when analysed in DepthmapX, Space Syntax. It was observed that the diagonal that connects the end of the bridge to the transport hub (Stadelhofen) is very actively used by pedestrians, which animates the space (Figure 109).

The global characteristics such as integration and choice seem to be less relevant to spaces of local/neighbourhood scale. They are not visited by people from afar and tend to serve the immediate needs of people living and working in their proximity. In this case, the “fit” of objective characteristics of individual public space to those needs is important for the degree of liveliness.

According to Stadträume (2010), the comparison between two public spaces of local/neighbourhood relevance, in which one received very high and the other received very low liveliness values, shows noticeable differences in measures of descriptive attributes at the scale of an individual public space (Figure 108).
Idaplatz was re-designed with thorough consideration of human activities and needs (through collaborative workshops between local authorities and the general public (Kocan, 2013). This space has higher degree of liveliness than Brupbacherplatz, which has been redesigned following generic guidelines. Obviously, to make more general conclusions, more examples and analysis of the same kind of public spaces and their attributes are needed, and will be a part of the future work.

Some additional conclusions regarding space descriptive attributes measured across the nineteen case studies with relation to public space quality are outlined below.

Observations conducted in the course of this study confirm the fact that elements such as water bodies and possibilities for interaction with them are very attractive to people, especially on hot summer days, and especially for families with young children (Alexander et al., 1977; Gehl, 2011).

Varied urban furniture that complies well with the ergonomics of the human body and that allows for different postures, such as lying down or sitting, and that can be moved around to accommodate different modes of communication between people, thereby creating spaces for socializing or for the distant observation of activities, provides for higher comfort and stimulates space use (E. T. Hall, 1966; Whyte, 1980).

The unimposed protection from traffic areas, such as the protection provided by trees/bushes placed along the perimeter of public spaces, buffer zones such as pedestrian paths that embrace public spaces, as well as the sufficient distance from the perceived center (active points in public space) to traffic, all contribute to the feeling of safety (Gehl, 2011).
In places where all the previously mentioned attributes are present, a higher measure of liveliness was detected.

Facades and café signage contribute to the visual appeal of public spaces. In case of Brupbacherplatz, these elements are not pronounced, while in Idaplatz, colourful café tables and umbrellas, as well as interiors of café opening into the street, create additional permeability and vibrancy in space.

The paths that are used by many pedestrians to pass through public spaces contribute to additional activity in the public spaces as well. When compared to Brupbacherplatz, Idaplatz has several paths going through it that people actively use to pass on foot and by bike, while Brupbacherplatz has only one relatively active path going through it. However, in order for people to stop by, there should be some additional attributes in the public space that would attract people and make them stay. Sechseläutenplatz is one such example (Figure 111).

Figure 111: The presence of water provides for additional activity in Sechseläutenplatz
The present research study is focused on the social aspects of public spaces and employs the concept of public space quality. The goal of the work was to develop a methodology that would allow quantitative measurement of public space quality. The problems which arose in the process of achieving the main goal were related to the identification of the maximally wide set of public space descriptive attributes that should both contribute to space quality and explore the interrelation between public space quality and those attributes. Conceptually, the quality of public space is examined in relation with space liveliness, an indicator that is based on the relationship between the people who stay in the space and the people who pass through it. Such an approach is based on the reviewed status of the current research in the field of urban design in Chapter 2. Two different approaches to measure the attribute of liveliness were tested. At first, liveliness was considered to be a measure of human density per square meter of public space. However, this measure was found to be ineffective to study the interrelation between space quality attributes and space use by people. The field measurements showed that public spaces with small areas and only a few people staying there could receive similar index value to the big squares with many more people present. Such an effect contradicts the reality and the feeling of vibrancy that could be perceived during on site observations. At the second consideration, liveliness was defined as the proportion of the number of people staying to the number of people passing through the public space. The last definition was quite informative and its application exposed a clear range of index values that could be associated with specific space types, such as a die Wiese, which is considered to be both a park and a square. In other words, based on the study results, it was possible to produce a stratification of different public space types based on the range of value indicators of liveliness, as well as to detect the extreme values for spaces that are considered to be “good” and successful by local design experts, such as the Idaplatz in Zürich. These results demonstrate that liveliness could be an effective way of measuring the quality of public spaces with regards to a specific space type.
6.1 CONTRIBUTIONS AND ACHIEVEMENTS

The first contribution of this work to the scientific knowledge is the developed method for the stratification of public spaces based on the degree of liveliness, which adds to the currently available methods for space classification based on its morphologic properties. When the two methods are applied together, they may bring deeper insights into the interrelation between space form and generated activity, which would contribute to the knowledge within the following research domains: environmental behaviour studies, place studies and space morphology studies (Moudon, 1992).

The present thesis sets the basis for the inverse design process by developing the method for public space quality evaluation. The inverse design approach is based on the paradigm of the synergetic effect of the interaction between various kinds of space attributes that brings them into the category of “good” public spaces. This approach is oriented towards the “final” point, i.e. the quality of the public space. All the public spaces deliberately defined as “good”, form the range for “good” space quality attributes, which are treated as intrinsic space descriptors. In this way, the design of public space starts from the social aspect as its main goal (i.e. liveliness) by determining the specific space attributes that most likely produce a good quality of public space. The method developed in the present study is opposed to the commonly taken approach in urban design practice that proceeds from mostly technically oriented, stakeholder driven and generic design brief that cannot guarantee the quality of public space since the targeted quality is a derivative from its own specifications and is not based on people’s actual needs. In this case, a good quality of public space is most likely a random result then persistent. An inverse design approach is aimed to follow a human-oriented design process, when social quality has the privilege to impose restrictions on the commercial components of urban design process. For the purpose of stable and sustainable urban development, this approach has its apparent advantages.

The application of the inverse design support method developed in this thesis for the case studies in Zürich first and foremost allowed to identify the range of liveliness for “squares” as a distinct public space type. Secondly, within this range, the spaces with the highest and the lowest liveliness values were selected and their descriptive attributes were compared in order to test the interrelation between liveliness and space descriptive attributes. Following the theoretical framework established in Chapter 4, the descriptive attributes of both spaces were measured at the three distinct levels of urban scale: the city, the catchment area and the individual public space. The calculated results for attributes such as integration, choice, the number of retail shops and restaurants, and the number of transport nodes at the city and
catchment area scales do not show a significant difference between the two public spaces. However, at the scale of an individual public space, the attributes that are related to the immediate/direct/physical interaction between people and space scored higher values for the public space with the higher liveliness degree by 80%. Consequently, the conclusion that may be drawn from this result is that for the public spaces of a neighbourhood relevance, as defined by the Stadträume (2010), descriptive attributes at the scale of an individual public space show a high degree of interrelation to space liveliness. In this particular case, it may be assumed that such spaces are used by people who live or work in the immediate vicinity; therefore, global characteristics such as integration, choice or accessibility measured for the entire urban grid of the city may not play a decisive role in the case of public spaces of a neighbourhood relevance.

Thus, the second contribution of this work to the scientific knowledge is the developed approach to distinguish specific public space quality attributes with accordance to the scale and the relevance of public space within a city.

Technically, the design for public space quality implies the consideration of a large amount of heterogeneous attributes. Conceptually, the category of public space quality is multivariate. Evidently, the estimates of public space quality from the perspective of social use, space morphology and functionality may take varying paths in accordance with their main focus. On the one hand, the heterogeneity and multivariate character of such aspects suggests the potential for the detailed analysis of individual public spaces and for treating their attributes in isolation from the rest of the urban context. On the other hand, there is an apparent need for public space integrative analysis, as it allows to evaluate the degree to which a realized public space project, which is immersed within a particular urban design context, fits (interrelates with) its contextual purpose and goals set within a project (Lynch, 2012).

This work suggests a way of constructing an attribute database for integrative public space quality analysis based on the CAD and VPI platforms represented by Rhino 3D (Associates, n.d.) and in Grasshopper, the algorithmic modeling add-on for Rhino 3D. For data collection and analysis purposes, this study defines an adequate infrastructure that leverages modern GIS-technologies, remote access and actual databases. Obviously, the list of space descriptive attributes derived from the well-established literature and used within this thesis is not all-encompassing. Therefore, the present thesis suggests technically treating public space as an open-ended model, in which new attributes can be added to the existing database through further research studies.
To summarize, the scientific contributions of this research work include:

- A theoretical framework for public space descriptive attributes measurement.
- A new method to measure public space liveliness.
- A new method for public space quality estimation based on liveliness measures and space descriptive measures.
- Setup of infrastructure for attributes measurement which leverages modern GIS-technologies, remote access and actual data bases.
- Identification of quality attributes that contribute to a public space quality of a specific type

The main contribution of the present work to the design knowledge and practice is in identifying the criteria for public space quality that can be objectively measured. Using the developed method it is possible to a) differentiate between space qualities based on their type and b) measure the quality for a specific space type based on a set of descriptive attributes. Thus, the following contributions to design practice may be envisioned:

- The possibility for the post-evaluation of newly designed public spaces. This is especially relevant in the situation of the ongoing public space redevelopment process in Zürich (Stadträume 2010).
- The application by the local planning authorities for qualitative comparison between the existing public spaces.
- The use of liveliness indicator to assess the performance of the existing spaces and to identify areas where interventions are needed to improve the quality of spaces

It was underlined in a number of recent research studies such as the one by Carmona (2015), that a model of public space that can fit all needs and contexts is not feasible. There is a need for differentiated public spaces that would fit different purposes. Also, current studies argue for mixed method research for the collection and analysis of data on contemporary public spaces (Creswell and Clark Piano, 2007).

The method developed in the present thesis addresses both problems. It provides a way for differentiated quality measurement for diverse public space types since it differentiates spaces based on their degree of liveliness. Thus, it is demonstrated that the attribute of liveliness can serve not only as a quality criteria, but also as a way to differentiate between different public space types using their qualitative ranges. Previous research studies tend to differentiate between spaces based on their physical form (Kropf, 2009). Thus, the types were defined based on their physical characteristics. In the present research work,
the space type is not identified through its formal/physical attributes; rather, it is identified through the analysis of its associated level of activity – the liveliness. The definition of space quality through its social use is more sensitive to the problem of the fit between people and the space (Carr et al., 1992; Montgomery, 1998).

The discussion regarding the need for differentiated public spaces in cities takes a more concrete path with the developed method as it helps to set the qualitative range for specific public space types and to analyse space descriptive attributes with respect to the space type. As could be observed from results of this research work, different attributes are significant for spaces of local relevance and for space of global relevance.

6.2 LIMITATIONS

The main limitations of the developed method are related to the broad scope of public space quality research, to its associated descriptive attributes, as well as to their mutual dependence and interrelation to performance attributes.

The choice of quality criteria for public spaces is not a formal problem; thus, there are no specific rules for unambiguous criterion choice. In most of the reviewed literature, such criteria are defined through subjective judgments of researchers based on extensive empirical observations of a large number of samples (i.e. public spaces).

In this research study, liveliness served as criterion for public space quality and it was tested across nineteen case studies. Its use was successful in identifying “good quality” spaces within the sample set examined. Moreover, by using the criterion of liveliness, it was possible to acquire specific liveliness ranges for different public space types. Consequently, it is assumed that liveliness can serve as a successful quality criterion for public space with regards to the social aspects of public spaces. However, as the choice of this criterion is a subjective decision, there is yet no proven evidence to demonstrate that it can be used with regards to other non-social aspects. It is also apparent that complex and ambiguous concepts such as public space quality cannot be resolved through the application of any single-aspect criterion. Thus, the following limitation can be identified with this respect:

- The applied criterion, liveliness, is proved to be an effective measure of public space quality with regards to social aspects. In order to test its relevance to other quality criteria related to other aspects such as economic viability, for example, the developed methodology should be further applied.
Another range of limitations encountered in the present study is related to the choice of descriptive attributes. Implicit mutual dependence of descriptive space attributes, coupled with their complex interrelationship to quality criteria, limits our ability to define quality criteria analytically as a function of space attributes. With regards to this problem, this study uses an empirical approach, in which the interrelationship between liveliness measures and descriptive attribute measures is observed and interpreted. As it is a priori unknown which of the attributes are most significant to the quality criterion, it is a common practice to incorporate as many attributes as possible into analysis to eliminate the chance of excluding any significant attributes.

All of the above said imply the following limitations:

- There were 45 descriptive attributes examined in this thesis. The developed method is independent from the number of attributes, in which case the public space is technically treated as an open model. For further method validation, it is planned to significantly increase the number of attributes, which would in turn require more advanced analysis methods, as well as more advanced computational analysis.

There are also limitation related to statistical data interpretation and computational capacities. Due to time constraints, it was possible to observe and count the number of people in the nineteen case studies in Zürich. There is a limitation, which follows:

- The method was applied to a limited sample size. The validity of liveliness as a measure of public space quality should be further tested on a wider range of case studies, most likely within different design contexts.

Subsequently, due to the ambiguity of public space quality, any generalizations with regards to the properties of good public spaces should be based on a wide range of analysed samples/case studies and their attributes. This process implies the operation of very large data sets that can be performed through the application of computational methods. The following limitations within the developed methodology were identified with this respect:

- At the current point in research, there was no established mathematical correlation between the liveliness measures and the measures of descriptive attributes. In the future, such a correlation may be identified and validated through the use of multivariate analysis and data mining.

By using the developed method and the established computational framework, it is possible to automatically retrieve attributes from the public space representation model and to store them under the umbrella of a single database. The latter is possible through attribute data capture into an excel table using built in functionality in Grasshop-
However, several technical limitations should be first resolved, namely:

- When analysing the geometric model of the entire city, the process of public space attributes calculation becomes slow. The solution to that may be the treatment of public spaces as separate models stored as individual files. In this case, the synchronization of measurement results within a single database should be implemented.

