POST-OCCUPANCY EVALUATION FOR LIVEABILITY IN URBAN DISTRICTS

MASTER THESIS PROJECT REPORT

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This research is conducted to pursue 30 ETCS thesis credits in the Master studies of City and Regional Planning. This is a product of a collaboration between the researcher home institution the University of Stavanger, the receiving institution the Technical University of Denmark where the researcher is a guest student, and Rambøll Denmark as thesis collaboration company.

PREFACE

Among many other things, I learnt about the importance of aesthetics when envisioning a built environment during my bachelor studies in Architecture in the city of Monterrey, Mexico. The curiosity and fascination with design and form took me to Italy, to learn in-depth about the majestic built environment there; the sculptural and decorative details on the buildings, the materials, the colours, the floor plans and the experiences they create. When living in Italy, I experienced for the first time the usage of public transport, walking to places and above all; a great feeling of urban life on the public space: the sounds, the weather, the options for diverse activities, the energy and movement in the meeting places for everyone. This experience of urban life was so contrasting to the one I lived before. This experience entirely changed my perspective on where I wanted to conduct my career interest. After my studies in architecture, I jumped into a master's degree in engineering and construction management, where beyond expanding my technical skills I pursued the opportunity to go abroad again and experience urban life in a completely different context. Then I went to Sweden, where I learned about the advanced sustainable lifestyle, the great connection with nature and the high standard of quality of life and wellbeing. This awakened my interest in the planning practices, and when I went back to my city Monterrey, I started professional practices in urban planning. I learnt about the importance of planning practices and their impact on people. Everything drawn on paper was going to be experienced by people in their daily life. Anyhow, I felt that my knowledge on the topic could be improved to create a greater impact. My interest in sustainability and people-centric urban development lead me to pursue studies in City Planning, with the great intentions of making responsible decisions that impact people lives and the environment positively. With all this, here I am today, writing about how to measure the built environment practices in the topic of liveability. I do believe that people-centric solutions are highly correlated to sustainability and that what is good for the people, and good for the environment, is also good for economic development. My main motivation to pursue knowledge on impact measurement and people-centric solutions is that I believe this enables the possibility to shape better urban environments, as I only want to do good for people in my future daily work.

Copenhagen, DK. 29.06.20

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ABSTRACT

Climate change and depletion of natural resources are global issues that demand a continuous transformation of the built environment. Urban sustainability practices and green building certifications lead the construction, renovations and operations in cities nowadays. These practices pursue optimization, emissions reduction on different systems or efficiency, for instance, the green energy transitions. However, these practices do not necessarily enhance social sustainability aspects such as quality of life, physical, social and cultural well-being. Furthermore, the attention to post-occupancy and operational aspects tend to be neglected in certifications and sustainability practices; as these relate mainly to the plan, design and construction phases. Therefore, it is needed to understand how the qualities that enhance liveability at the urban district's scale can be defined for a local context, and how can these qualities be evaluated to understand liveability performance in urban districts. This research project aims to generate a post-occupancy evaluation tool (POE) to better understand the performance of urban districts interventions regarding a sustainably enhanced liveability. The POE development methodology is based on a comprehensive literature review regarding the concept of liveability and how this can be measured through indicators. The outcome is a holistic list of liveability principles to enhance the liveability performance and a POE framework for assessing the urban districts liveability during operations. Finally, a case study evaluation is conducted to determine the tool scalability.

Key words: liveability, post-occupancy evaluation, urban districts, impact measurement, green building certification,

TERMS AND DEFINITIONS

POE for Liveability at The Urban districts

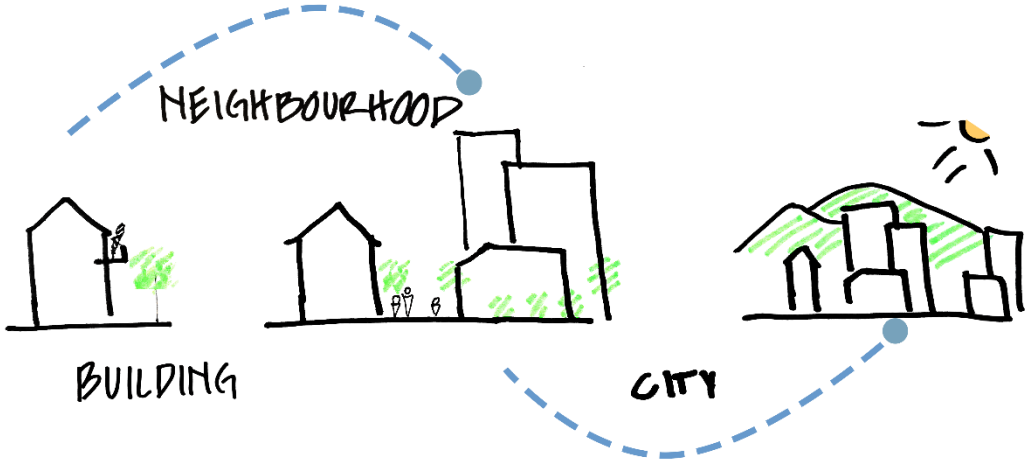


FIGURE 1 - POE URBAN SCALE

POE

Post Occupancy Evaluation is the study of buildings already in use to provide stakeholders with information about performance. It assists in addressing the "gap between designed intentions and the actual outcomes in use" (RIBA, 2016) and provides a fundamental understanding of this performance on its impact on the socio-economic, environmental and cultural implications of the solution. POE can go beyond energy and user satisfaction, to evaluate other intangible issues such as productivity, identity, atmosphere and community.

Liveable City

The term is widely interpreted in different ways. For this research, liveability is how safe, comfortable and enjoyable the city life is (Gehl, 2018). For many urban residents, liveability includes such diverse qualities as the healthfulness of the environment, protection from natural disasters, and absence of crime, as well as opportunities for employment, affordability of housing, and the quality of schools and public services.

Urban District - Neighbourhood

"A large and complex physical environment which includes within it a wide variety of more limited environments. It serves many and varied user groups, who interact within themselves and with each other in different and complex ways. Each neighbourhood also has its distinctive features which distinguish it from other neighbourhoods." (Churchman & Ginosar, 1999)

Private and public recreational space is the open land that is laid out for recreational purposes. This includes all green areas as well as fortified areas such as squares and ball courts, public recreational areas, water areas and agricultural and forest land. Private recreational areas are the ones accessible to the public, for example, a private forest or park. (DK-GBC-1, 2015).

Public space - "…all those parts of the built and natural environment where the public has free access. It encompasses all the streets, squares and other rights of way, whether predominantly in residential, commercial or community/civic uses; the open spaces and parks; and the 'public/private 'spaces where public accesses unrestricted at least during daylight hours. It includes the interfaces with key internal and external and private spaces to which the public normally has free access". (BRE, 2017)

Traffic areas – Open land laid out for roads, parking, rail, bicycle paths and other street variants, such as pedestrian or playgrounds. (DK-GBC-1, 2015)

ABBREVIATIONS

BGI	Blue Green Structure
B&H	By og Havn
BREEAM	Building Research Establishment Environmental Assessment Method. Green Building Certification scheme.
DGNB	German Sustainable Building Council. Green Building Certification scheme.
DK-GBC	Danish Green Building Council
FM	Facilities Managers
GIS	Geographic Information Systems
IFHP	International Federation for Housing and Planning
LEED	Leadership in Energy and Environmental Design. Green Building Certification scheme.
POE	Post-Occupancy Evaluation
SE	Social and economic wellbeing – Category on BREEAM Communities Standard
TQC	Twelve Quality Criteria
UN	United Nations

CONTENTS

LIST OF FIGURES AND TABLES

1. INTRODUCTION

1. Introduction

Increased demands in cities and climate change enable a continuous process of transformation and improvement of the built environment. As stated in the New Urban Agenda part of the Habitat III Conference by United Nations (UN), urban areas are now seen as a scenario for solutions, beyond a cause of the global challenges. (United Nations, 2017). Consequently, the new construction, renovation and the management of the built environment in cities are now carried with a great focus for sustainable urban development. Moreover, it was established during Habitat III a shared vision beyond sustainability, where cities ensure the quality of life to their inhabitants; that is, an adequate standard of living with quality urban services that foster social cohesions and enhance liveability. All in all, intentions are widely stated to conduct urban sustainability practices with a greater people-centric and to understand their impact on liveability.