- Alternatively, high performance computers could be used. The identified limitations are planned to be resolved as part of the future work that will be described in the following, final chapter of this thesis.
The traditional, abstract approach in the field of quality research is embedded in the framework of multidimensional attribute space, where each object under investigation is treated as a point with coordinates, equal to its attributes’ values. That approach enables the researcher not only to explore quality locations of different objects, but also provides the opportunity to study the correlation between the quality criterion and its attributes. That means that one looks at the quality studies through the “spatial” lenses, and therefore the attributes are treated as structured substances in abstract multidimensional space. However, such an approach implies a number of requirements for attributes, with the main being the provable formal independence between attributes. In practice, it means that one must be conscious of the process of attributes selection while using such an approach. To eliminate such restrictions implies to study both attributes and quality as they are, while trying to analyse the whole produced by such a data array. However, within such a paradigm, the main restriction is human mental abilities, which do not allow to analyse simultaneously more than three to four interdependent factors. Such limitations are overcome by modern approaches such as large-scale data analysis, and data mining, etc. due to powerful computation facilities of nowadays.

Within the current (largely empirical) state of this research work, the traditional approach for attribute data analysis dominates. The next envisioned logical step in this research study is to apply new technological advances, such as data mining, to research on the interrelation between public space liveliness and (numerous and homogeneous) space descriptive attributes.

In particular, the use of cluster analysis would allow for objective classification of public space types. Moreover, the use of data mining methods would allow for automatic stratification of space attributes from space liveliness perspective. Such an in depth analysis may yield a better understanding of the causal relationships that form successful public spaces, as well as their antipodes, which is a necessary prerequisite for the sustainable development of these important elements of contemporary urban environments. The conducted research work can be regarded as a good foundation to be further explored by data mining methods.

The following sections provide several suggestions with regards to the potential practical applications of the developed method and its
associated tools. Specifically, the approbation of the developed computational tool set was carried out together with students during teaching exercises at ETH, Zürich, Moscow Architectural Institute and The Moscow School of Architecture, within SUPat research project (NRP65), and during the joint workshop with local design experts from Tiefbauamt, Zürich.

7.1 Potential Applications for Teaching

During the teaching exercise, students were given a task to analyse the ways in which the railroad, the river and the traffic road bisecting the city influence pedestrian movement and how such disintegration of urban fabric can be resolved through the application of the developed tool set. After the introduction, students were asked to identify the design problem they would like to explore. To a large extent, the choice of the students was dictated by “surface” problems, such as accessibility/navigation and noise emission caused by trains and cars.

Based on the given tool set, one group of students developed a new tool for accessibility analysis of any given location in the city by various transportation modes, where the goal was to identify the areas in which interventions are needed to promote the use of public transport vs. private transport. This tool provides a way to evaluate the accessibility within a project area, i.e. it helps to visualize the zones that are not accessible on foot or public transport at an early stage of the design. The basic parameters this tool uses are: the traveling speed (walking, bus and car) and the distance to the target point (in this case, the distance between living areas and the local train station). In the first step, students superimposed a grid of regularly distributed points on a city area and measured the shortest distance along the traffic/pedestrian network from each point on a grid to the train station.

Second, based on the distance and the traveling mode (walking, taking bus or car), each point was shifted vertically. The location of each point at the Z axis corresponded to the accessibility level; thus, the higher the point, the worse was the accessibility with the selected transportation mode. These points were used to interpolate a surface through them and for visualization purpose only. Figure 112 demonstrates the accessibility from various points in the city to the train station (represented as a tall red cylinder) by bus (green) and by car (in red). Due to the parametric nature of the model, it is possible to shift the location of a destination point (in this case, a train station) and to get a direct feedback on the changing state of accessibility.
One of the findings at this teaching exercise was that the preliminary analysis phase did not constitute a challenge for students. They could identify and formulate design problems; however, it was challenging for them to translate these problems into design parameters and implement them within parametric software. In general, the parametric/relational thinking is not common and is not a part of the curriculum of the traditional architectural design education. The use of such tools in the educational process may potentially enhance the students’ understanding of relational aspects between the designed form and space qualitative characteristics.

Applications of the visibility analysis tool were carried out by a group of students at the Moscow Architectural Institute (MarchI) and The Moscow School of Architecture (MARCH), together with the course supervisor Evgeny Shirinyan. One example of the developed application includes visibility analysis of the redevelopment project area of a former industrial site in Moscow, Russia. An interesting use of the visibility tool is illustrated on Figure 113, where the student jointly analyses visibility of the exterior public space in the territory and the interiors within the surrounding buildings. Such joint analysis provides for better understanding of visual interrelations of interior to exterior spaces in the urban fabric. This, in turn, can be used for improved permeability between spaces, which can contribute to social activity inside, as well as well outside of the buildings (Beirão and Koltsova, 2015).
Another interesting application of the visibility analysis tool was demonstrated in the course of the joint workshop with students and local design professionals in Moscow. In particular, the superstructure constructed on the top of a building in central Moscow was analyzed in terms of its visual impact on window views from the surrounding buildings, as well as from pedestrian paths in its proximity. The results are shown in Figure 114 and Figure 115.

Figure 113: Visibility analysis within former industrial redevelopment area; a,b,c – visibility analysis from major pedestrian paths, d – combination of functional zoning with visibility analysis (Student: Timofeev Anton; Supervisor: Evgeny Shirinyan)

Figure 114: Visibility of the superstructure (in white) with respect to window views from the surrounding buildings (Students: Olga Surogina, Irina Garifullina; Supervisor: Evgeny Shirinyan)
The developed tools were also tested within a framework of the SUPat project, which was a part of NRP65. The main goal of this project was to establish a collaborative platform that would help to work out the objectives for redevelopment of suburban areas in more sustainable ways. The main research questions were linked to the operationalization of urban qualities and to the choice of quality indicators within the collaborative setup, as well as on the ways to integrate the knowledge of the transdisciplinary group members involved in the project. This work was highly beneficial for the understanding of local design regulations through the feedback of the group members. In the course of this project, the tools were applied to test different design scenarios of pedestrian accessibility, visibility of building dominants and shadow analysis. The latter one is an important part of design process in Zürich.
During the collaborative workshop with Tiefbauamt Zürich, the tools and methods developed for this thesis were jointly used with methods for urban economic analysis developed within the framework of another PhD thesis by Zuend, Woodbury, and Schmitt (2016). The goal of the workshop was to demonstrate a novel approach to computational analysis of public space development projects, while leveraging a variety of data sets. The computational analysis method was used to understand the potential impact of new infrastructural projects and developments of public space on the City of Zürich from the perspective of economic and pedestrian utilisation. The analysis of new development projects was conducted at the meso and micro scales. The results show how the originally assumed design concept can be informed and further enhanced through the application of computational analysis (Figure 117).
The analysis of the relationship between economic aspects and social aspects of public space quality is an interesting direction for future research. For example, it would be interesting to analyse the way new developments immersed into the urban fabric of Zürich impact social use through new economic activity. There are two very thought-provoking examples in Zürich with this respect.

The first one is the new development of Europaallee adjacent to the Zürich main station. This is an upper scale development with rent prices above average. Apart from residence, offices and retail, this new development houses several colleges. One side of the development is bordered by railroad. The other side of the development is adjoined by a lower-income area. According to local newspapers and business reports, businesses located within this latter area benefit from social activity brought into it by the new development of Europaallee (CBRE, 2011). It would be interesting to analyse the way one area impacts another one in terms of public space use. In other words, it would be of interest to study how liveliness in public spaces within both areas is influenced by the emerging economic activity.

A similar situation can be observed in Josefwiese. This space was originally used by local residents for open-air leisure activities such as BBQs, ball games and petanque, all of which were free of charge. The redevelopment of the historic viaduct that adjoins Josefwiese and the placement of expensive boutiques brought new social/income groups into this place. Such a mix of social groups, of course, changes the social dynamics of the public space. The way in which the two groups interact and the way how this interaction affects the liveliness represent yet another topic to explore in the future.

When examined from the social standpoint, the concept of public space quality brings up a plethora of opportunities to explore during future steps. The previously provided examples of the developed method and the tool set application revealed just a small fraction of potential topics for future research.

At this point in the thesis, I would like to share my own considerations related to the role of physical public space in contemporary cities and to the way it may/should impact social interactions. The extreme sense of individualism, and often the unjustified self-esteem that can be observed in some people, especially in young adults, brings out some concerns regarding the peaceful coexistence of individuals within the society. This is further supported by changing social dynamics in large European cities, where modern means of communications such as smartphones support the individualist approach and oftentimes
provoke it. In situations where people are already polarized in their opinions, it becomes more and more difficult to cooperate due to the fact that the sheer number of opinions required to reach a consensus is increasing exponentially. At the same time, the consensus within a democratic society is a priority by default, which now comes into direct conflict with the individualism of society members. If everyone’s opinion should count and is an important aspect of the contemporary, highly individualistic society, reaching an agreement with respect to any endeavour may be problematic.

In that context, physical public space can play that special role within entire urban and social systems and encourage social interaction and cooperation, especially among young people. This thesis explores the ways in which the use of spaces and the interactions between people can be supported and which, in turn, can help to contribute to more cohesive public life in cities.
**APPENDIX**

**A1 Observation Results**

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Lying</th>
<th>Walking</th>
<th>Kid playing</th>
<th>Grilling</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday (12-00-14.00)</td>
<td>4</td>
<td>33</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>14.08.2014</td>
<td>cloudy, windy, +19-20, a bit sun</td>
<td></td>
</tr>
<tr>
<td>Monday (16-00-18.00)</td>
<td>9</td>
<td>51</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>26.08.2014</td>
<td>warm, quite, +23-25</td>
<td></td>
</tr>
<tr>
<td>Weekend (13-00-16.00)</td>
<td>3</td>
<td>25</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>17.08.2014</td>
<td>sunny-cloudy, +23-25, a bit windy</td>
<td></td>
</tr>
</tbody>
</table>

---

**Static Elements in Pedestrian Space**

- Trees
- Benches
- Water feature
- Green loan

- Indicate with an 'x' if people do one of the activities.

---

**Images**

- Static elements in pedestrian space
- Short description or indication
  - Trees (yes/no)
  - Benches (yes/no)
  - Water feature (yes/no)
  - Green loan (yes/no)

---

**Comments**

- All comments for any special situations / observation points

<table>
<thead>
<tr>
<th>Time</th>
<th>Special situation / observation points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Only women sitting, in their 40s-50s, most probably living locally as they greet passers by</td>
</tr>
<tr>
<td>Monday</td>
<td>13:12 couple with toddler and baby arrived and sat on bench to feed toddler lunch and a baby</td>
</tr>
<tr>
<td>Monday</td>
<td>2 guys in 20s-30s sitting and chatting (1 has laptop)</td>
</tr>
<tr>
<td>Friday</td>
<td>1 guy on the opposite side checking iPhone</td>
</tr>
<tr>
<td>Weekend</td>
<td>2 women in their 40s-50s drinking prosecco nicely placed on the tray in front of the bench</td>
</tr>
<tr>
<td>Weekend</td>
<td>2 older women sitting and chatting</td>
</tr>
<tr>
<td>Time</td>
<td>Weekday</td>
</tr>
<tr>
<td>----------</td>
<td>-----------</td>
</tr>
<tr>
<td>Date</td>
<td>Weather condition</td>
</tr>
<tr>
<td>14.08.2014</td>
<td>mostly cloudy, windy</td>
</tr>
<tr>
<td>26.09.2014</td>
<td>warm, pleasant and sunny, +25</td>
</tr>
<tr>
<td>17.08.2014</td>
<td>sunny-cloudy, +23-25, a bit windy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>Daytime</th>
<th>Weekday</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Sitting watching others/around</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Standing</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Walking</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Laying</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Walking dogs</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Kids playing</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Eating</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Indicate with an ‘x’ if people do one of the activities.**

**Additional observation comments:**
- One person reads a book in the corner café on the opposite side of the road.
- One of five sitting on the benches near the café.
- Small groups of people are sitting and talking, non-Swiss people, most probably shop owners.
- People are sitting on the bench the rest on the plastic chairs brought from the shop.
- One shop owner is sitting on the bench in front of Habesha.
- People are sitting and talking, non-Swiss people, most probably shop owners.
- One person reads a book in the corner café on the opposite side of the road.

**Static elements in pedestrian space:**
- Trees: yes, 9 of them, 2 of them are big enough to provide shade.
- Benches: 9, 4 in shadow, no.
- Water: fountain, lake: (yes/no) its use by people: no.