1.1 Motivation

Sustainability and the built environment

Still, with the call to foster social sustainability, the actions undertaken for sustainable urban development are unevenly distributed among the pillars of sustainability; namely environmental, economic and social impact (UN ECOSOC, 2016). Different sustainability actions in the urban systems, for instance, the green energy transitions; pursue goals such as efficiency, development, emissions reduction or climate change effects mitigation; but do not necessarily improve the citizen's well-being or foster social sustainability. Likewise, there are performance-based assessments and impact measurement tools for economic and environmental sustainability; such as urban metabolism-resources flow, life cycle assessment (LCA), life cost analysis, among others. In the topic of social sustainability, the tools developed for performance measurement are based on soft and qualitative data and consider either the evaluation at the building or city scale; not addressing directly the impact of the district scale.

Alongside, the sustainability initiatives in urban planning practices are commonly directed and validated through green building certifications standards. These assess many sustainability qualities with a significant focus on environmental aspects. Furthermore, the strategies and evaluation in green building certification standards are mainly related to the plan, design and construction phases, but with less focus on occupancy and operations activities. The urban planning practices emphasis has been mostly associated with land-use and mobility, being functionality the primary concern. The residents' wellbeing, on the other hand, tends to be a secondary issue that is not central in certifications or in post-occupancy evaluations.

1.2 Justification

Why measuring liveability matters?

The urban planning practices have the potential to incorporate features that enhance the liveability in cities by understanding the citizens wants and needs. (Ramboll, 2018). Therefore, understanding and measuring liveability matters if we seek continuous improvement and enhancing urban life qualities. Daily life in cities is affected by the experiential and sensorial qualities of the urban

environment. Together, this determines the level of satisfaction the settings can provide to residents with its appearance, comfort and safety. (Southworth, 2003). Understanding the user's satisfaction and experience in urban scale interventions can help managers and planners improve the built environment. It is a way to reveal problems to take corrective actions for improvement (USGBC, 2013). Therefore, a POE in the topic of liveability can help to understand urban planning and design practices in terms of their impact on people's wellbeing and can enable a continuous improvement of urban life.

As defined by Rambøll, the term 'Liveability' refers to the frame conditions that enable a decent life, physical and mental wellbeing. The concept brings together three dimensions: physical urban systems, social components and cultural believes and values. (Ramboll-2, 2020). According to the survey report ´Creating Liveable Cities Together ´published by Rambøll in 2018, a liveable city is the one which provides good living conditions for its inhabitants.

1.3 REPORT NAVIGATION

This report is structured as follows. Chapter one presents the introduction to the interest area of this research, which is Liveability performance in urban districts. Chapter two comprehends the literature review in the topic of liveability concept, green building certification schemes, post-occupancy evaluation and indicators design theories. After contextualizing with existing theories, Chapter three introduces the research problem framing. Chapter four presents the research design, which includes the methodology, the data gathering, analysis and interpretation. Chapter five presents the analysis and results. It puts together the knowledge acquired with the literature review, and the methodology to create a framework that gives a response to the problem framing. This phase designs a holistic set of liveability principles and creates indicators to evaluate them. The indicators are tested on a case study to understand tool usability and replicability. Chapter six discusses the main barriers and opportunities on this research method approach and intend; it generates a critique about the tool usability and the need to assess urban districts performance alongside recommendations for future studies. Chapter seven is the conclusion, where it is presented a summary of the work done.

The following section presents the literature review as a contextualization of liveability in cities, the state of the art of POE, and theoretical understanding on indicators design.

2. LITERATURE REVIEW

2. LITERATURE REVIEW

This section is structured in two main sub-section Understanding Liveability and State of The Art of POE & Indicators Design Theories. Each sub-section presents literature from selected journals, master thesis, certifications standards and survey reports on the topic area.

2.1 UNDERSTANDING LIVEABILITY

The industry, the academia and the practice relate to different interpretations of the term Liveability; as it goes beyond social, political, economic and cultural interests. Therefore, the 'understanding' of Liveability and its application varies depending on the context, the practice area, the local values or even by period or thinking. Although it can be approached by urban planning and design, Liveability in cities goes beyond good design practices for people. Liveability reflects interdependency on different city systems, as it is a theme build-up by multiple disciplines to cover all aspects that influence human´s wellbeing. (Kulasingam T. Granados A., 2017).

This subsection comprehends a literature study that identifies the state of the art of liveability in concept, by the perspective of what people wants and demands are. Also, it identifies liveability by measurement, through the perspective of what green building certifications evaluate. The chosen perspectives rely on the research decisions to look at peoples understanding of liveability and to gain insights on how social sustainability is currently evaluated. The general intent is to generate the knowledge basis for the Liveability Principles definition, further presented in Chapter 5.

2.1.1 LIVEABILITY CONCEPT: WHAT PEOPLE DEMANDS

As the interpretation of Liveability is highly varied, the angle of this project work is to understand what people consider as a liveable city. The Liveability Concepts presented here are stated by locally developed city evaluation tools and surveys as an understanding of what are the people demands.

Liveability and the built environment

Liveability is affected by the built environment plan, design, construction, and operations. There are physical settings at the urban scale that have a direct impact on liveability, such as public spaces, streets and neighbourhoods. The quality of the space in between buildings shapes people's experience and wellbeing. As introduced by Szibbo (2016), streets, for example, must provide healthy, comfortable and protected environments, free from pollution and traffic intrusions and noise control. The understanding of the people wants, needs and the plan for a good experience of the urban life; alongside the metrics for evaluating how the spaces are performing, can enable improvements for liveability. Therefore, city surveys are a practice regularly conducted by municipalities to understand how people are experiencing urban life, their level of satisfaction and their preferences; in order to come up with strategies that improve this performance.

Creating Liveable Cities Together - Survey Report

The survey report ´Creating Liveable Cities Together ´published in 2018 by Rambøll is the selected conceptual framework for understanding people's demands for liveability in cities. It is selected due

to the three following statements. Firstly, *the report* is published by the company this thesis is being written in collaboration with, Rambøll. The company is a direct reference for concepts definitions, as it is practices are in the urban planning and construction field, with great research and innovation focus, and strong "liveability" approach. *Secondly*, the report presents an understanding of the people's demands in the physical context of analysis, Denmark. *Thirdly*, it is selected due to its recent publication in 2018 and its great alignment to the qualities that can be enhanced through "planning of urban spaces based on what citizens want" (Ramboll, 2018).

This survey analysis was conducted through a survey of two phases. The phase one comprehends a National Survey that provides the understanding of what makes a city an attractive place to live. The second phase presents Copenhagen as one of the seven City-Specific Surveys by evaluating the city attractiveness based on 31 factors. The survey results comprehend 31 liveability factors and their overall weight given by the residents. There are seven key priority factors that residents consider with higher relevance for a liveable city. The factors are Protection against flooding, Green areas, Security against crime, Affordable housing, Employment possibilities, Mobility and Clean air.

The Social City Index Tool

The Social City Index tool (IFHP, 2019) created by the International Federation of Housing and Planning (IFHP) is selected as a comparison framework for city survey evaluation. The tool is developed in the local context but with an international approach. The rating system integrates indicators that analyse data inputs from surveys and statistics, relying mainly on survey inputs. The data collected is indexed against the national average values on the topic of analysis. The tool makes a diagnosis of cities social development with the intention of balancing the three pillars of sustainability. It integrates three scales of analysis: household, neighbourhood and city. The tool contains 40 indicators in total, from which 16 indicators rely on the neighbourhood scale. This scale is integrated by the categories Safety, Access and Social Capital.

2.1.2 Liveability Measurement: what green buildings certification schemes evaluate

Certification schemes are perceived nowadays as a common language for sustainability (DK-GBC-5, 2019). Therefore, their usage in green constriction is increasing all over the world. This sub-section analyses what the green building certifications evaluate in the topic of social sustainability at their urban or city scale schemes. As the certifications are created in different contexts, their categorization and parameters contained may differ. Therefore, social sustainability is the category selected as the base ground concept to link similar criteria among the different certifications. Four green building certification systems were pre-analysed in their relevance at the Scandinavian context. Table 1 summarizes the characteristics compared. These characteristics are the number of existing projects in the region, the schemes at the urban or city scale, the certified projects in the region within these schemes, the categories for social sustainability and the identified sustainability issues; where other certification categories evaluate aspects that are correlated to social sustainability.

TABLE 1 – SUMMARY OF GREEN BUILDING CERTIFICATIONS

	DGNB	BREEAM	LEED	INTERNATIONAL LIVING FUTURE INSTITUTE
Projects in Scandinavia	84	1204	466	0
District and Urban scale Schemes	*Urban Districts	BREEAM Communities	*LEED for Neighborhood Development *LEED for Cities *LEED for Communities	*Living Community Challenge
Projects within these scales	9 projects	8 projects	No Scandinavian projects at the urban scale	
Categories	Sociocultural and Functional Quality *4 categories *12 parameters	Social and economic wellbeing *3 categories *17 parameters	Post occupancy wellbeing measurement (O+M Scheme, for buildings)	N/a
Sustainability issues	*Environmental Category *Process Quality	*Transport and movement *Governance		

The certification systems DGNB and BREEAM are the only ones with urban scale certified projects on the region. Therefore, the schemes to review in detail on this research will be DGNB Urban Districts and BREEAM Communities due to their relevance in Northern Europe. The following lines present a detailed contextualization of these two certification schemes

DGNB – Urban Districts

The German Sustainable Building Council (DGNB) by its abbreviation in German, it's a non-profit organization that since 2007 develop standards for the green building certification of different building typologies. The DGNB certification system has been widely accepted, and its relevance continues to grow. It has more than 1,700 projects registered worldwide by now, and in Scandinavia it is only used in Denmark. In 2012 it was released the first adapted version of DGNB for the Danish market due to similitude in construction standards. The Danish version of the DGNB Certification system is a joint effort between the German Sustainable Building Council and the Danish Green Building Council (DK-GBC) (DK-GBC-3, 2020). In Denmark, there are by now in 82 buildings undergoing the DGNB certification in the different certification typologies. There are seven different certification typologies and DGNB Urban Districts is one of them.

The latest updated version of DGNB Urban Districts was released in 2016 and is soon to be a new one in 2020. There are currently eight pre-certified projects and one midway certified in Denmark on this

certification typology. The Urban Districts typology focus is in the project plan and design, due to the potential to address challenges ahead in the early planning phase (DK-GBC-2, 2019). However, there are three possible certification forms within DGNB Urban Districts which depend on the project stage of development. The first one is Precertification with the masterplan completed; the second one is Midway Certification with 25% of the total construction finished and infrastructure developed, and the third one is Certification, with 75% of the gross area established. The applicable projects typology can be new construction, masterplan or renovation of existing urban areas. The minimum project size for DGNB Urban Districts is two-hectare and must incorporate several buildings and public open space. The housing share can be between 10 and 90% of the district development, but not entirely it. This certification typology has as main categories the Environmental, Economic, Sociocultural & Functional, Technical and Process qualities. The Sociocultural and Functional Quality "assesses the urban life's qualities and the potential for diversity among users and residents (…)and the flexibility of the area concerning the future use of the urban area" (DK-GBC-2, 2019). The overall weight of this quality in the certification is 22.5%. There are four evaluation topics within the 'Sociocultural and Functional' quality. The topics are Diversity and Structure, City-life quality, Function and Adaption, and Aesthetics; and 12 criteria evaluate them. When analysing the other qualities of the certification typology there were identified topics that are also related to liveability and wellbeing, for example, PRO 1.1 Involvement, within the Process Quality and ENV 1.3 Urban Microclimate within the Environmental Quality. These other topics identified will be discussed and analysed within this research indicators development phase.

BREEAM – Communities

Building Research Establishment Environmental Assessment Method (BREEAM) is a certification system developed by BRE Group, a research centre originated in the UK. It is a sustainability assessment methodology for master planning projects, infrastructure and buildings. The certification was launched in 1990, and it is known as the first assessment methodology developed worldwide for buildings sustainability. Nowadays it is used in 86 countries (BREEAM, 2019). There are 1,204 projects registered in Scandinavia, from which eight of them are within the BREEAM Communities standard. It is Sweden where most of the projects are located since the Sweden Green Building Council has adopted this certification scheme for the country's planning and construction practices.

BREEAM Communities was created in 2012, and it is one of the five technical standards for the built environment certification (BRE, 2017). It certifies sustainability on large-scale development plans of new communities and regeneration projects. The latest version within this standard was developed in 2017. To pursue the BREEAM Communities scheme, the projects must enable on their scope qualities such as new transport infrastructure, public space, employment, social and ecological value, new facilities and services, capacity of community-level utilities such as energy or impact on existing communities. Three key steps structure the sustainability assessment. The first step is establishing the principles of the project-development. The second step is to determine the layout of the project, and the third one is the detailed design of the project. The scheme has two certification phases: The Step-one Interim BREEAM Communities certificate; and the Step two & three- final BREEAM Communities. The scheme has six assessment categories: Governance (GO), Social and economic

wellbeing (SE), Resources and energy (RE), Land use and ecology (LE), Transport and movement (TM), and Innovation (Inn); containing in total 40 evaluation criteria. The SE category weight on the overall certification accounts for 42.7%. There are 17 parameters within the SE category.

The BREEAM Communities Technical Manual reflects on the difficulty to categorise sustainability issues definitively "as they often affect all three dimensions of sustainability social, environmental and economic" (BRE, 2017). Therefore, it is stated on the different evaluation criteria the interrelation among them and other category areas. For example, the SE category contains as subcategories: Local economy, Social Wellbeing and Environmental Conditions, combining for social values criteria related to all three pillars of sustainability. There is no credit related to post-occupancy assessment, for the certification scheme BREEAM Communities.

This sub-section presented the literature review that will be the base to design the liveability principles. The following sub-section present the theoretical understanding and methodologies for POE and indicators design.

2.2 State of the art of POE & indicators design theories

This section objective is to gain an understanding of theories and methodologies for POE and indicators design. The acquired knowledge will generate the basis to design the liveability indicators.

2.2.1 Post-Occupancy Evaluation (POE)

What is a POE? Its benefits and applications.

Post-Occupancy Evaluation (POE) is understood as "examinations of the effectiveness for human users of occupied design environments" (Zimmerman A. & Martin M., 2001). POE is a methodology particularly focused on buildings. The methodology has had several adaptations to diverse building typologies and some applications to other built environment scales. It is implemented in new construction and existing one. The POE intends to measure the "client satisfaction and functional fit with a specific space" (Zimmerman A. & Martin M., 2001) in terms of the performance and impact of the physical traits on the occupants and how do they experience usage on the space designed. As stated in the article Post-occupancy evaluation: benefits and barriers (2001), the main benefit from conducting a POE is the provision of information that results in continuous improvement, to make any corrections to suit the needs of the occupants better. The evaluation helps to find out what has resulted well or as planned, what to improve in the future, what didn't work correctly and the reasons why and lastly, what and how can be done differently for improvement (Heath et al., 2019). In general, it addresses issues, improves future design by knowing how the built structures are behaving by identifying new functions or requirements to be changed or incorporated. It enables better and data-driven communication of values and benefits. Typically, a POE is carried out after full occupation. In projects where the methodology is incorporated from the project plan, there is also included a Pre-occupancy Evaluation.