**Obstacles for people to use space:**
- Fences, holes in ground: yes, no.

**Green loan:**
- (yes/no) its use by people: no.
## Public Space Observation

Name of the public space: Bullingerplatz

<table>
<thead>
<tr>
<th>Time</th>
<th>Day of week</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Lying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wednesday</td>
<td>13:00-14:00</td>
<td>14</td>
<td>43</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>14.08.2014</td>
<td>cloudy, a bit sunny, +20, windy</td>
</tr>
<tr>
<td>Friday</td>
<td>16:00-18:00</td>
<td>40</td>
<td>63</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>26.09.2014</td>
<td>warm, pleasant and sunny, +25</td>
</tr>
<tr>
<td>Weekend</td>
<td>13:00-16:00</td>
<td>50</td>
<td>75</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>17.08.2014</td>
<td>sunny, cloudy, +23-25, a bit wet</td>
</tr>
</tbody>
</table>

### Static elements in pedestrian space

<table>
<thead>
<tr>
<th>Short description or indication</th>
<th>Yes/no (yes/no) their use for shadow</th>
<th>Benches (yes/no) how many, use by people</th>
<th>Water - Fountains, lakes etc. (yes/no) its use by people</th>
<th>Obstacles for people to use space (fences, holes in ground etc.) specific</th>
<th>Details for people to use space (e.g., benches, shadows) find nearby</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees, just planted, small</td>
<td>yes</td>
<td>yes</td>
<td>yes, fountain surrounded by road</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Leaves, big enough to provide shadow</td>
<td>yes</td>
<td>yes</td>
<td>yes, surrounded by road</td>
<td></td>
<td>cars in the circle</td>
</tr>
<tr>
<td>Benches</td>
<td>yes</td>
<td>10</td>
<td>4 in total, 4 of them are oriented to the road</td>
<td>no</td>
<td>cars in the circle</td>
</tr>
<tr>
<td>Water</td>
<td>yes</td>
<td>10</td>
<td>4 in total, 4 of them are oriented to the road</td>
<td>no</td>
<td>cars in the circle</td>
</tr>
<tr>
<td>Obstacles</td>
<td>yes</td>
<td>10</td>
<td>4 in total, 4 of them are oriented to the road</td>
<td>no</td>
<td>cars in the circle</td>
</tr>
<tr>
<td>Details for people to use space</td>
<td>yes</td>
<td>10</td>
<td>4 in total, 4 of them are oriented to the road</td>
<td>no</td>
<td>cars in the circle</td>
</tr>
</tbody>
</table>

### Comments

Write comments for any special behaviors / observation points

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>Traffic at the circle moves in a confusing way</td>
</tr>
<tr>
<td>Weekend</td>
<td>2 people washing hands in small fountain</td>
</tr>
<tr>
<td>Friday</td>
<td>Event: stage installed, rest singing, market around fountain</td>
</tr>
<tr>
<td>Friday</td>
<td>Lots of parked bikes around fountain. Boating restaurant opposite with Bavarian music does not attract many ppl</td>
</tr>
<tr>
<td>Weekend</td>
<td>Many people sitting on benches &amp; on fountain, over side is closed from the traffic</td>
</tr>
<tr>
<td>Weekend</td>
<td>Many people with kids</td>
</tr>
</tbody>
</table>

### Images

- Static elements in pedestrian space
- Trees
- Benches
- Water - Fountains, lakes etc.
- Obstacles for people to use space
- Details for people to use space
- Comments
- Additional observation comments
<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Laying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>45 (20 benches, 25 café)</td>
<td>130</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>09.09.2014</td>
<td>x</td>
<td>x</td>
<td>x (x-x-df)</td>
<td>08.09.2014</td>
<td>sunny, hot, +26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td>60</td>
<td>160</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>05.09.2014</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>07.09.2014</td>
<td>warm day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>10</td>
<td>155</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>07.09.2014</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>07.09.2014</td>
<td>sunny, hot day, +24-26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Static elements in pedestrian space**

- Trees (yes/no): yes, larger on one side, provide shadow on most of the benches, however, not many benches.
- Benches (yes/no): yes, on the perimeter but not near the middle has benches for the possibility to organize public events.
- Water fountain, lake/etc (yes/no): no.
- Green loan (yes/no): no.
- Obstacles for people to use space (fences, holes in ground/s): no.
- Everyday where does it happen: café nearby.

**Comments**

Write comments for any special behaviour / observation points

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>Tourists passing through, business guys passing with luggage</td>
</tr>
<tr>
<td>Weekday</td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>30 people sitting on benches along the perimeter of the square, in middle more crowdy: bike event, music, food/drinks</td>
</tr>
<tr>
<td>Weekend</td>
<td>People are browsing and staring, taking pictures</td>
</tr>
</tbody>
</table>
# Public Space Observation

Name of the public space: Fritschiwiese

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people doing activities (indicated by ‘x’)</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting/watching others around</th>
<th>Standing</th>
<th>Walking</th>
<th>Lying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (12:00-14:00)</td>
<td>60</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>06.08.2014</td>
<td>+20-25, sunny with clouds</td>
</tr>
<tr>
<td>Friday (16:00-18:00)</td>
<td>190</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>26.09.2014</td>
<td>warm, pleasant and sunny+20</td>
</tr>
<tr>
<td>Weekend (13:00-16:00)</td>
<td>70</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>06.09.2014</td>
<td>sunny, pleasant, +24</td>
</tr>
</tbody>
</table>

### Static Elements in Pedestrian Space

- Trees (yes/no): Their use for shadow
- Benches (yes/no): How many? How many used by people
- Water - Fountain, lake etc. (yes/no): Its use by people
- Green loan (yes/no): Its use by people
- Obstacles for people to use space (fences, holes in ground etc., specify)
- Green loan area of rain? Heating call nearby

**Yes**

- Trees: yes, many people using them
- Water: yes, two types - classic & open
- Benches: yes, many people using them
- Green loan: yes, many people using them
- Obstacles: yes, people arguing, not extensively observed on the day of observation, however, on another day there were more people, more temporary or around

**No**

- Green loan area: none

### Comments

Write comments for any special behaviors / observation points

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>Local 'hangers' arguing near the 'classic' fountain</td>
</tr>
<tr>
<td>Weekday</td>
<td>Kids playground scattered around the place</td>
</tr>
<tr>
<td>Friday</td>
<td>1 group of cuban people having BBQ on the side, loud cuban music, quite isolated from others</td>
</tr>
<tr>
<td>Friday</td>
<td>Young parents with kids chilling on lawn, kids of different ages range from 0-12 years</td>
</tr>
<tr>
<td>Weekend</td>
<td>People tanning in the sun, picnicking, people jogging, riding bikes through, walking dogs...</td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
</tr>
</tbody>
</table>
### Public Space Observation

**Name of the public space:** Hallwylplatz

#### Time Table

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Lying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>107</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.08.2014</td>
<td>sunny-cloudy, +20, a bit windy</td>
</tr>
<tr>
<td>Friday (16:00-18:00)</td>
<td>136</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>26.09.2014</td>
<td>warm, pleasant and sunny+20</td>
</tr>
<tr>
<td>Weekend</td>
<td>45</td>
<td></td>
<td></td>
<td>x (iPhone, headphones)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>06.09.2014</td>
<td>sunny, pleasant, -06</td>
</tr>
</tbody>
</table>

#### Static Elements in Pedestrian Space

- Trees: yes, mature enough to provide shade
- Benches: yes, used by people
- Water: fountain in the middle, people sitting on it
- Obstacles for people to use space: small structure (technical building in middle)

#### Short Description or Indication

- Yes, many benches to sit on
- Yes, fountain in the middle

#### Comments

- **Weekday:**
  - Many, handmade table with benches, table tennis, plastic chairs
  - Mostly young people and people in their 40ies (working nearby)
- **Friday:**
  - 7 people in one corner of 16, 30 in the other, 1 mom with kid at the square, kid rides the sledge
- **Weekend:**
  - Several families stop here on their way by bicycles

---

**Indicate with an ‘x’ if people do one of the activities.**
### Public Space Observation

**Name of the public space:** Idaplatz

<table>
<thead>
<tr>
<th>Time</th>
<th>Weekday (12:00-14:00)</th>
<th>Friday (16:00-18:00)</th>
<th>Weekend (15:00-16:00)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N of people at indicated time</td>
<td>27</td>
<td>100</td>
<td>70</td>
</tr>
<tr>
<td>N of people passing within 15min</td>
<td>30</td>
<td>64</td>
<td>60</td>
</tr>
<tr>
<td>Sitting</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Reading</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Sitting/watching others/around</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Standing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lying</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking dogs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kids playing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>04.08.2014</td>
<td>26.09.2014</td>
<td>30.08.2014</td>
</tr>
<tr>
<td>Weather condition</td>
<td>+25 mostly sunny with clouds</td>
<td>warm pleasant and sunny+25</td>
<td>sunny +25</td>
</tr>
</tbody>
</table>

#### Static elements in pedestrian space

- **Trees**: Yes, they are big enough to provide shade for benches.
- **Benches**: 17 benches.
- **Water**: Fountain for drinking, used for drinking during time of observation.
- **Green loan**: Yes, used by people.
- **Obstacles for people to use space**: No.
- **Shade as source of clean shade**: Yes.
- **Cafe nearby**: Clean and not noisy.

#### Comments

- **Weekday (12:00-14:00)**: People coming with plastic bags to have lunch, preferred sitting area at the café tables and around fountain (perceived center), staying for about 40 min, first eating then chatting.
- **Weekday (16:00-18:00)**: Mostly young people having lunch (most probably from nearby offices (design or architecture)), dressed casually, hipster like.
- **Friday**: Parents are sitting in open cafes and kids running and playing around.
- **Weekend**: 70 people altogether in square (including cafes), 22 out of 70 are sitting on the benches and at the square.
- **Weekend**: The square is very lively, sparrow told me that it became more lively with the opening of the cafes owners.
### Public Space Observation

**Name of the public space:** Josefwiese

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others around</th>
<th>Standing</th>
<th>Walking</th>
<th>Laying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (12:00-14:00)</td>
<td>50</td>
<td>305</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>24.07.2014</td>
<td>+26 sunny</td>
</tr>
<tr>
<td>Friday (16:00-18:00)</td>
<td>650</td>
<td>40</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>26.09.2014</td>
<td>warm, pleasant and sunny +25</td>
</tr>
<tr>
<td>Weekend (13:00-16:00)</td>
<td>190</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>30.08.2014</td>
<td>sunny, +25</td>
</tr>
</tbody>
</table>

#### Static elements in pedestrian space

- **Trees (yes/no)**
  - Description: yes, many mature trees

- **Bench (yes/no)**
  - Description: yes, many benches along the perimeter

- **Water - fountain, lake etc. (yes/no)**
  - Description: yes, very popular with kids due to possibilities for interaction

- **Green loan (yes/no)**
  - Description: yes, people mainly stay there, BBQ, sports - yoga, walking, rope, ball games etc.

- **Obstacles for people to use space (fences, holes in ground etc)**
  - Description: space is surrounded by fence and is more a destination than a transit area

- **Is there a source of noise? How close nearby?**
  - Description: yes, no disturbance from traffic

#### Additional observation comments

**Weekday:**
- many dogs on loan, freesby, ping pong, ball games

**Friday:**
- mostly families with kids, but also other age groups, older observing kids playing or reading

**Weekend:**
- younger sitting/laying and listening to music on headphones

**Weekend:**
- 13:25 50 people on green lawn, 50 playground, approx. 50 around cafés

---

**Indicate with an 'X' if people do one of the activities.**
Public Space Observation
Name of the public space: Kasernenareal

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Lying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (12:00-14:00)</td>
<td>41</td>
<td>90</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>21.08.2014</td>
<td>sunny, cloudy, windy, +19-20</td>
<td></td>
</tr>
<tr>
<td>Friday (16:00-18:00)</td>
<td>75</td>
<td>85</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>05.09.2014</td>
<td>warm day</td>
<td></td>
</tr>
<tr>
<td>Weekend (13:00-16:00)</td>
<td>6</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>06.09.2014</td>
<td>sunny, pleasant, +26</td>
<td></td>
</tr>
</tbody>
</table>

Indicate with an 'x' if people do one of the activities.

Static elements in pedestrian space:
- Trees (yes/no): their use for shade
- Benches (yes/no): how many, use by people
- Water - fountains, lake etc. (yes/no): its use by people
- Green loan (yes/no): its use by people
- Obstacles for people to use space (fences, holes in ground etc.): specify
- Shade: presence of shade? Reason: call nearby

Short description or indication:
- yes
  - not many, only at playground
  - which is surrounded by fence, not used by kids, only grownups sitting there
- no
  - yes but not extensive used
- no
  - appears deers, no noise

Comments:
Write comments for any special behaviours / observation points

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>an 'arty' place with hipster looking young people</td>
</tr>
<tr>
<td>Weekday</td>
<td>not many places to sit except the loan itself - many people smoking</td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Holiday</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>restaurants all closed, no events except the music studio is open</td>
</tr>
<tr>
<td>Weekend</td>
<td>bad smell</td>
</tr>
</tbody>
</table>
## Public Space Observation

Name of the public space: **Marktplatz Oerlikon**

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (12-00-14.00)</td>
<td>194</td>
<td>200</td>
</tr>
<tr>
<td>Friday (16-00-18.00)</td>
<td>115</td>
<td>175</td>
</tr>
<tr>
<td>Weekend (13-00-16.00)</td>
<td>70</td>
<td>63</td>
</tr>
</tbody>
</table>

### Observations

<table>
<thead>
<tr>
<th>Activity</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Lying</th>
<th>Walking dogs</th>
<th>Kite playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>09.05.2014</td>
<td>sunny, hot, 25</td>
</tr>
<tr>
<td>Friday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.08.2014</td>
<td>sunny, 21-23</td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.08.2014</td>
<td>sunny, +26</td>
</tr>
</tbody>
</table>

### Static elements in pedestrian space

- Trees (yes/no) their use for shadow: yes.
- Benches (yes/no): how many, use by people: many, frequently used.
- Water - fountain, lake etc (yes/no): its use by people: yes, frequently used.
- Green loan (yes/no): its use by people: no.