How to define the POE purpose

The POE pursues a particular goal on what impact is meant to be understood. The guide Creating positive spaces by measuring the impact of your design (Heath et al., 2019) states guidelines to define the POE purpose. Firstly, it is needed to state what is expected to learn and why. For example, if the data gathering intends to measure whether current targets are being met, or if there is the intention of a comparative approach and over-time evaluations. Secondly, it is necessary to define what will be done with the information gathered. Options are that the information gathered is intended to make changes on the existing building based on results. Otherwise, if the data collected is intended to inform decision making on new projects.

Levels of POE

As explained by Preiser & Vischer (2005), the levels on which a POE can be conducted are Indicative, Investigative, Diagnostic. The indicative level is commonly based on interviews, walk-throughs with the intend to general extend of the project performance major strengthens and weaknesses. The second level, investigative, allows identifying where the cause and effects of the problems. The second level comprehends more data-driven analysis and more in-depth research. The third level,

Diagnostic, correlates the physical environment measurements together with the qualitative and subjective occupants' responses. (Christensen, 2019)

Process, methodology and data collection.

The process to conduct a POE is structured into three key phases: data collection, data analysis and conclusion & results. The data collection can include quantitative and qualitative information. The quantitative evidence can be numerical data, for example, resources consumption measurements such as water, energy, temperature, etc. Another type of numerical data can be questionnaires with binary rating systems such as yes/no answers, as well as statistics. The qualitative evidence is text-based such as conducting interviews, questionnaires, observations and case studies based on open-ended responses to questions. These qualitative elements allow to expand on "reasons behind numbers" (Heath et al., 2019). The results from qualitative data can represent a bigger challenge when interpreting them. Therefore, it is recommended to utilize, for example, a colour coding to label data or to look for keywords. The guide Creating positive spaces by measuring the impact of your design classify the following areas to measure in buildings.

TABLE 2 - POE AREAS TO MEASURE
TAKEN FROM THE GUIDE CREATING POSITIVE SPACES BY MEASURING THE IMPACT OF YOUR DESIGN

Technical performance	Systems, materials, light, temperature, air quality
Functional performance	Space, layout, efficiency
Social performance	Health and well-being, communication, collaboration, community
Economic performance	Value for money, running costs
Organisational performance	Business measures, HR, PR
Environmental performance	Energy, water, waste
Innovation	Performance of innovative materials, systems and processes

Beyond being quantitative or qualitative elements, the data sources can be provided from different means and stakeholders, as shown below:

TABLE 3 - POE data sources
TAKEN FROM THE GUIDE CREATING POSITIVE SPACES BY MEASURING THE IMPACT OF YOUR DESIGN

Data gathering	How? Stakeholder involved
Audits of resources consumption	Information provided by building managers, utilized to identify trends over time and to be compared to benchmarks.
Space performance by user's experience	Occupants and the space existing measurements
On site observations	Walkthrough to record physical characteristics of the space
Physical monitoring, testing, surveys	Performance meters, on site continuous measurements, as for example, air quality monitoring
Study of records	Background project information as for example, cost analysis compared to operational costs
Questionnaires, interviews and focus groups	Consultation with stakeholders to get feedback about satisfaction and experience from clients, facility managers or occupants.

The stakeholder involvement in a POE can vary depending on the data input. Some actors commonly integrated are Facilities Managers (FM), Building occupants or inhabitants, clients, employees and maintenance staff, project sponsors, project developers and the project owner. The presentation of the POE results can include general building information, findings illustrated graphically, insights as key learnings and recommendations and actions to improve outcomes.

Barriers on implementing a POE

The implementation of POE is not widely carried out. Some of the reasons stated as barriers by Zimmerman & Martin (2001) are that standard practice of design is yet not cyclical on all its systems. For many projects, once finished, there is no follow up or come back by the planning entities once the project is into the facility manager hands. As stated in this research introduction, a comparison of plan vs operations is already practised in some systems. But this leads to the fragmentation of specializations. The developer is a different person than the investor and often a different person than the building owner (Zimmerman A. & Martin M., 2001). Each actor has a particular goal in the building; different incentives drive the actions. Nowadays, there are many efforts in participatory planning, on which future building occupants are involved since the planning phase. Another identified barrier appears when post-occupancy measurements are carried out based on separate indicators and understanding of "what constitutes a good building". A performance energy indicator does not necessarily tell about behavioural change and interest in energy efficiency the user might have.

POE in green building certifications

Among the pre-analysed green building certifications, the certification Leadership in Energy and Environmental Design (LEED) is the only one that evaluates POE. LEED has the credit Occupant Comfort Survey within the category Indoor Environmental Quality, as part of the Operations and Maintenance certification scheme (O+M). The credit intends to evaluate the user's comfort in topics of acoustics, building cleanliness, indoor air quality, lighting and thermal comfort. The methodology suggests survey application to rate satisfaction with a seven-point scale, ranging from +3 very satisfied to -3 very dissatisfied. For its reliability, it recommends doing the evaluation every two years, to have anonymous responses from over the 30% of the building occupants, to collect and summarise responses and to generate a document with a corrective action plan. The corrective plan is meant to be focused in the areas with a dissatisfaction rate above 20%

POE at the urban scale

The literature and practice for POE are related to buildings and their immediate surroundings, but rarely related to the neighbourhood scale (Churchman & Ginosar, 1999). The variety of elements that play a role in the neighbourhood scale do not necessarily fit the commonly used evaluation methods for a building. For this scale, most of the planners rely on data analysis in topics of the demographic, socio-economic and physical development in the planning process, and not necessarily information from the immediate inhabitants and their interactions with the built environment.

According to Southworth (2003), the practices of addressing the complexity of the quality at the urban scale is what defined the urban planning field. During the 70's, San Francisco was one of the pioneering cities in evaluating urban environmental qualities. The methodology comprehended surveyors going to the 1500 city blocks to learn about "views, maintenance, visual interest of street facades, block variation, presence of nature, distance to open space, microclimate, compatibility of traffic and clarity of local image" (Southworth, 2003). With the technology existing nowadays, it can be reached accuracy at larger scales. Quantitative data and analysis can be obtained for urban qualities through digital aerial photo imagery, Geographic Information Systems (GIS) and demographic data.

POE in public space assessment

An example of urban scale post-occupancy assessment is the Twelve Quality Criteria (TQC). As stated Gehl Institute, TQC "Is a tool for researching how public spaces are experienced by their users" (Gehl, 2018). The tool allows evaluating peoples' experience in public spaces in the topics of protection, comfort, and enjoyment. The evaluation is based on on-site observations on the residents and users experience in the public space. It has twelve assessment criteria categorized within the topics of protection (3) comfort (6) and enjoyment (3). And the index values for grading are positive, neutral or negative. As the assessment is based on perception, the resulted values on the evaluating data are meant to be subjective and qualitative.

POE evaluation in practice in the local context: NORDHAVN

Nordhavn, known as "the largest metropolitan development project in northern Europe" (COBE, 2019) is an urban district project currently under development in the city of Copenhagen. The project has finished its first phase of development and accounts more than 2500 inhabitants already. To the project owner, it is relevant to improve the development continuously, as it is going to continue growing for the next 40 years (By&Havn, By&Havn, 2019). Therefore, there are several post-occupancy strategies already carried out in Nordhavn.

Neighbouring Meetings

Neighbouring meetings are held in Nordhavn twice a year. These are organized by the project owner B&H. According to West S. (2020), the objective is to inform but also to engage involvement from residents, occupants and associations and everyone interested in this development project. Therefore, everyone is invited via newspaper announcements and the B&H newsletter and social media channels. The meetings methodology incorporates a workshop with focus groups. Here, there is a mix of information and dialogue through themed tables. The themes are related to topics of interest for the occupants concerning construction development in the area, management and improvements. The topics are based on inquiries received from the residents combined with construction project updates and the particular project features that B&H would like to 'highlight', for example, the construction related to public space, leisure activities and new functions in the area. Although the higher intent is to inform and enhance involvement, the hearing of the people's demands has resulted in project improvements. For instance, Hamburg Square in the Aarhus Street neighbourhood was originally planned without greenery. Due to people interest, the landscape

design plan is changed, and now it incorporates increased green features on it. After the neighbouring meetings, a summary of the central topics discussed is made. This summary is published on social media and B&H website, available for everyone.

Etnografisk beskrivelse af Århusgadekvarteret

The survey report Etnografisk beskrivelse af Århusgadekvarteret – Ethnographic description of Århusgadekvarteret, Nordhavn was conducted in 2016 by Nomadisk af Natur (2016) for B&H. The methodology comprehends ethnographic analysis, surveys and interviews. The intend was to generate knowledge and comparison of the visions for Nordhavn and the reality of the residents living there, to enhance further development in line with the residents needs and experiences. The report summarizes the user experience in Nordhavn, why the residents have chosen to live there, how they experience their neighbourhood and what hopes they have for the future development in the area.

Imageanalyse By & Havn 2019

The Imageanalyse- Image Analysis (By&Havn-2, 2019) is a survey project also conducted by B&H in 2019. With this, they measure the residents' satisfaction with living in Nordhavn (West, 2020). The survey is an ongoing program meant to be repeated yearly in two schemes: quantitative in 2020 and qualitative and quantitative in 2021 and repeated consecutively in 2022 and 2023. The survey methodology is integrated by qualitative and experience elements related to satisfaction, and measurements of quantitative data collected from urban spaces visited by the people throughout the year. The qualitative part is conducted by phone interviews, while quantitative information comes from Epinion's Denmark panel, with online data set imagery. The surveys intend is to be management tools for urban development and project improvement.

This subsection detailed the purpose, benefit, method, and types of POE; as well as existing barriers on its implementation. In the topic of its applicability to urban scale analysis, it was presented literature explaining about its feasibility, as well as examples of existing practices on the urban scale in the local context of this research analysis. The next sub-section presents the theory on how to design indicators for impact measurement.

2.2.2 Indicators Design Theories

Urban Sustainability Indicators

According to the report Indicators for Sustainable Cities by the European Commission (2018), the urban sustainability indicators allow city planners, managers and policymakers to measure the impact of urban design and systems in the socio-economic and ecological spheres of sustainability. These enable the diagnosis of problems and areas to address, as well as to monitor the interventions. As defined by the report and based on the Food and Agriculture Organization of the UN, "indicators provide information about the functioning of a specific system, for a specific purpose – to support decision making and management" (European Comission, 2018). According to the report, indicators can be used as analytical tools, as pilot tools or as performance assessment tools. The last one being the primary purpose of using sustainability indicators. Some issues that indicator systems present the underrepresentation, little focus of lack of interlink of the pillars of sustainability. The European

Commission report also states that the overall defining elements of an indicator are their clearness, simplicity, scientifically tone and the easy reproduction.

The publication Urban Sustainability Reporting by Maclaren (1996), presents a review and understanding for designing indicators for urban sustainability. On this report, the author identifies the shared characteristics among the urban sustainability indicators reviewed. It summarizes that sustainability indicators are integrative, forward-looking, distributional and with multiple stakeholders' input (Mclaren, 1996). These detailed characteristics among the four of them are expanded in the following table.

TABLE 4 – CHARACTERISTICS OF URBAN SUSTAINABILITY INDICATORS

Integrative	Integrative and composite. These create linkage among sustainability spheres: social, environmental and economic; for example: • Integrative - Unemployment rate: measure of economic and social stress. • Composite - The cost of recycling per ton of waste recycled: integrating environmental and economic aspects.
Forward-looking	Measure the progress towards achieving intergenerational equity, for example: • Trend indicator – Describes historical trends and provides overview of future sustainability. Might contemplate targets – levels that must be meet, and thresholds – levels that should not be exceed • Predictive indicator – mathematical models for future state. I.e. population growth. • Conditional indicators – If &Then. I.e. If future residential population, then the land area needed to accommodate expected urban population.
Distributional	Measure intragenerational equity considering the distribution of conditions among the sustainability spheres within population and geographical areas. • GPD per capita, instead to disaggregate indicators by factors such as age, gender and location in order to account for distributive effects.

Maclaren (1996) presents a methodology to develop Urban Sustainability Reporting. The steps included are reproduced in the following table. This framework is the inspiration for the indicator's framework design in Chapter 5.2 Liveability Indicators (See page 37)

TABLE 5 - STEPS IN URBAN SUSTAINABILITY REPORTING
INSPIRED BY MACLAREN (1996)

A. Definition of urban sustainability goals	
B. Scoping	Target audience, purpose and number of indicators, temporal and spatial boundaries
C. Selection of appropriate indicator framework	• Domain based • Goal based • Sectoral • Issue • Casual

D.	Definition of indicators selection criteria	Viability and validity.
E.	Identification of Set of Potential Indicators	list of resulting parameters based on specialized knowledge.
F.	Evaluation of indicators and final set selection	evaluation of each of the potential indicators against the designed selection criteria.
G.	Data collection and Indicators Results Analysis	Data source, metrics for evaluation, index values
H.	Report preparation	Summarization of work done: indicator, relevance and trend.
I.	Assessment of indicators performance	review, modification or elimination of indicators due to usability

The importance of the viability and validity.

The Step 4 - Definition of indicators selection criteria invites to determine what are the fundamentals of the indicators to be created, in terms of the indicator's viability and validity. The common characteristics this report finds in the analysed frameworks in the topic of their indicator's selection criteria are scientifically valid, representative of a broad range of conditions, responsive to change relevant to the needs of potential users, based on accurate and accessible data, data availability over time, understandable by prospective users, comparable with indicators developed by other jurisdictions, cost-effective to collect and use, attractive to the media and unambiguous (Mclaren, 1996).