### Obstacles for people to use space (fences, holes in ground etc., specify): no.

### Comments

**Write comments for any special behaviours / observation points**

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>Many teenagers, most probably school nearby.</td>
</tr>
<tr>
<td>Weekday</td>
<td>Very lively place at weekdays, lunchtime - big Oechsner Sport shop entrance around the middle.</td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>Many elderly men play large chess.</td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
</tr>
</tbody>
</table>
Public Space Observation
Name of the public space: Max Bill Platz

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Lying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (12:00-14:00)</td>
<td>29</td>
<td>100</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>07.08.2014</td>
<td>sunny, 22-24, a bit windy</td>
</tr>
<tr>
<td>Friday (16:00-18:00)</td>
<td>58</td>
<td>135</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.08.2014</td>
<td>sunny, 21-23</td>
</tr>
<tr>
<td>Weekend (13:00-16:00)</td>
<td>48</td>
<td>60</td>
<td>x</td>
<td></td>
<td>x newspaper in sun</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24.08.2014</td>
<td>sunny-cloudy, +20</td>
</tr>
</tbody>
</table>

Static elements in pedestrian space:
- Trees (yes/no): yes, designed around trees, not many people use them for sitting as they look dirty and there are ants.
- Benches (yes/no): no.
- Shaded areas (yes/no): yes, many cafes and restaurants, there are many people passing by.
- Water (fountains, lakes, etc.) (yes/no): no.
- Obstacles for people to use spaces (fences, holes in ground, etc.) (yes/no): no.
- Movable objects (yes/no): no.
- Noise from passing cars (yes/no): no.

Comments:
- Many people passing through space.
- People mainly go to bakery Buchmann, Starbucks and Max Restaurant but not stay at the square itself.
- Many people passing by but not very disturbing.
### Public Space Observation

**Name of the public space:** MFO Park

**Indicate with an ‘x’ if people do one of the activities.**

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (10:00-14:00)</td>
<td>50</td>
<td>120</td>
</tr>
<tr>
<td>Friday (16:00-18:00)</td>
<td>25</td>
<td>140</td>
</tr>
<tr>
<td>Weekend (13:00-16:00)</td>
<td>20</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Weather condition</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>08.09.2014</td>
<td>sunny, hot, 26</td>
<td></td>
</tr>
<tr>
<td>22.08.2014</td>
<td>sunny, 21-23</td>
<td></td>
</tr>
<tr>
<td>24.08.2014</td>
<td>sunny cloudy, &lt;20</td>
<td></td>
</tr>
</tbody>
</table>

**Static elements in pedestrian space**

- Trees (yes/no): their use for shadow
- Benches (yes/no): how many, use by people
- Water - fountains, lake etc. (yes/no): its use by people
- Green loan (yes/no): its use by people
- Obstacles for people to use space (fences, holes in ground etc.): specify

<table>
<thead>
<tr>
<th>Short description or indication</th>
<th>Yes or No</th>
<th>Various kinds</th>
<th>Yes, small deco pond</th>
<th>No</th>
<th>No</th>
<th>Is clean</th>
</tr>
</thead>
<tbody>
<tr>
<td>No but plenty of ‘liming’ plants on the structure</td>
<td>yes various kinds</td>
<td>yes, small deco pond</td>
<td>no</td>
<td>no</td>
<td>is clean</td>
<td></td>
</tr>
</tbody>
</table>

**Additional observation comments**

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>Cafes around full of people</td>
</tr>
<tr>
<td>Weekday</td>
<td>People come in groups of 2-7 to have lunch</td>
</tr>
<tr>
<td>Friday</td>
<td>Pregnant women sitting</td>
</tr>
<tr>
<td>Friday</td>
<td>Teenagers use this place actively, place to cuddle</td>
</tr>
<tr>
<td>Weekend</td>
<td>Teenagers got fined by policeman</td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
</tr>
</tbody>
</table>
### Public Space Observation

**Name of the public space:** Oerlikerpark

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (12:00-14:00)</td>
<td>35</td>
<td>63</td>
</tr>
<tr>
<td>Friday (16:00-18:00)</td>
<td>63</td>
<td>81</td>
</tr>
<tr>
<td>Weekend (15:00-16:00)</td>
<td>73</td>
<td>36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>18.05.2016</td>
<td>slightly chilly, +22</td>
</tr>
<tr>
<td>Friday</td>
<td>27.05.2016</td>
<td>sunny, +20</td>
</tr>
<tr>
<td>Weekend</td>
<td>06.06.2016</td>
<td>sunny, +27</td>
</tr>
</tbody>
</table>

### Static elements in pedestrian space

- Trees (yes/no): yes
- Benches (yes/no): yes
- Water (fountains, lake etc.): yes
- Green lawn (yes/no): yes
- Obstacles for people to use space (fences, holes in ground): no

### Comments

Write comments for any special behaviour / observation points:

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>People eat at the long table having lunch, almost the whole length is occupied, nice way to socialise</td>
</tr>
<tr>
<td>Weekday</td>
<td>The other side with kids playground is used less extensively for lunch, a few kids with mom on the playground</td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>People sometimes spend free time making BBQ and listening to music, no need to pay for services</td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
</tr>
</tbody>
</table>

### Indicate with an "x" if people do one of the activities.

<table>
<thead>
<tr>
<th>Time</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Laying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18.05.2016</td>
<td>slightly chilly, +22</td>
</tr>
<tr>
<td>Friday</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27.05.2016</td>
<td>sunny, +20</td>
</tr>
<tr>
<td>Weekend</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>06.06.2016</td>
<td>sunny, +27</td>
</tr>
</tbody>
</table>

### Additional observation points

- Trees: yes, many
- Benches: yes, also other urban furniture, custom designed for laying
- Water: yes, but not used for sitting
- Green lawn: yes, not used for sitting
- Obstacles for people to use space: designed at several levels, space is split in 2 parts by the road
- No place to smoke. No place for a café nearby
- Noise: yes, from the bus only.
### Public Space Observation

**Name of the public space:** Röntgenplatz

**Observation Results**

#### Time & Weather

<table>
<thead>
<tr>
<th>Time</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>18.08.2014</td>
<td>sunny, windy, +23, sometimes clouds</td>
</tr>
<tr>
<td>Weekday</td>
<td>26.09.2014</td>
<td>warm pleasant and sunny, +25</td>
</tr>
</tbody>
</table>

#### Activities at Indicated Times

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (12-00-14.00)</td>
<td>17</td>
<td>x</td>
</tr>
<tr>
<td>Friday (10-00-12.00)</td>
<td>16</td>
<td>x</td>
</tr>
<tr>
<td>Weekend (13-00-16.00)</td>
<td>6</td>
<td>57</td>
</tr>
</tbody>
</table>

#### Comments

**Write comments for any special behaviours / observation points**

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>This square looks very lively, many people passing by on foot and by bike</td>
</tr>
<tr>
<td>Weekday</td>
<td>Most probably school and kindergarten as kids of different ages pass through</td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Holiday</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>Many people pass by on bike</td>
</tr>
<tr>
<td>Weekend</td>
<td>2 guys came to sit and have a beer at the table, 2 others joined afterwards</td>
</tr>
<tr>
<td>Weekend</td>
<td>Socialising taking place, guys at the table cheer others passing by</td>
</tr>
</tbody>
</table>
# Public Space Observation

Name of the public space: Sechseläuten Platz

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15 min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Laying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>12:00-14:00</td>
<td>72</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>18.08.2014 sunny, windy, +23, sometimes clouds</td>
</tr>
<tr>
<td>Friday</td>
<td>16:00-18:00</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>08.07.2016 sunny, warm day, +25</td>
</tr>
<tr>
<td>Weekend</td>
<td>13:00-16:00</td>
<td>180</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>09.07.2016 warm day, +26</td>
</tr>
</tbody>
</table>

## Static elements in pedestrian space

- **Trees (yes/no)**: their use for shade
- **Benches (yes/no)**: how many, use by people
- **Water - fountain, lake etc. (yes/no)**: its use by people
- **Green loan (yes/no)**: its use by people
- **Obstacles for people to use space (fences, holes in grounds etc.)**: specify
- **Special area of children? Reason call nearby**: Very damp, certain but constant street noise

### Short description or indication

- There are trees which provide some shade for sitting areas through their leaves and the shade penetrates
- Benches are available and are used by people
- Water - fountain and lake etc. are visible
- Green loan is not visible
- Obstacles for people to use space are common
- Special area of children? Reason call nearby

## Comments

Write comments for any special behaviors / observation points

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>Kids playing in fountain, kids skating through the place and fountain, other kids laying directly on the ground or benches resting after play</td>
</tr>
<tr>
<td>Friday</td>
<td>Many elderly people watching others, staying longer at the spot, Younger people (25-45 age) stay around 20 min</td>
</tr>
<tr>
<td>Weekend</td>
<td>Many teenagers ride BMX, skates</td>
</tr>
<tr>
<td>Weekend</td>
<td>Fountain is the main point of attraction for kids and their parents</td>
</tr>
</tbody>
</table>
### Public Space Observation

**Name of the public space:** Stadelhoferplatz

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Lying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (12-00-14.00)</td>
<td>80 (10 benches, 50 cafes)</td>
<td>105</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>08.09.2014</td>
<td>sunny, hot, +25</td>
</tr>
<tr>
<td>Friday (16.00-18.00)</td>
<td>75</td>
<td>160</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>05.09.2014</td>
<td>sunny, +25</td>
</tr>
<tr>
<td>Weekend (15-18.00)</td>
<td>65</td>
<td>180</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>09.07.2016</td>
<td>warm day, +26</td>
</tr>
</tbody>
</table>

#### Static elements in pedestrian space

<table>
<thead>
<tr>
<th>Trees (yes/no)</th>
<th>Their use for shadow</th>
<th>Benches (yes/no)</th>
<th>How many, use by people</th>
<th>Water - fountain, lake etc (yes/no)</th>
<th>Its use by people</th>
<th>Green loan (yes/no)</th>
<th>Its use by people</th>
<th>Obstucles for people to use space (fences, holes in ground etc) (yes/no)</th>
<th>Specify</th>
<th>Surely place seen clean? Noise, callers nearby (yes/no)</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes, mature trees that provide sufficient shadow</td>
<td>yes, around the perimeter</td>
<td>yes, but fenced, not really for interaction rather for observation</td>
<td>no</td>
<td>the ground level is elevated</td>
<td>clean, noise from trains</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Comments

Write comments for any special behaviors / observation points

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td>Mixed age groups, teenagers (either in groups or phoning),</td>
</tr>
<tr>
<td>Friday</td>
<td>Older people sitting watching others (waiting for transport maybe), mom with baby catching up with a friend</td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
</tr>
</tbody>
</table>
Public Space Observation
Name of the public space: Traugott Wahlen Park

Time | N of people at indicated time | N of people passing within 15 min |
--- | --- | --- |
Weekday (13.00-14.00) | 40 | 40 |
Weekday (16.00-18.00) | 50 | 40 |
Weekend (13.00-16.00) | 90 | 60 |

<table>
<thead>
<tr>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Lying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Does place seem clean? Noise, café nearby: clean, almost no noise, several cafés in the proximity.

Static elements in pedestrian space:

Trees (yes/no) their use for shadow: yes, many trees, not yet mature but create shadow

Bench (yes/no) how many, use by people: yes various types

Water - fountains, lakes etc. (yes/no) its use by people: yes, the water body makes it possible to cool down

Green loan (yes/no) its use by people: yes, used intensively

Obstacles for people to use space (fences, holes in ground etc.) specific: no

Comments:

Write comments for any special behaviours / observation points:

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>School kids use this place extensively as well as people from offices around at lunch time</td>
</tr>
<tr>
<td>Weekday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>Water body attracts many kids, length of pedestrian paths allows to ride bikes and scooters</td>
</tr>
<tr>
<td>Weekend</td>
<td>Ball games at the lawn, people tanning...</td>
</tr>
</tbody>
</table>

Images:

Static elements in pedestrian space

Trees: yes, many trees, not yet mature but create shadow

Bench: yes various types

Water: fountain, lake etc. (yes/no) its use by people: yes, the water body makes it possible to cool down

Green loan: yes, used intensively

Obstacles: no

Comments:

Write comments for any special behaviours / observation points:

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>School kids use this place extensively as well as people from offices around at lunch time</td>
</tr>
<tr>
<td>Weekday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>Water body attracts many kids, length of pedestrian paths allows to ride bikes and scooters</td>
</tr>
<tr>
<td>Weekend</td>
<td>Ball games at the lawn, people tanning...</td>
</tr>
</tbody>
</table>
### Public Space Observation

**Name of the public space:** Turbinenplatz

#### Time N of people at indicated time N of people passing within 15min

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>75</td>
<td>116</td>
</tr>
<tr>
<td>Friday</td>
<td>45</td>
<td>400</td>
</tr>
<tr>
<td>Weekend</td>
<td>8</td>
<td>35</td>
</tr>
</tbody>
</table>

#### Indicate with an ‘X’ if people do one of the activities.

<table>
<thead>
<tr>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Laying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>07.08.2014</td>
<td>sunny with clouds, 23-25</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>15.08.2014</td>
<td>sunny, windy, +23</td>
</tr>
</tbody>
</table>

#### Weekly elements in pedestrian space

| Short description or indication | Trees (yes/no) their use for shadow | Benches (yes/no) how many, use by people | Water - Fountains, lakes, etc. (yes/no) its use by people | Green loan (yes/no) its use by people | Obstacles for people to use space (fences, holes in grounds etc.) specific | Obstacles for people to use space (trees, benches) specific | Obstacles for people to use space (hills, cliffs, etc.) specific | Grass, many spots to get shade | shadows of trees nearby |
|--------------------------------|------------------------------------|------------------------------------------|----------------------------------------------------------|-------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------|
|                                | yes, many, used alternatively by people, around 20 benches scattered around the place | no                                        | only patches of green grass around trees surrounded by fences | no                                  | no                                                                         | no                                                              | yes, many places to get shaded                               | yes                                                      |

#### Additional observation comments

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>Many people at the corner café, generally people having lunch at the square, enjoying sun</td>
</tr>
<tr>
<td>Weekday</td>
<td>For some reason workers don’t seat on benches but prefer spots not dedicated for sitting</td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>Photographers (couple), people (family) with kids</td>
</tr>
<tr>
<td>Weekend</td>
<td>Photographers (family) with kids, taking photos in hand</td>
</tr>
</tbody>
</table>

#### Images

- Static elements in pedestrian space
- Trees (yes/no) their use for shadow
- Benches (yes/no) how many, use by people
- Water - Fountains, lakes, etc. (yes/no) its use by people
- Green loan (yes/no) its use by people
- Obstacles for people to use space (fences, holes in grounds etc.) specific
- Obstacles for people to use space (trees, benches) specific
- Obstacles for people to use space (hills, cliffs, etc.) specific
- Grass, many spots to get shade
- Shadows of trees nearby

#### Comments

Write comments for any special behaviour / observation points.