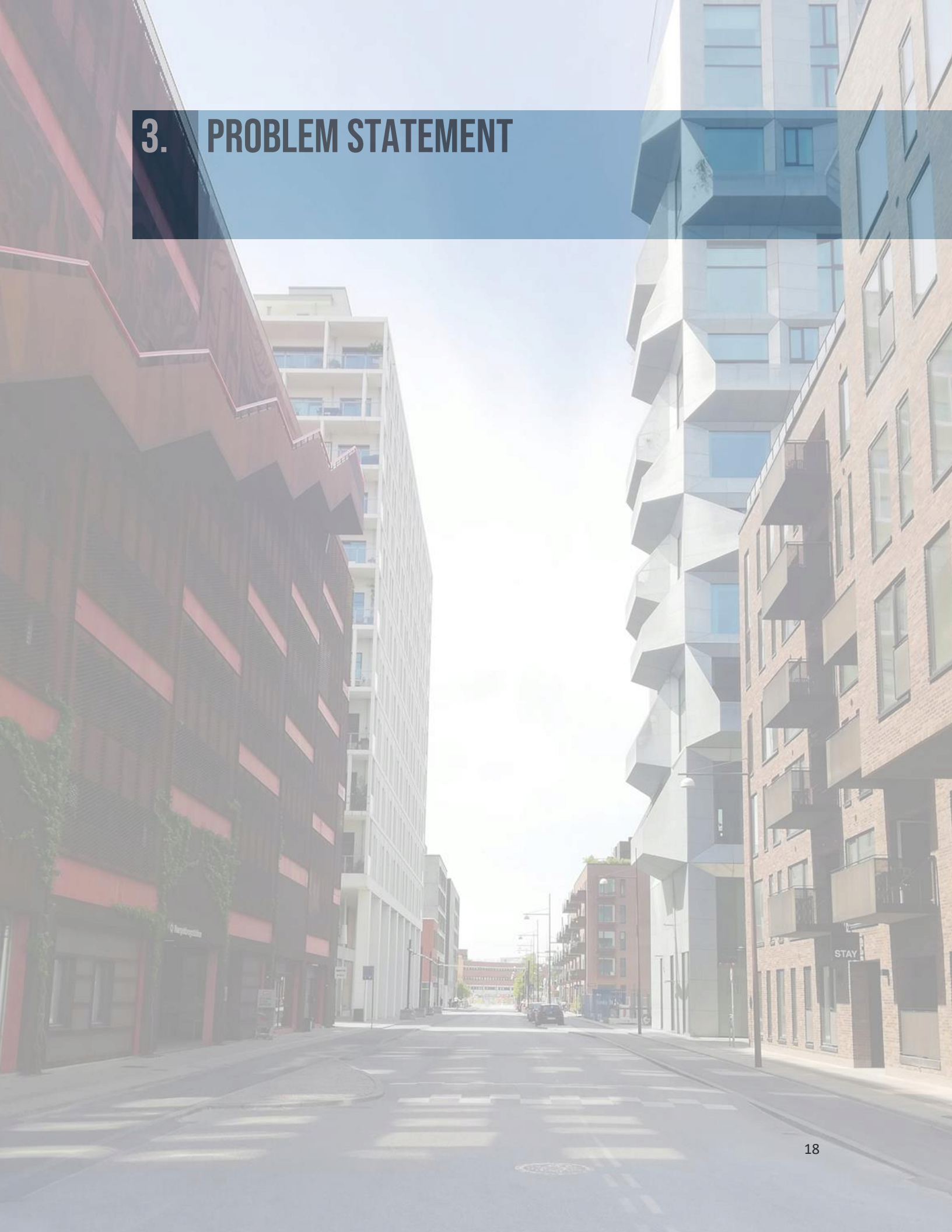
2.3 LITERATURE REVIEW SUMMARY

This chapter presented the literature reviewed in the topic of Liveability, POE and indicators development. It was learned throughout the chapter about the relevant areas that make a city liveable according to Denmark residents and the Creating Liveable Cities Together-Survey Report. The green building certification schemes have already a high focus on assessing urban areas, neighbourhoods and communities in their plan and design phases; but nothing related yet to POE. The topics embedded in certification schemes are highly correlated to liveability as presented on the Ramboll survey report, so these certification criteria could be a ground for measuring the liveable practices. The scales that predominates when conducting surveys or a POE is either the building scale or the city scale. Very few literatures related to POE methodologies for district-scale was identified. The review of the POE literature supports the statement on the reduced application these evaluation methods have on the neighbourhood and district scale. When conducting performance evaluation for city scale, these are based on qualitative and experience related factors, and not related to integrative means for measurement: for example, combining systems performance, quantitative and qualitative data. A city-scale evaluation can allow to identify and weight concepts that are relevant to the inhabitants. However, the overview of the performance city surveys provide is in a too large scale to transform it into improvements. This means that, if it is decided to implement corrective

solutions, further analysis needs to be done at smaller scales, for example, districts and neighbourhoods to come up with insights that can be transformed into actions.

All this enables the opportunity to create evaluation means for urban districts post-occupancy. After insights have been acquired in liveability and POE as this research topic areas, the next section explores the problem framing and research question formulation.

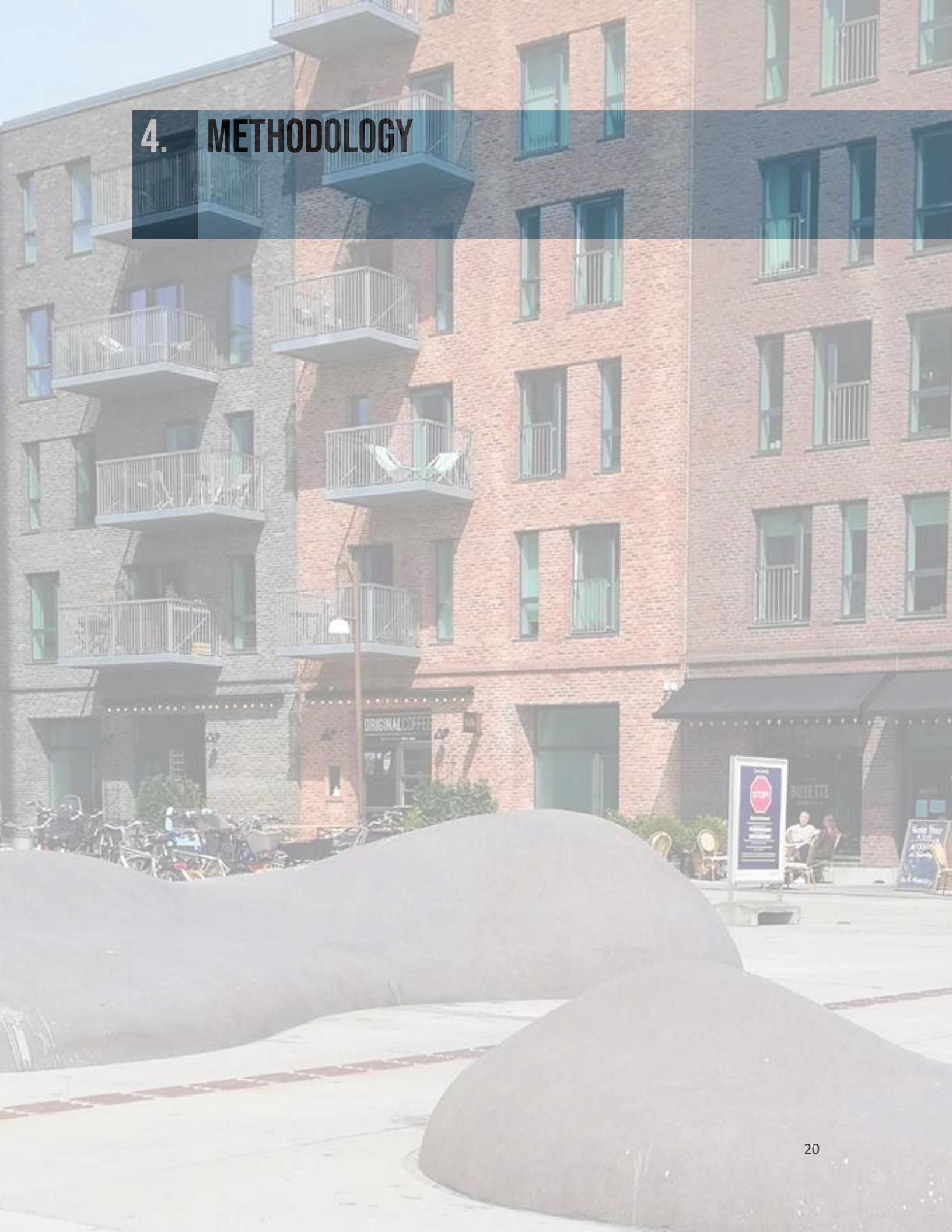
3. PROBLEM STATEMENT



3. Problem Framing

After the literature review, it is identified the needed to define the key aspects that make a place liveable and create place-specific evaluation standards for it. As performance understating is more responsive to local conditions and recognizes that the city is continuously evolving (Southworth, 2003), it is desirable to generate performance understanding of liveability, rather than a fixed end state. Hence, this research objective is to design a POE for Liveability in Urban Districts that either pursue a green building certification scheme or either have a great sustainability or people-centric approach. The research question formulation that puts together these identified areas of interest is the following:

Research question PHASE 1	Research question PHASE 2	Research question PHASE 3
How the qualities that enhance liveability at the urban district's scale can be defined for a local context?	How can these qualities be evaluated to understand liveability performance in urban districts?	How liveable are urban districts planned under sustainability premises?



4. METHODOLOGY

4. METHODOLOGY

The scope of this research is to create a POE for Liveability Impact in Urban Districts and to give a response to the defined research questions presented in the previous chapter. This chapter presents the methods applied for conducting this research and to respond to the research questions formulated in the previous section. The section is integrated with the research design and phases, the research approach, the means for data collection, the quality of the assessment, and an introduction to the case study, which will be the instrument for the tool evaluation.

Copenhagen as the context of development.

Being ranked as the European Green Capital in 2014 and soon to be the first to become Carbon Neutral Capital in 2025 (The City of Copenhagen, 2012), the City of Copenhagen is one of the leaders in sustainability and people-centric urban life in Europe. The city experiences a process of constant improvement and has great examples of what enhances liveability on the built environment. For these reasons, the context for this research development and cases study is set to be the Capital city of Denmark: Copenhagen. However, the tool applicability is intended for Scandinavia and places where there are projects that pursue or have the label of one of the studied green building certification schemes.