#### Date

- 07.08.2014
- 15.08.2014
- 27.05.2016

#### Weather condition

- Sunny with clouds, 23-25
- Sunny, windy, +23
- Sunny, +26
## Public Space Observation

### Name of the public space: Wipkinger Park

<table>
<thead>
<tr>
<th>Time</th>
<th>N of people at indicated time</th>
<th>N of people passing within 15min</th>
<th>Sitting</th>
<th>Reading</th>
<th>Sitting watching others/around</th>
<th>Standing</th>
<th>Walking</th>
<th>Laying</th>
<th>Walking dogs</th>
<th>Kids playing</th>
<th>Eating</th>
<th>Date</th>
<th>Weather condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday (12:00-14:00)</td>
<td>70</td>
<td>130</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>02.09.2014</td>
<td>chilly</td>
</tr>
<tr>
<td>Friday (16:00-18:00)</td>
<td>150</td>
<td>80</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>05.09.2014</td>
<td>hot, sunny, +26</td>
</tr>
<tr>
<td>Weekend (15:00-16:00)</td>
<td>150</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20.05.2016</td>
<td>sunny, +26</td>
</tr>
</tbody>
</table>

### Static elements in pedestrian space
- Trees (yes/no): yes, many
- Benches (yes/no): not many benches, mostly people use stairs along the river to sit on them
- Water - fountains, lake etc. (yes/no): yes, river bank is extensively used
- Green loan (yes/no): yes - often used when sunny
- Obstacles for people to use space (fences, holes in ground etc.) (yes/no): may be problematic for disabled people as there is a landscape undulation from main road to river bank
- Sunbathing area (yes/no): very clean, no noise, like a school canteen

### Comments
**Write comments for any special behaviours / observation points:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Additional observation comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>Many people jogging through</td>
</tr>
<tr>
<td>Weekday</td>
<td>Walking dogs / kids playing in kids zoo / farm</td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Weekend</td>
<td>people baking on the lawn, picnicking, many people with kids, sport, games etc.</td>
</tr>
</tbody>
</table>

### Additional observation comments
- Very clean, no noise, like a school canteen
- Many people jogging through
- Walking dogs / kids playing in kids zoo / farm
- People baking on the lawn, picnicking, many people with kids, sport, games etc.
### A.2 Statistical Data

**T_1**

Workforce in specified perimeters

2013

Source: Statistik Stadt Zürich

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Workforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AnnyKlawaplatz</td>
<td>32 488</td>
</tr>
<tr>
<td>2</td>
<td>Brupbacherplatz</td>
<td>34 186</td>
</tr>
<tr>
<td>3</td>
<td>Buerkliplatz</td>
<td>85 671</td>
</tr>
<tr>
<td>4</td>
<td>Bullingerplatz</td>
<td>31 357</td>
</tr>
<tr>
<td>5</td>
<td>Fritschiewiese</td>
<td>25 803</td>
</tr>
<tr>
<td>6</td>
<td>Hallwylplatz</td>
<td>93 411</td>
</tr>
<tr>
<td>7</td>
<td>Idaplatz</td>
<td>28 679</td>
</tr>
<tr>
<td>8</td>
<td>Josefwiess</td>
<td>40 513</td>
</tr>
<tr>
<td>9</td>
<td>Kasernenareal</td>
<td>74 935</td>
</tr>
<tr>
<td>10</td>
<td>MFOpark</td>
<td>27 091</td>
</tr>
<tr>
<td>11</td>
<td>MaxBillplatz</td>
<td>31 101</td>
</tr>
<tr>
<td>12</td>
<td>Oerlikermarktplatz</td>
<td>31 235</td>
</tr>
<tr>
<td>13</td>
<td>Oerlikerpark</td>
<td>23 414</td>
</tr>
<tr>
<td>14</td>
<td>Roetgenplatz</td>
<td>45 835</td>
</tr>
<tr>
<td>15</td>
<td>Sechseleutenplatz</td>
<td>67 111</td>
</tr>
<tr>
<td>16</td>
<td>Stadelhoferplatz</td>
<td>60 385</td>
</tr>
<tr>
<td>17</td>
<td>Turbinenplatz</td>
<td>31 573</td>
</tr>
<tr>
<td>18</td>
<td>Wahlenpark</td>
<td>27 338</td>
</tr>
<tr>
<td>19</td>
<td>Wipkingerpark</td>
<td>37 059</td>
</tr>
</tbody>
</table>
### T.2
Taxable income* in 1000 CHF (yearly)
2013

Source: Statistik Stadt Zürich

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Median basic rate**</th>
<th>Median married rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ArnyKlewatplatz</td>
<td>39.8</td>
<td>56.2</td>
</tr>
<tr>
<td>2</td>
<td>Brupbacherplatz</td>
<td>40.2</td>
<td>57.2</td>
</tr>
<tr>
<td>3</td>
<td>Bueerklipplatz</td>
<td>41.4</td>
<td>120.0</td>
</tr>
<tr>
<td>4</td>
<td>Bullingerplatz</td>
<td>39.6</td>
<td>54.3</td>
</tr>
<tr>
<td>5</td>
<td>Frischviese</td>
<td>40.0</td>
<td>57.1</td>
</tr>
<tr>
<td>6</td>
<td>Haltivylplatz</td>
<td>42.7</td>
<td>64.1</td>
</tr>
<tr>
<td>7</td>
<td>Ideplatz</td>
<td>40.9</td>
<td>58.3</td>
</tr>
<tr>
<td>8</td>
<td>Josefviere</td>
<td>40.7</td>
<td>66.9</td>
</tr>
<tr>
<td>9</td>
<td>Kasernenareal</td>
<td>38.6</td>
<td>59.6</td>
</tr>
<tr>
<td>10</td>
<td>MFOpark</td>
<td>41.7</td>
<td>75.5</td>
</tr>
<tr>
<td>11</td>
<td>MaxBillplatz</td>
<td>42.1</td>
<td>74.6</td>
</tr>
<tr>
<td>12</td>
<td>Oerlikonmarktplatz</td>
<td>41.3</td>
<td>76.4</td>
</tr>
<tr>
<td>13</td>
<td>Oerlikerpark</td>
<td>41.0</td>
<td>75.0</td>
</tr>
<tr>
<td>14</td>
<td>Roetgenplatz</td>
<td>40.0</td>
<td>66.0</td>
</tr>
<tr>
<td>15</td>
<td>Sechseleutenplatz</td>
<td>47.6</td>
<td>118.2</td>
</tr>
<tr>
<td>16</td>
<td>Stadelhoferplatz</td>
<td>47.9</td>
<td>117.0</td>
</tr>
<tr>
<td>17</td>
<td>Turbinenplatz</td>
<td>45.1</td>
<td>65.9</td>
</tr>
<tr>
<td>18</td>
<td>Wahlenpark</td>
<td>42.2</td>
<td>73.0</td>
</tr>
<tr>
<td>19</td>
<td>Wipkingerpark</td>
<td>45.9</td>
<td>74.1</td>
</tr>
</tbody>
</table>

* Proportion of definitive tax bills of all tax bills 2013: 97.7%.
** Rate for unmarried individuals. Excluding individuals living with one or several biological children but not living with the other biological parent (single parents).
A.3 COMPUTATIONAL TOOLS

Accessibility Analysis Tool

```csharp
using System;
using System.Collections.Generic;
using Grasshopper.Kernel;
using Rhino.Geometry;
using Tool.Data.Graph;
using Tool.Algorithm;
using System.Drawing;
using Grasshopper.GUI.Gradient;
using System.Windows.Forms;
using System.Diagnostics;
using Rhino;
using Rhino.DocObjects;
namespace Tool.Components
{
    public class Accessibility_Comp : GH_Component //,
    IGH_SketchAwareObject
    {
        #region FIELD
        private Graph network = new Graph();
        private double distanceLimit = double.PositiveInfinity;
        private GH_Gradient g;
        private bool m_previewValue = false;
        #endregion
        /// <summary>
        /// Initializes a new instance of the Accessibility_Comp
class.
        /// </summary>
        public Accessibility_Comp()
        {
            base("Accessibility", "Accessibility",
                "Accessibility analysis of road network" +
                Toolbox.Mark,
                "iA_toolbox", "Tools")
        }
        /// <summary>
        /// Registers all the input parameters for this component.
        /// </summary>
        public override bool Write(GH_IO.Serialization.GH_IWriter writer)
        {
            writer.SetBoolean("Preview_value", this.m_previewValue);
            return base.Write(writer);
        }
        public override bool Read(GH_IO.Serialization.GH_IReader reader)
        {
            this.m_previewValue =
            reader.GetBoolean("Preview_value");
            return base.Read(reader);
        }
```
protected override void RegisterInputParams(GH_Component.GH_InputParamManager pManager)
{
    pManager.AddParameter(new Graph_Param());
pManager.AddPointParameter("Starting points", "P", "Starting points of movement", GH_ParamAccess.list);
    //pManager[1].Optional = true;
pManager.AddParameter("Speed", "V", "Movement speed [km/h]", GH_ParamAccess.item, 6);
pManager.AddParameter("Time", "T", "Time limit [min]", GH_ParamAccess.item,30);
pManager.AddParameter("Distance", "D", "Distance limit [m] + Environment.NewLine + "(optional: overrides V,T inputs)", GH_ParamAccess.item);
pManager[4].Optional = true;
}

/// <summary>
/// Registers all the output parameters for this component.
/// </summary>
protected override void RegisterOutputParams(GH_Component.GH_OutputParamManager pManager)
{
    //pManager.AddNumberParameter("OUT", "out", "timer", GH_ParamAccess.item);
pManager.AddCurveParameter("Network", "N", "Accessible road network", GH_ParamAccess.list);
}

/// <summary>
/// This is the method that actually does the work.
/// </summary>
/// <param name="DA">The DA object is used to retrieve from inputs and store in outputs.</param>
protected override void SolveInstance(IGH_DataAccess DA)
{
    Graph_Goo graph = new Graph_Goo();
    if (!DA.GetData(0,ref graph))
        return;
    List<Point3d> starts = new List<Point3d>();
    if (!DA.GetDataList<Point3d>(1, starts))
        return;

double speed = 6;
double time = 30;
if(!DA.GetData(4,ref this.distanceLimit))
{
    if (DA.GetData(2, ref speed) && DA.GetData(3, ref time))
        distanceLimit = ((speed / 60) * time) * 1000;
}

this.g = new GH_Gradient();
g.AddGrip(0.0, Color.Green);
g.AddGrip(this.distanceLimit/2, Color.Yellow);
g.AddGrip(distanceLimit, Color.Orange); //DarkSlateGray
this.network = graph.Value;
List<int> starts_id = RoadGeometry.NearRoads(this.network.Roads, starts);
this.network.Reset();
foreach (int start_id in starts_id)
{
    Dijkstra.computePaths(network.Roads[start_id], this.distanceLimit);
}
List<Curve> accessible_roads = new List<Curve>();
foreach (GraphRoad road in network.Roads)
{
    if (road.Distance != double.PositiveInfinity)
        accessible_roads.Add(road.Geometry);
}
DA.SetDataList(0, accessible_roads);
//this.Message = timer.ElapsedMilliseconds.ToString();
//DA.SetData(0, network.timer.ElapsedMilliseconds);

/// <summary>
/// Provides an Icon for the component.
/// </summary>
protected override System.Drawing.Bitmap Icon
{
    get
    {
        return Tool.Properties.Resources.accessibility;
    }
}

/// <summary>
/// Gets the unique ID for this component. Do not change this ID after release.
/// </summary>
public override Guid ComponentGuid
{
    get { return new Guid("{47c1b0fc-7595-4a0b-ae55-584227baee70}"); }
}

public override GH_Exposure Exposure
{
    get { return GH_Exposure.tertiary; } //secondary; 
}

//public override void ClearData()
base.ClearData();
if (network.Roads != null)
{
    foreach (GraphRoad road in network.Roads)
    {
        road.Geometry.Dispose();
    }
    network.Roads.Clear();
}

public override void CollectData()
{
    if (Params.Input[1].Phase == GH_SolutionPhase.Blank)
        m_differentCurves = true;
    if (Params.Input[1].Phase == GH_SolutionPhase.Failed)
        m_differentCurves = false;
    base.CollectData();
}

private bool IsCacheValid(List<GH_Curve> A, List<GH_Curve> B)
{
    if (A == null) return false;
    if (B == null) return false;
    if (A.Count != B.Count) return false;
    for (int i = 0; i < A.Count; i++)
    {
        if (!object.ReferenceEquals(A[i], B[i]))
            return false;
    }
    return true;
}