4.1 RESEARCH DESIGN

The process and methods for gaining knowledge, collecting information and analysing it to result in the creation of the tool are represented graphically on the following figure. There are three main phases in this research, as following described:

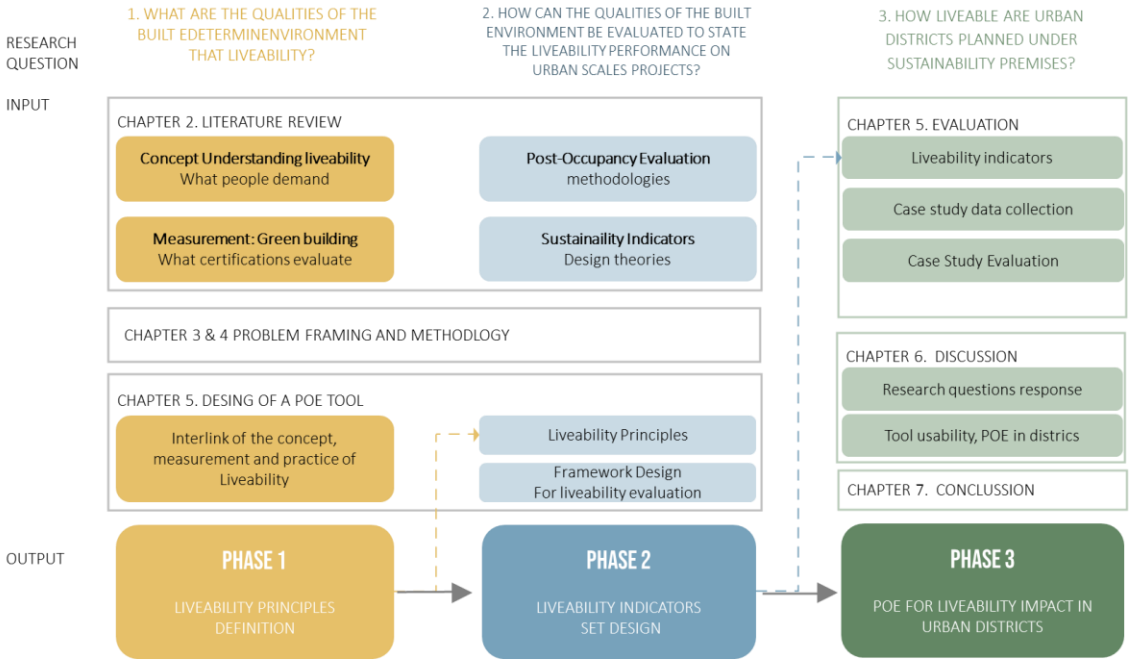


FIGURE 2 - RESEARCH METHODOLOGY

The diagram above illustrates the main activities and how they connect with each other to define this thesis process and methodology. After introducing to this research motivation, chapter two presents the theoretical frameworks for liveability and POE and indicators design t theories review. Chapters three and four generate the problem framing and the methodology, which are the connecting point for the theoretical and design frameworks. Chapter five presents the empirical method for designing the liveability principles and the POE indicators, as well as the case study evaluation. The last two chapters, discussion and conclusion, present the acquired knowledge, results and summarization of the work done.

4.2 Research approach and Data Collection

This study pursues a mixed-method approach, as it combines both the practice of qualitative and quantitative research design (Creswell, 2014). It combines the existing theories for POE and Indicators design and the existing assessments for sustainability criteria in green building certification schemes, with the empirical design of the tool evaluation criteria. The overall data collection and analysis also have a mixed approach, as they combine qualitative and quantitative data inputs. The data interpretation will rely entirely on a quantitative assessment. This research combines primary and secondary data sources, understanding as primary the new information collected directly or as a measure to obtain data; and secondary, the existing knowledge, information and data. The detailed explanation on research decisions, the data collection, analysis and interpretation methods utilized throughout this study are structured below by the project phase they relate to.

PHASE 1

WHAT ARE THE QUALITIES OF THE BUILT ENVIRONMENT THAT DETERMINE LIVEABILITY?

PHASE 1. LIVEABILITY PRINCIPLES DEFINITION

The intend of this phase is to understand how the qualities that enhance liveability at the urban district's scale can be defined for a local context. To respond to this, an empirical method is designed. Phase one identifies which are the key liveability principles by interlinking what people want, what green building certifications measure and what is built. To achieve this, literature review is conducted on the state of the art of liveability in concept and measurement. It is also collected information from the selected case study to understand what is put into practice. Phase one combines data inputs from the literature review 2.1 Understanding liveability and the empirical study of Nordhavn, in 4.4 Case study: Nordhavn. The outcome is a list of liveability principles with their categories and parameters. This phase generates an understanding of "liveability" that is the departing point on what to measure on phase 2. The methods for data collection, analysis and interpretation are as follows:

Understanding Liveability

First, it was made a review of existing local city surveys or tools reports to understand what the peoples' demands are. The selected reports are Creating Liveable Cities Together ´published in 2018 by Rambøll and the Social City Index tool, developed by IFHP. The reports were chosen as their a made in the local context of this thesis work, Denmark. The first one is selected as is the departing point of understanding liveability provided by the company this thesis is written in collaboration. From the first one, is extracted a list of Liveability factors and main categories. The second one is selected because it is a tool that assesses and creates parameters at the neighbourhood level; the level this research intends to work on. From the second one is extracted a List of parameters within the neighbourhood scale evaluation. Both of them are quantitative data collection from secondary sources.

Measurement - Green Building Certification schemes

Secondly, a review was made in the topic of Green building certification standards, their schemes, their certification manuals for urban districts and their social sustainability categories and parameters; to understand what the certification schemes are evaluating for plan and design. From a poll of four certifications pre-analysed, two were selected, through a numerical assessment with data available on the certifications website about the projects certified within the DGNB, BREEAN, LEED AND Living Future. The two selected ones are the ones with higher relevance at the local context; this understood by an empirical evaluation of the number of projects in the region. The two selected are the Danish version of the DGNB and BREEAM. For the first one, it was extracted a list of parameters and evaluation methods withing the category "Social and Functional Quality" part of the scheme Urban Districts from the certification guide DGNB Dansk bæredygtighedscertificering Byområder. (DK-GBC-1, 2015). For the second one, it was extracted a list of parameters and evaluation methods within the category "Social and Economic Wellbeing", part of the scheme BREEAM Communities and the certification manual BREEAM Communities Technical Manual (BRE, 2017). Both of them are quantitative data collection from secondary sources.

Case study Nordhavn

Thirdly, it was selected an urban scale project to understand how liveability transits from plan and design to implementation. The intention was to gather data about categories and parameters that are put into practice for liveability. The case study was selected due to its relevance at the local context, and because it pursues DGNB certification. More is elaborated on the case study selection further in this section. For the case study as reference of liveability, the following information was collected.

The qualitative data collection from primary sources is the following.

- Interview conducted online with the project developer COBE. The interview integrated a questionnaire with open ended questions. The obtained information is the project general description presented on this research. The project general description is complemented with information obtained from the owner By&Havn and the developer COBE websites.
- Interview conducted via telephone call with the project stakeholder ENERGYLAB in order to learn about the performance measurements on the project area. The interview was with open ended questions.

The data analysis contains quantitative information from primary and secondary sources. An empirical summarization of the project practices was made to categorize their existing practices into liveability.

Liveability Principles Definition

As a result, the Liveability principles analyse and interpret the data from the three previous steps, with the intention to generate a list of liveability principles which are the interlink of the values for liveability in concept, in measurement and in practice. This section considers no new external data, but the analysis of the one collected on the previous steps. Therefore, the analysis and interpretation conducted are a primary sources.

For the data analysis, three tables are generated. These tables contain information on the identified key values/parameters for liveability. One table is for the concept (Rambøll and IFHP tools), one for measurement (DGNB and BREEAM) and one for the practice of liveability (Nordhavn). The parameters on each list are grouped into categories. A qualitative data interpretation from primary sources is made to generate a list of liveability principles, by means of repetition, keywords are identified within the parameters. The categories are defined by reference of the report Creating Liveable Cities Together ´published in 2018 by Rambøll based on "keywords" repetition. The resulting Liveability principles are the quantitative data interpretation of the repetition of "keywords" among' the parameters on all the three tables.