#region BAKE
public override bool IsBakeCapable
{
    return true;
}

public override void BakeGeometry(RhinoDoc doc, List<Guid> obj_ids)
{
    ObjectAttributes att = Rhino.RhinoDoc.ActiveDoc.CreateDefaultAttributes();
    att.ColorSource = ObjectColorSource.ColorFromObject;
    this.BakeGeometry(doc, att, obj_ids);
}
#endregion
public override void BakeGeometry(RhinoDoc doc, ObjectAttributes att, List<Guid> obj_ids)
        {
            att.ColorSource = ObjectColorSource.ColorFromObject;
            att.PlotColorSource = ObjectPlotColorSource.PlotColorFromObject;
            foreach (GraphRoad road in network.Roads)
            {
                if (road.Distance == 0)
                {
                    att.ObjectColor = Color.Green;
                    att.PlotColor = Color.Green;
                    doc.Objects.AddCurve(road.Geometry, att);
                }
                else if (road.Distance != double.PositiveInfinity)
                {
                    att.ObjectColor = g.ColourAt(road.Distance);
                    att.PlotColor = g.ColourAt(road.Distance);
                    doc.Objects.AddCurve(road.Geometry, att);
                }
            }
        }

        #endregion
        
        #region PREVIEW
        public override void DrawViewportWires(IGH_PreviewArgs args)
        {
            //base.DrawViewportWires(args);
            foreach (GraphRoad road in network.Roads)
            {
                if (road.Distance == 0)
                {
                    // args.Display.Draw2dText("START", Color.Red, road.Center, true, 20);
                    args.Display.DrawCurve(road.Geometry, Color.Green, 5);
                }
                else if (road.Distance != double.PositiveInfinity)
                {
                    Color colour = g.ColourAt(road.Distance);
                    // args.Display.Draw2dText(road.Distance.ToString(), Color.White, road.Center, true, 10);
                    args.Display.DrawCurve(road.Geometry, colour, 5);
                    if (this.m_previewValue)
                    {
                        //
args.Display.Draw2dText(Math.Round(road.Distance, 2) + "m : " +
Math.Round(road.Time, 0) + " min", Color.Black, road.Center, true,
12);
args.Display.DrawDot(road.Center,
Math.Round(road.Time, 0) + " min" + Environment.NewLine +
Math.Round(road.Distance, 2) + "m", Color.White, Color.Black);
}
}
foreach (Node node in network.Nodes)
{
Color.Black, node, true, 50);
    args.Display.DrawDot(node,
node.Connections.Count.ToString());
}
#endregion
#region MENU
public override bool AppendMenuItems(ToolStripDropDown menu)
{
    GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    this.Menu_AppendPreviewItem(menu);
    this.Menu_AppendEnableItem(menu);
    this.Menu_AppendBakeItem(menu);
    this.Menu_AppendWarningsAndErrors(menu);
    GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    this.AppendAdditionalMenuItems(menu);
    this.Menu_AppendObjectHelp(menu);
    return true;
}
protected override void
AppendAdditionalComponentMenuItems(ToolStripDropDown menu)
{
    GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    ToolStripMenuItem toolStripMenuItem0 =
    GH_DocumentObject.Menu_AppendItem((ToolStrip)menu, "time/distance",
    new EventHandler(this.PreviewChange), true, this.m_previewValue);
    toolStripMenuItem0.ToolTipText = "Time and distance preview";
    // + Environment.NewLine + "If thickness is more than 0,
    // then create tube profile";
}
private void PreviewChange(object sender, EventArgs e)
{
    this.m_previewValue = !this.m_previewValue;
    this.RecordUndoEvent("time/distance");
}
        this.ExpireSolution(true);
    }
    #endregion
}
Graph Analysis Tool

```csharp
using System;
using System.Collections.Generic;
using Grasshopper.Kernel;
using Rhino.Geometry;
using Tool.Data.Graph;
using System.Windows.Forms;

namespace Tool.Components
{
    public class Graph_Comp : GH_Component
    {
        /// <summary>
        /// Initializes a new instance of the Graph_Comp class.
        /// </summary>
        public Graph_Comp()
        {
            // Initialize the component.
        }

        /// <summary>
        /// Registers all the input parameters for this component.
        /// </summary>
        protected override void RegisterInputParams(GH_Component.GH_InputParamManager pManager)
        {
            pManager.AddCurveParameter("Network", "N", "Splitted segments of road network", GH_ParamAccess.list);
        }

        /// <summary>
        /// Registers all the output parameters for this component.
        /// </summary>
        protected override void RegisterOutputParams(GH_Component.GH_OutputParamManager pManager)
        {
            // Register output parameters.
        }

        /// <summary>
        /// This is the method that actually does the work.
        /// </summary>
        protected override void SolveInstance(IGH_DataAccess DA)
        {
            List<Curve> crvs = new List<Curve>();
            if (!DA.GetDataList<Curve>(0, crvs))
                return;
        }
    }
}
```
Graph network = new Graph(crvs.Count);
foreach (Curve crv in crvs)
{
    network.Add(new GraphRoad(crv));
}

DA.SetData(0, new Graph_Goo(network));

/// <summary>
/// Provides an Icon for the component.
/// </summary>
protected override System.Drawing.Bitmap Icon
{
    get
    {
        return Tool.Properties.Resources.graph_24;
    }
}

/// <summary>
/// Gets the unique ID for this component. Do not change this ID after release.
/// </summary>
public override Guid ComponentGuid
{
    get { return new Guid("7b48bc01-5e57-4782-be26-1b8f9892188c"); }
}

public override GH_Exposure Exposure
{
    get { return GH_Exposure.secondary; }
}

#region MENU
public override bool AppendMenuItems(ToolStripDropDown menu)
{
    GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    this.Menu_AppendPreviewItem(menu);
    this.Menu_AppendEnableItem(menu);
    this.Menu_AppendWarningsAndErrors(menu);
    GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    //this.AppendAdditionalMenuItems(menu);
    this.Menu_AppendObjectHelp(menu);
    return true;
}
#endregion
Openness Analysis Tool

```csharp
using System;
using System.Collections.Generic;
using Grasshopper.Kernel;
using Rhino.Geometry;
using Tool_Data.Openness;
using System.Drawing;
using Grasshopper.Kernel.

namespace Tool.Components
{
    public class Openness_Comp : GH_Component
    {
        /// <summary>
        /// Initializes a new instance of the Openness_Comp class.
        /// </summary>
        public Openness_Comp()
        {
            base("Openness", "Openness",
                "Spatial openness analysis" + Toolbox Mark,
                "iA_toolbox", "Tools"
            );
        }

        private List<Area.Node> m_area_nodes = new
        List<Area.Node>();
        private List<Area> m_areas = new List<Area>();

        /// <summary>
        /// Registers all the input parameters for this component.
        /// </summary>
        protected override void
        RegisterInputParams(GH_Component.GH_InputParamManager pManager)
        {
            pManager.AddCurveParameter("Borders", "A", "Area
            borders", GH_ParamAccess.list);
            pManager.AddPointParameter("Point", "P", "Observation
            points", GH_ParamAccess.list);
            pManager.AddBrepParameter("Buildings", "B", "Buildings'
            envelopes", GH_ParamAccess.list);
            pManager.AddNumberParameter("Mesh", "M", "Mesh
            accuracy", GH_ParamAccess.item);
            pManager.AddNumberParameter("Distance", "D", "Limitation
            of analytical distance", GH_ParamAccess.item);
            pManager.AddIntegerParameter("Rays", "R", "Count of
            analytical rays", GH_ParamAccess.item);
        }

        /// <summary>
        /// Registers all the output parameters for this component.
        /// </summary>
        protected override void
        RegisterOutputParams(GH_Component.GH_OutputParamManager pManager)
        {
```
/// <summary>
/// This is the method that actually does the work.
/// </summary>
/// <param name="DA">The DA object is used to retrieve from inputs and store in outputs.</param>
protected override void SolveInstance(IGH_DataAccess DA) {
    List<Curve> crvs = new List<Curve>();
    if (!DA.GetDataList(0, crvs))
        return;
    List<Brep> breps = new List<Brep>();
    if (!DA.GetDataList<Brep>(1, breps))
        return;
    double edge_length = 300;
    DA.GetData(2, ref edge_length);
    double distance = 300;
    DA.GetData(3, ref distance);
    int ray_count = 12;
    DA.GetData(4, ref ray_count);
    this.m_areas = new List<Area>();
    foreach (Curve crv in crvs) {
        if (!crv.IsClosed || !crv.IsPlanar())
            this.AddRuntimeMessage(GH_RuntimeMessageLevel.Warning, "Border is not closed or not planar");
            //return;
    }
    m_areas.Add(new Area(crv, edge_length, distance, ray_count));

    //List<Point3d> points = new List<Point3d>();
    //if (!DA.GetDataList(0, points))
    //    return;
    List<Obstacle> obstacles = new List<Obstacle>(breps.Count);
    for (int i = 0; i < breps.Count; i++) {
        obstacles = new List<Obstacle>(breps.Count);
        for (int i = 0; i < breps.Count; i++) {
obstacles.Add(new Obstacle(breps[i], i));
}
//List<Point3d> intersections = new List<Point3d>();
for(int i = 0; i < m_areas.Count; i++)
{
    //intersections.AddRange(
        m_areas[i].AnalyseArea(obstacles);
}
//List<Line> lines = new List<Line>();
//this.m_area_nodes = new List<Area_Node>();
//foreach (Point3d point in points)
///
//    Area_Node node = new Area_Node(point,
distance,ray_count);
//    node.AnalyseRays(obstacles);
//    intersections.AddRange(node.GetIntersections());
///
//} List<Mesh> meshes = new List<Mesh>();
foreach (Area area in m_areas)
{
    meshes.AddRange(area.Geometry);
}
DA.SetDataList(0, meshes);
//DA.SetDataList(1, intersections);
/// <summary>
/// Provides an Icon for the component.
/// </summary>
protected override System.Drawing.Bitmap Icon
{
    get
    {
        return Tool.Properties.Resources.openness_24;
    }
}

public override GH_Exposure Exposure
{
    get { return GH_Exposure.tertiary; } // secondary; }
}
/// <summary>
/// Gets the unique ID for this component. Do not change
this ID after release.
/// </summary>
public override Guid ComponentGuid
{
    get { return new
public override void CollectData()
{
    base.CollectData();
    this.m_area_nodes.Clear();
}

#region PREVIEW
public override void DrawViewportWires(IGH_PreviewArgs args)
{
    base.DrawViewportWires(args);
    if (m_areas != null && m_areas.Count > 0)
    {
        for (int i = 0; i < m_areas.Count; i++)
        {
            if (m_areas[i].IsValid())
            {
                args.Display.DrawDot(m_areas[i].Centroid, m_areas[i].Average.ToString(), m_areas[i].Color, m_areas[i].Average > 0.5 ? Color.Black : Color.White);
            }
        }
    }
#endregion
Road Splitting Computation

```csharp
using System;
using System.Collections.Generic;

using Grasshopper.Kernel;
using Rhino.Geometry;
using Tool.Algorithm;
using System.Windows.Forms;
using Tool.Data.Visual;

namespace Tool.Components
{
    public class RoadSplitting_Comp : GH_Component
    {
        /// <summary>
        /// Initializes a new instance of the RoadSplitting_Comp
        /// </summary>
        public RoadSplitting_Comp()
        {
            base("Splitting Curves", "Splitting",
            "Splits curves at intersection points"
            + Environment.NewLine + "and subdivides curves into segments" +
            Toolbox.Mark, "IA_toolbox", "Tools"
            );
        }

        /// <summary>
        /// Registers all the input parameters for this component.
        /// </summary>
        protected override void RegisterInputParams(GH_Component.GH_InputParamManager pManager)
        {
            pManager.AddCurveParameter("Curve", "C", "Road network geometry", GH_ParamAccess.list);
            pManager.AddNumberParameter("Length", "L", "Maximum road segment length [m]", GH_ParamAccess.item); // Space.Units,
            pManager[1].Optional = true;
        }

        /// <summary>
        /// Registers all the output parameters for this component.
        /// </summary>
        protected override void RegisterOutputParams(GH_Component.GH_OutputParamManager pManager)
        {
            pManager.AddCurveParameter("Network", "N", "Splitted segments of road network", GH_ParamAccess.list);
        }

        /// <summary>
        /// This is the method that actually does the work.
        /// </summary>
        /// <param name="DA">The DA object is used to retrieve from
inputs and store in outputs.</param>
protected override void SolveInstance(IGH_DataAccess DA)
{
    //this.Params.Input[1].Description = "Maximum road
    segment length" + Space.Units;
    //this.m_attributes.ExpireLayout();
    //Grasshopper.Instances.InvalidateCanvas();
    //this.Attributes.ToolTipEnabled = true;
    this.Attributes.PerformLayout();
    List<Curve> inputCurves = new List<Curve>();
    if (!DA.GetDataList<Curve>(0, inputCurves))
        return;
 }

List<Curve> outputCurves = RoadGeometry.SplitIntersectedCurves(inputCurves);
  double roadSegment_Size = 1000;
  if (DA.GetData(1, ref roadSegment_Size))
    outputCurves = RoadGeometry.SplitBySize(outputCurves, roadSegment_Size);

DA.SetDataList(0, outputCurves);
}

/// <summary>
/// Provides an Icon for the component.
/// </summary>
protected override System.Drawing.Bitmap Icon
{
    get
    {
        return Tool.Properties.Resources.splitting_24;
    }
}

/// <summary>
/// Gets the unique ID for this component. Do not change
/// this ID after release.
/// </summary>
public override Guid ComponentGuid
{
    get { return new Guid("685caa2b-1739-4823-80b6-d74b8084436"); }
}

public override GH_Exposure Exposure
{
    get { return GH_Exposure.secondary; } // .secondary; }
}

#region MENU
public override bool AppendMenuItems(ToolStripDropDown menu)
{  
    GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    this.Menu_AppendPreviewItem(menu);
    this.Menu_AppendEnableItem(menu);
    this.Menu_AppendWarningsAndErrors(menu);
    GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    //this.AppendAdditionalMenuItems(menu);
    this.Menu_AppendObjectHelp(menu);
    return true;
}
#endregion
Road Visibility Analysis Tool

```csharp
using System;
using System.Collections.Generic;

using Grasshopper.Kernel;
using Rhino.Geometry;
using Tool.Data.Visual;
using Grasshopper.GUI.Gradient;
using System.Drawing;
using System.Windows.Forms;
using Rhino.DocObjects;
using Rhino;

namespace Tool.Components
{
    public class RoadVisibility_Comp : GH_Component //,
    IO滥用AwareObject
    {
        private List<Building> buildings = new List<Building>();
        private List<Road> roads = new List<Road>();
        private GH.Gradient gradient = new GH.Gradient();
        private bool _filter = false;
        private bool _envelopeFilter = true;
        private bool _node_result = false;
        private int actual = -1;

        /// <summary>
        /// Initializes a new instance of the RoadVisibility_Comp
        /// class.
        /// </summary>
        public RoadVisibility_Comp()
        : base("Network Visibility", "Visibility(N)",
             "Network Visibility" + Toolbox.Mark,
             "IA Toolbox", "Tools")
        {
        }

        public override bool Write(GH_IO.Serialization.GH_IWriter writer)
        {
            writer.SetBool("envelope_filter",
                          this.m_node_result);
            return base.Write(writer);
        }

        public override bool Read(GH_IO.Serialization.GH_IReader reader)
        {
            this.m_node_result =
            reader.GetBool("envelope_filter");
            return base.Read(reader);
        }

        /// <summary>
        /// Registers all the input parameters for this component.
        /// </summary>
    }
```
/// </summary>
protected override void
RegisterInputParams(GH_Component.GH_InputParamManager pManager)
{
pManager.AddParameter(new Space_Param());
pManager.AddIntegerParameter("ID", "I", "Analysis of a
double building by index value", GH_ParamAccess.item);
pManager[1].Optional = true;
}

/// <summary>
/// Registers all the output parameters for this component.
/// </summary>
protected override void
RegisterOutputParams(GH_Component.GH_OutputParamManager pManager)
{
}

/// <summary>
/// This is the method that actually does the work.
/// </summary>
/// <param name="DA">The DA object is used to retrieve from
inputs and store in outputs.</param>
protected override void SolveInstance(IGH_DataAccess DA)
{
    Space_Goo results = new Space_Goo();
    if (!DA.GetData(0, ref results))
        return;
    this.buildings = results.Buildings;
    //this.roads = results.Roads;
    gradient = results.Gradient;
    this.roads.Clear();
    foreach (Road road in results.Roads)
        this.roads.Add(road);

    int envelope_id = 0;
    //if (m_envelopeFilter)
    {{
        m_filter = DA.GetData<int>(1, ref envelope_id);
        if (m_filter) { m_envelopeFilter = true; } else
            { m_envelopeFilter = false; }
        this.actual = envelope_id;
        if (m_filter && envelope_id >= results.Buildings.Count - 1 || envelope_id < 0)
            { this.AddRuntimeMessage(GH_RuntimeMessageLevel.Warning, "Building " +
envelope_id + " don't exist");
              m_filter = false;
            //m_envelopeFilter = false;
    }
}
foreach (Road road in this.roads)
{
    road.ResetValue();
}
Space.MaxRoadInit_value = 0;
if (!m_filter)
{
    foreach (Building building in buildings)
    {
        foreach (BuildingNode node in building.Nodes)
        {
            foreach (int id in node.VisibleRoads)
            {
                if (m_node_result)
                {
                    this.roads[id].AddValue(node.ViewValue);
                }
                else
                {
                    this.roads[id].AddBuilding(node.Building_ID);
                }
            }
        }
    }
}
this.gradient = Space.RecalculateGradient_dynamicRoad();
else
{
    foreach (BuildingNode node in buildings[envelope_id].Nodes)
    {
        foreach (int id in node.VisibleRoads)
        {
            this.roads[id].isVisible = true;
        }
    }
}
#endregion COMPONENT SETUP

public override bool IsBakeCapable
{
    get
    {
        return true;
public override void BakeGeometry(RhinoDoc doc, List<Guid> obj_ids)
{
    ObjectAttributes att = Rhino.RhinoDoc.ActiveDoc.CreateDefaultAttributes();
    att.ColorSource = ObjectColorSource.ColorFromObject;
    this.BakeGeometry(doc, att, obj_ids);
}

public override void BakeGeometry(RhinoDoc doc, ObjectAttributes att, List<Guid> obj_ids)
{
    att.ColorSource = ObjectColorSource.ColorFromObject;
    att.PlotColorSource = ObjectPlotColorSource.PlotColorFromObject;
    if (roads != null && roads.Count > 0)
    {
        foreach (Road road in roads)
        {
            //IF ENVELOPE IS SELECTED - ANALYSE CUSTOM BUILDING
            if (m_envelopeFilter && m_filter)
            {
                if (road.isVisible)
                {
                    ObjectAttributes atributes = new ObjectAttributes();
                    att.PlotColor = Color.White;
                    att.ObjectColor = Color.White;
                    doc.Objects.AddCurve(road.Geometry, att);
                }
                else
                {
                    ObjectAttributes atributes = new ObjectAttributes();
                    att.PlotColor = Color.Black;
                    att.ObjectColor = Color.Black;
                    doc.Objects.AddCurve(road.Geometry, att);
                }
            } //FULL ANALYTICAL RESULT - SEE MOST BUILDING LOGIC
            else
            {
                if (m_node_result)
                {
                    ObjectAttributes atributes = new ObjectAttributes();
                    att.PlotColor =
gradient.ColourAt(road.Values.Count);
att.ObjectColor =
gradient.ColourAt(road.Values.Count);
    doc.Objects.AddCurve(road.Geometry, att);
} else
{
    //ObjectAttributes attributes = new
    att.PlotColor =
    gradient.ColourAt(road.VisibleBuildings.Count);
    att.ObjectColor =
    gradient.ColourAt(road.VisibleBuildings.Count);
    doc.Objects.AddCurve(road.Geometry, att);
}

/// <summary>
/// Provides an Icon for the component.
/// </summary>
protected override System.Drawing.Bitmap Icon
{
    get
    {
        return Tool.Properties.Resources.road_visibility_24;
    }
}

public override bool IsPreviewCapable
{
    get
    {
        return true;
    }
}

public override GH_Exposure Exposure
{
    get
    {
        return GH_Exposure.tertiary; } // secondary;
    
}

/// <summary>
/// Gets the unique ID for this component. Do not change this ID after release. 
/// </summary>
public override Guid ComponentGuid
{
    get
    {
        return new Guid("{b0d0e9a-0910-422c-9eb6-d60956971b7}"");
    }
}
private void RoadDistribution(object sender, EventArgs e)
{
    if (!m_road_distribution)
    {
        // distribution and preview
        Print("Road distribution calculating...");
        foreach (Building building in buildings)
        {
            foreach (BuildingNode node in building.Notes)
            {
                foreach (int id in node.VisibleRoads)
                {
                    this.roads[id].AddValue(node.ViewValue);
                }
            }
        }
        // preview values of the roads' segments
        m_road_distribution = true;
        this.ExpirePreview(true);
    }
    else
    {
        // disable preview of the roads' segments
        m_road_distribution = false;
        this.ExpirePreview(true);
    }
}

public override void ClearData()
{
    base.ClearData();
    if (roads != null)
    {
        foreach (Road road in roads)
        {
            road.Geometry.Dispose();
        }
        roads.Clear();
    }
    #endregion
    #region PREVIEW

    // public override BoundingBox ClippingBox
    //{
    //    get
    //    {
    //        BoundingBox bb = base.ClippingBox;
    //        if (roads.Count > 0)
    //        {
    

foreach (Road road in roads)
{
    bb.Union(road.Geometry.GetBoundingBox(false));
}
return bb;

public override void DrawViewportWires(IGH_PreviewArgs args)
{
    base.DrawViewportWires(args);
    //COLORIZE ROAD SEGMENTS
    if (roads != null && roads.Count > 0)
    {
        foreach (Road road in roads)
        {
            // IF ENVELOPE IS SELECTED - ANALYSE CUSTOM BUILDING
            if (m_envelopeFilter && m_filter)
            {
                if (road.isVisible)
                {
                    args.Display.DrawCurve(road.Geometry,
                        Color.White, 5);
                }
                else
                {
                    args.Display.DrawCurve(road.Geometry,
                        Color.Black, 5);
                }
            }
            // FULL ANALYTICAL RESULT - SEE MOST BUILDING LOGIC
            else
            {
                // Color.Red, Color.White);
                if (m_node_result)
                {
                    args.Display.DrawCurve(road.Geometry,
                        gradient.ColourAt(road.Values.Count), 5);
                }
                else
                {
                    args.Display.DrawCurve(road.Geometry,
                        gradient.ColourAt(road.VisibleBuildings.Count), 5);
                }
            }
        }
    }
    // ELSE IF (ROAD DISTANCE != DOUBLE.POSITIVE_INFINITY)
    elseif (road.Distance != double.PositiveInfinity)
    {
        //
        // Color colour =
        //
        args.Display.Draw2dText(road.Distance.ToString(), Color.White,
            road.Center, true, 10);
// args.Display.DrawCurve(road.Geometry, colour, 5);
// if (this.m_previewValue)
// args.Display.Draw2dText(Math.Round(road.Distance, 2).ToString(),
Color.White, road.Center, true, 10);

// PREVIE BUILDING INDEXES
if (roads.Count > 0 && m_envelopeFilter)
{
    foreach (Building building in buildings)
    {
        if (building.ID == this.actual)
        {
            args.Display.DrawDot(building.infoPoint,
building.ID.ToString(), Color.Black, Color.White);
        }
        else
        {
            args.Display.DrawDot(building.infoPoint,
building.ID.ToString(), Color.White, Color.Black);
        }
    }
}
#endregion
#region MENU
public override bool AppendMenuItems(ToolStripDropDown menu)
{
    GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    this.Menu_AppendPreviewItem(menu);
    this.Menu_AppendEnableItem(menu);
    this.Menu_AppendBakeItem(menu);
    this.Menu_AppendWarningsAndErrors(menu);
    GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    this.AppendAdditionalMenuItems(menu);
    this.Menu_AppendObjectHelp(menu);
    return true;
}
#endif
protected override void
AppendAdditionalComponentMenuItems(ToolStripDropDown menu)
{
    // GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
    // ToolStripMenuItem toolStripMenuItem =
    GH_DocumentObject.Menu_AppendItem((ToolStrip)menu, "Envelope filter", new EventHandler(this.PreviewChange), true, this.m_envelopeFilter);
// toolStripMenuItem1.ToolTipText = "Rectangle cross section profile for Donkey." + Environment.NewLine + "If thickness is more than 0, then create tube profile";

GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);
ToolStripMenuItem toolStripMenuItem1 = GH_DocumentObject.Menu_AppendItem((ToolStrip)menu, "Building facade", new EventHandler(this.PreviewChange), true, this.m_node_result);
toolStripMenuItem1.ToolTipText = "Visible area of building facades" + Environment.NewLine + "if unchecked, then shows amount of visible buildings";
}

private void PreviewChange(object sender, EventArgs e)
{
    switch (sender.ToString())
    {
        //case "Envelope filter":
        //    RecordUndoEvent("Enveloper filter");
        //    m_envelopeFilter = !m_envelopeFilter;
        //    break;
        case "Building facade":
            RecordUndoEvent("Building facade");
            m_node_result = !m_node_result;
            break;
    }
    //this.RecordUndoEvent("ChangePreviewMode");
    this.ExpireSolution(true);
    #endregion
}
Visibility Analysis Tool

using System;
using System.Collections.Generic;

using Grasshopper.Kernel;
using Rhino.Geometry;
using Grasshopper.GUI.Gui3d;
using System.Drawing;
using Tool.DrawingView;
using System.Windows.Forms;
using System.Diagnostics;

namespace Tool.Components
{
    public class Visibility_Comp : GH_Component
    {
        #region FIELD
        bool m_angle_limitation = true;
        bool m_angle_influence = true;
        bool m_distance_influence = true;
        bool m_precise_result = false;
        bool m_point_calculation = true;
        bool m_direction_limitation = true;
        bool m_one_direction = false;
        bool m_void = false;
        bool m_developePrint = false;

        Stopwatch timer = new Stopwatch();
        Stopwatch timer_1 = new Stopwatch();

        private List<Building> buildings = new List<Building>();
        #endregion
        #region OVERRIDE
        // <summary>
        /// Initializes a new instance of the Visual_Comp class.
        /// </summary>
        public Visibility_Comp()
        : base("Visibility", "Visibility",
            "Visibility analysis" + Toolbox.Mark, "iA_toolbox", "Tools")
        {
        }

        public override bool Write(IGH_IO.Serialization.GH_IWriter writer)
        {
            writer.SetBoolean("angle_influence",
            this.m_angle_influence);
            writer.SetBoolean("angle_limitation",
            this.m_angle_limitation);
            writer.SetBoolean("distance_influence",
            this.m_distance_influence);
            writer.SetBoolean("prezi_result",
            this.m_precise_result);
            return true;
        }
        #endregion
    }
}

return base.Write(writer);
}

public override bool Read(GH_IO.Serialization.GH_IReader reader)
{
    this.m_angle_influence = reader.GetBoolean("angle_influence");
    this.m_angle_limitation = reader.GetBoolean("angle_limitation");
    this.m_distance_influence = reader.GetBoolean("distance_influence");
    this.m_precise_result = reader.GetBoolean("presize_result");
    return base.Read(reader);
}

/// <summary>
/// Registers all the input parameters for this component.
/// </summary>
protected override void RegisterInputParams(GH_Component.GH_InputParamManager pManager)
{
    pManager.AddCurveParameter("Network", "N", "Splitted segments of road network +Environment.NewLine+"segment middle point as viewpoint", GH_ParamAccess.list);
    pManager.AddBrepParameter("Buildings", "B", "Buildings (as list of BReps)", GH_ParamAccess.list);
    pManager.AddParameter("Mesh accuracy", "M", "Building mesh face edge length [m] + Environment.NewLine+(longer edge = less calculation time)", GH_ParamAccess.item, 100000);
    pManager.AddParameter("Terrain", "T", "Terrain or Buildings (as list of meshes)", GH_ParamAccess.list);
    pManager.AddParameter("Distance", "D", "View distance limit", GH_ParamAccess.item);
    pManager[1].Optional = true;
    pManager.HideParameter(1);
    pManager[2].Optional = true;
    pManager[3].Optional = true;
    pManager.HideParameter(3);
    pManager[4].Optional = true;
    //pManager.AddParameter("ID", "I", "Index of analysed building", GH_ParamAccess.item, -1);
    //pManager[5].Phase = GH_SolutionPhase.Collected;
    pManager.AddParameter("Angle", "A", "View angle limit [max 360]", GH_ParamAccess.item);
    pManager[5].Optional = true;
}

/// <summary>
/// Registers all the output parameters for this component.
/// </summary>
protected override void RegisterOutputParams(GH_Component.GH_OutputParamManager pManager)
{  
    pManager.AddParameter(new Space_Param());  
    pManager.AddMeshParameter("Mesh", "M", "Colored mesh",  
        GH_ParamAccess.list);  
    //pManager.AddVectorParameter("V", "V", "V",  
        GH_ParamAccess.list);  
}  

//public override void CollectData()  
//{  
//    if (Params.Input[5].Phase == GH_SolutionPhase.Blank)  
//        Print("Blank data");  
//    if (Params.Input[5].Phase ==  
//        GH_SolutionPhase.Colleced)  
//        Print("Collected");  
//    if (Params.Input[5].Phase == GH_SolutionPhase.Failed)  
//        Print("Failed");  
//        base.CollectData();  
//}  

/// <summary>  
/// This is the method that actually does the work.  
/// </summary>  
/// <param name="DA">The DA object is used to retrieve from  
inputs and store in outputs.</param>  
protected override void SolveInstance(IGH_DataAccess DA)  
{
    //READ INPUT PARAM
    if (m_angle_influence)  
        {this.Message = "Pedestrian";}else{this.Message = "";}
    Space.Angle_Influence = m_angle_influence;  
    Space.Angle_Limitation = m_angle_limitation;  
    Space.Distance_Influence = m_distance_influence;  
    Space.Presize_Result = m_precise_result;  
    Space.Point_Calculation = m_point_calculation;  
    Space.Direction_Limitation = m_direction_limitation;  
    Space.OneDirection = m_one_direction;  
    Space.WhiteVoid = m_white_void;  
    double direction_angle_limitation = 180;  
    if (DA.GetData(5, ref direction_angle_limitation))  
    {  
        Space.Direction_Limitation = true;  
        Space.Angle_Limitation = true;  
        //m_angle_limitation = true;  
        Space.Direction_Angle_Limitation =  
            direction_angle_limitation;  
    }  
    else  
    {  
        Space.Direction_Limitation = false;  
    }  
}
Space.Angle_Limitation = false;
//m_angle_limitation = false;
}

List<Curve> crvs = new List<Curve>();
if (!DA.GetDataList<Curve>(0, crvs))
    return;
List<Brep> breps = new List<Brep>();
bool breps_loaded = DA.GetDataList<Brep>(1, breps);
List<Mesh> terrain = new List<Mesh>();
bool meshes_loaded = DA.GetDataList(3, terrain);
if (!breps_loaded && !meshes_loaded)
{
    this.AddRuntimeMessage(GH_RuntimeMessageLevel.Warning, "Buildings are missing!");
    return;
}

//Space.Buildings = breps;
if (Space.Point_Calculation)
{
    Space.RoadLenghtSum = crvs.Count;
}
else
{
    double lengthSum = 0;
    for (int i = 0; i < crvs.Count; i++)
    {
        lengthSum += crvs[i].GetLength();
    }
    Space.RoadLenghtSum = lengthSum;
}

//double edge = 10.0;
DA.GetData(2, ref Space.EdgeLenght);
//MeshingParameters param = new MeshingParameters();
//param.MinimumEdgeLength = edge;
//param.MaximumEdgeLength = edge;
Space.ViewLimit = DA.GetData(4, ref Space.ViewDistance);

// READ ALL BUILDING ENVELOPES
buildings = new List<Building>();
if (m_developePrint)
    Print("////////////////////////");
if(m_developePrint)
    timer.Start();
if (breps_loaded)
{
for (int b = 0; b < breps.Count; b++)
{
    buildings.Add(new Building(breps[b], b));
}

if (meshes_loaded)
{
    for (int m = 0; m < terrain.Count; m++)
    {
        buildings.Add(new Building(terrain[m]));
    }
}
Space.maxView_value = 1;
if (m_developePrint)
{
    timer.Stop();
    Print("ALL BUILDINGS’ ENVELOPES INITALIZATION: " +
    timer.ElapsedMilliseconds + " ms");
    timer.Reset();
    timer.Start();
}

// ANALYSE AND READ ALL VIEWPOINTS FROM ROADS
List<Road> roads = new List<Road>();
for (int c = 0; c < crvs.Count; c++)
{
    if(crvs.Count > 1)
        Print("Calculation :" + (Math.Round((double)
    c / (crvs.Count-1)), 2) * 100) + "%";
    //timer_1.Start();
    Road road = new Road(crvs[c], c);
    //timer_1.Stop();
    if (GH_Document.IsEscapeKeyDown())
    {
        Print("Calculation was aborted!");
        //DA.SetData(0, null);
        //ClearData();
        DA.DisableGapLogic();
        //this.ClearData();
        //this.Locked = false;
        this.AddRuntimeMessage(GH_RuntimeMessageLevel.Error, "Calculation was aborted!");
        //GH_Document doc = OnPingDocument();
        //if (doc != null)
        //    doc.RequestAbortSolution();
        //Grasshopper.Instances.InvalidateCanvas();
        return;
    }
    road.AnalysisVisibility(buildings);
    roads.Add(road);
if(m_developePrint)
    Print(".roads initialization: "+timer_1.ElapsedMilliseconds+" ms");

Space.RecalculateGradient_dynamic();
this.Message = Space.MaxValueRatio() + " %";
//Space.RecalculateGradient_fix();

if (m_developePrint)
{
    Road.PreviewTimers();
    timer.Stop();
    Print("ANALYSE AND READ ALL VIEWPOINTS FROM ROADS: "+timer.ElapsedMilliseconds + " ms");
    timer.Reset();
    timer.Start();
}
List<Mesh> meshes = new List<Mesh>();
for (int b = 0; b < buildings.Count; b++)
{
    //buildings[b].ColorMeshFaces();
    //meshes.AddRange(buildings[b].Faces_Mesh);
    //buildings[b].ColorMeshVertexes();
    buildings[b].ColorMesh();
    meshes.AddRange(buildings[b].Preview_Mesh);
}
if (m_developePrint)
{
    timer.Stop();
    Print("DRAW MESH: "+timer.ElapsedMilliseconds + " ms");
    timer.Reset();
}
Print("Calculation completed.");
//this.Locked = false;
DA.SetData(0, new Space_Goo(buildings, roads, Space.Gradient));
if(meshes != null)
    DA.SetDataList(1, meshes);

/// <summary>
/// Provides an Icon for the component.
/// </summary>
protected override System.Drawing.Bitmap Icon
{
    get
    {    

return Tool.Properties.Resources.visibility_24;
}

public override GH_Exposure Exposure
{
    get { return GH_Exposure.tertiary; } //secondary; }
}

/// <summary>
/// Gets the unique ID for this component. Do not change
this ID after release.
/// </summary>
public override Guid ComponentGuid
{
    get { return new Guid("d48c7eb7-a34b-44d4-bdc1-3cc409c51e7b"); }
}

public override void ClearData()
{
    base.ClearData();
    //if (buildings != null || buildings.Count > 0)
    //{
    //    foreach (Building building in buildings)
    //    { 
    //        building.Dispose(); 
    //    }
    //    buildings.Clear();
    //}
}

private void Print(string message)
{
    Rhino.RhinoApp.WriteLine(message);
}

#region MENU
public override bool AppendMenuItems(ToolStripDropDown menu)
{
    GH_DocumentObject.Menu_AppendSeparator(menu);
    this.Menu_AppendPreviewItem(menu);
    this.Menu_AppendEnableItem(menu);
    this.Menu_AppendWarningsAndErrors(menu);
    GH_DocumentObject.Menu_AppendSeparator(menu);
    this.AppendAdditionalMenuItems(menu);
    this.Menu_AppendObjectHelp(menu);
    return true;
}

protected override void AppendAdditionalComponentMenuItems(ToolStripDropDown menu)
{
}
GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);

ToolMenuStripMenuItem toolStripMenuItem0 = GH_DocumentObject.Menu_AppendItem((ToolStrip)menu, "Angle to srf", new EventHandler(this.PreviewChange), true, this.m_angle_influence);
toolStripMenuItem0.ToolTipText = "Angle to facade surface as additional constrain."; // + Environment.NewLine + "If thickness is more that 0, then create tube profile";

ToolStripMenuItem toolStripMenuItem1 = GH_DocumentObject.Menu_AppendMenuItem((ToolStrip)menu, "Angle limitation", new EventHandler(this.PreviewChange), true, this.m_angle_limitation);
toolStripMenuItem1.ToolTipText = "Rectangle cross section profile for Donkey." + Environment.NewLine + "If thickness is more that 0, then create tube profile";

ToolStripMenuItem toolStripMenuItem2 = GH_DocumentObject.Menu_AppendItem((ToolStrip)menu, "Distance to srf", new EventHandler(this.PreviewChange), true, this.m_distance_influence);
toolStripMenuItem2.ToolTipText = "Distance to facade surface as additional constrain."; // + Environment.NewLine + "If thickness is more that 0, then create tube profile";

ToolStripMenuItem toolStripMenuItem3 = GH_DocumentObject.Menu_AppendMenuItem((ToolStrip)menu, "Direction limitation", new EventHandler(this.PreviewChange), true, this.m_direction_limitation);
toolStripMenuItem3.ToolTipText = "Rectangle cross section profile for Donkey." + Environment.NewLine + "If thickness is more that 0, then create tube profile";

ToolStripMenuItem toolStripMenuItem4 = GH_DocumentObject.Menu_AppendMenuItem((ToolStrip)menu, "One direction", new EventHandler(this.PreviewChange), true, this.m_one_direction);
toolStripMenuItem4.ToolTipText = "One way viewing direction.";

ToolStripMenuItem toolStripMenuItem5 = GH_DocumentObject.Menu_AppendSeparator((ToolStrip)menu);

ToolStripMenuItem toolStripMenuItem6 = GH_DocumentObject.Menu_AppendItem((ToolStrip)menu, "Complex shapes", new EventHandler(this.PreviewChange), true, this.m_precise_result);
toolStripMenuItem6.ToolTipText = "Complex shape analysis" + Environment.NewLine + "(mode accurate results)";

ToolStripMenuItem toolStripMenuItem7 = GH_DocumentObject.Menu_AppendMenuItem((ToolStrip)menu, "Viewpoints result", new EventHandler(this.PreviewChange), true, this.m_point_calculation);
toolStripMenuItem7.ToolTipText = "Rectangular cross section profile for Donkey." + Environment.NewLine + "If thickness is more that 0, then create tube profile";

ToolStripMenuItem toolStripMenuItem8 = GH_DocumentObject.Menu_AppendMenuItem((ToolStrip)menu, "Gradient v2", new EventHandler(this.PreviewChange), true, this.m_weight_void);
toolStripMenuItem8.ToolTipText = "Change to different gradient color"; // + Environment.NewLine + "If thickness is more that 0, then create tube profile";
private void PreviewChange(object sender, EventArgs e) {
    switch (sender.ToString()) {
    case "Angle to srf":
        this.RecordUndoEvent("a");
        this.m_angle_influence = !m_angle_influence;
        break;
    case "Distance to srf":
        this.RecordUndoEvent("b");
        this.m_distance_influence = !m_distance_influence;
        break;
    case "Complex shapes":
        this.RecordUndoEvent("c");
        this.m_precise_result = !m_precise_result;
        break;
    case "Viewpoints result":
        this.RecordUndoEvent("d");
        this.m_point_calculation = !m_point_calculation;
        break;
    case "Direction limitation":
        this.RecordUndoEvent("e");
        this.m_direction_limitation = !m_direction_limitation;
        break;
    case "One direction":
        this.RecordUndoEvent("f");
        this.m_one_direction = !m_one_direction;
        break;
    case "Gradient v2":
        this.RecordUndoEvent("g");
        this.m_wite_void = !m_wite_void;
        break;
    }
    this.ExpireSolution(true);
}


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<tr>
<th>Number</th>
<th>Author(s)</th>
<th>Title and Details</th>
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[59] Ahmed Khan, Frank Moulaert, Jan Schreurs, and Konrad Mi-


Bibliography


Bibliography