PHASE 2

HOW CAN THE QUALITIES OF THE BUILT ENVIRONMENT BE EVALUATED TO STATE THE LIVEABILITY PERFORMANCE ON URBAN SCALES PROJECTS?

PHASE 2 LIVEABILITY INDICATORS DESIGN

The intend of this phase is to respond *to the question of how can these qualities be evaluated to understand liveability performance in urban districts.* Phase two

analyses the phase one Liveability principles and the Literature review in the topic of POE and indicators design. Phase two integrates the theoretical learning from chapters 2.2 State of the art of POE & Indicators design theories, and the Chapter 5.2 Liveability Indicators Design. This phase intends to generate the indicators as liveability measurement instruments. The outcome is the final set of indicators. The methods for data collection, analysis and interpretation are as follows:

State of the art of POE & Indicators design theories

Firstly, it was made a review of POE methodology' to learn about its usability on this design process. Qualitative data collection from secondary sources was made. For the theoretical framework for POE, a collection of peer-reviewed articles and master thesis in the topic of POE were reviewed. Together with the Manual for Creating Positive Spaces by Measuring the Impact of Your Design (Heath et al., 2019) and the evaluation tool Twelve Quality Criteria (Gehl, 2018), from Gehl Institute. Alongside, a review of sustainability indicators design theories was made to gain a deeper understanding of their design process and metrics for evaluation. The methodology designed by Mclaren (1996) in the topic of Urban Sustainability Reporting (Mclaren, 1996) is the reference framework for this research indicators design. These theoretical frameworks were selected due to the need to have as a departing point for this tool creation.

Framework design for Liveability evaluation

Secondly, the indicators framework design integrates qualitative data interpretation to generate this research framework to design the indicators. The resulting framework is an empirical combination of the knowledge obtained of POE methodology and sustainability reporting theories. The framework also includes phase one defined Liveability principles and the gathered information about measurement techniques utilized in the certification schemes. The details about the framework design process are included in chapter 5.2 liveability indicators.

Set of liveability indicators

Thirdly, the final set of indicators evaluates liveability in three areas: system, layout and experience. These areas contain different means of data collection, as explained below. The quantitative data collection from secondary sources is mainly related to data input will come from statistics and statistical interpretation, as well as from the project plans audit. The qualitative data collection from primary sources is related to project on-site observations and image analysis, and experience. A survey is designed for this evaluation. The survey integrates two closed-ended questions per indicator. The questions refer to the user experience and behaviour. The survey details can be found in Appendix section (See page 99).

Information on about the measurement methods are included in 5.2 Liveability Indicators (See page 43)

PHASE 3

HOW LIVEABLE ARE URBAN DISTRICTS PLANNED UNDER SUSTAINABILITY PREMISES?

PHASE 3. TOOL USABILITY EVALUATION

The intend of this phase is to test the tool usability by evaluating it on a case study. This phase also gives a response to the question how liveable are the urban districts planned under sustainability premises. Phase three conducts the case study evaluation and generates adjustments to the POE indicators. Phase three contain as input the section 5.2 Liveability Indicators, as the case study is evaluated with the indicators designed. This phase intends to learn about the usability of the tool and its improvement opportunities regarding its components and measurements. The outcome of this phase is the POE for liveability impact at the urban districts. The methods for the case study data collection, analysis and interpretation are as follows:

Case study evaluation

Data of the case study is gathered for its system, layout and experience performance.

The quantitative data collection for systems evaluation coming from secondary sources is the following:

- Review of statistics from existing reports that contain analysis made in previous years in the project area. The reports reviewed are the internal report Imageanalyse (By&Havn-2, 2019) and (Nomadisk af Natur, 2016) facilitated by the stakeholder and project ownerBy&Havn.
- Review of local Statistics, obtained from Statistics Denmark
- Data from geographic information systems maps analysed on QGIS.

The qualitative data collection for layout evaluation coming from secondary sources is:

- On-site observations - Three field study trips are made to the project area to evaluate the practice of Liveability in the built environment. The visits were on May 26, May 31, and June 4, 2020.
- Project plans audit on AutoCAD to compare and integrate the on-site observations. The project plans were provided by COBE.

The qualitative data integration for experience evaluation comes from primary sources:

A survey with 14 closed-ended questions in total was conducted in the project area, targeting residents and frequent visitors. The collected sample responses were 32. Some of the answers were collected as questionnaires during the field study trip and some others through an online form. The demographic profile of the survey participants is included in the Appendix Section (See page 105)

4.3 Quality of assessment

Reliability and Validity

Although empirical research is conducted, the sources rely on the theoretical background explained above. The departure point to generate the categories for liveability is the Creating Liveable Cities Together ´published in 2018 by Rambøll, and the seven key factors themes this report identifies. The tool metrics for evaluation are the integration of the existing measurement in the certifications and evaluation methodologies as the Twelve Quality Criteria, and their empirical extrapolation to POE evaluation means. For the metrics for evaluation, BREEAM and DGNB are contemplated not only on the category "social", but any other certification categories which criteria results relevant to the intends of this research. The case study evaluation is utilised to analyse the tool usability. The resulting grading is demonstrative of the tool usage, but not illustrative of the Case Study Qualities, as the analysis was made with the existing information about the project area, which is recently developed.

4.4 Case study: Nordhavn

On this research, there is a single case study approach. The research decision is made due to the intention of gaining an in-depth understanding of the practices in the case study and the evaluation methodology this indicator's set proposes. The trade-off of a single case in-depth analysis is that it eliminates the possibility to compare projects and learn about patterns. The intend of the case study evaluation is to learn about the tool usability and not to compare to Urban Districts. Therefore, a single case study approach is the best fit for it.

Urban District Definition

Liveability in cities is determined by all scales, from the individual building design to the neighbourhood elements, to the city systems. For this research, the urban district definition for the tool usability and case study evaluation is considered as follows:

Urban Districts – urban area, neighbourhood, city block with mixed-use that includes open public space. The scale city block is also contemplated as part of this definition, even when not necessarily incorporating mixed-use but when in relation to an existing built environment that complement these functions.

Case study selection

To select the case study, the following qualities were considered. A projects size between 2 and 400 ha (DK-GBC-1, 2015) that has a strong urban sustainability approach or that has been developed to pursue a certification scheme. The project is either new development or renovation within an urban grid, but with at least 1 year of being completed if first phase of development.

Liveability in practice: Nordhavn

As described earlier, this section explores one local case study to learn which are the local practices for liveability. The objective is to understand which are the key liveability values for project developers, planners and designers; and how is liveability planned and transformed into physical assets in the urban scale interventions.

FIGURE 3 – NORDHAVN: FROM INDUSTRY TO LIVEABLE CITY
TAKEN FROM COBE.DK

Nordhavn is known as “the largest metropolitan development project in northern Europe” (COBE, 2019). It is selected as a case study in the analysis phase due to its great sustainable approach in city planning, its smart city solutions, its great people-centric design and its intent to pursue the DGNB Urban areas certification. Industrial harbour activities occupied the project area since the mid-1800s. The area is now repurposed as a sustainable urban district. The masterplan is expected to be developed within the next 40-50 years. The plan comprehends a land area of 360 ha grouped into islets which also represent the development stages of the neighbourhoods with their respective identities. The project has developed its first phase, on which there is a current population of 2,500 inhabitants. The general strategy is designed by COBE Architecture, planning and design firm. COBE won the Nordhavn competition in 2009 and designed 1) The structure plan, which is the concept of islets creating districts connected by the ‘green-loop’ – green mobility corridor and canals, and 2) the masterplan for the starting stage of development, which comprehends Traelastholm, Sundmolen and Levantkaj Vest. The project pursues DGNB Certification to align the overall sustainable approach along with the project development. (Boserup, 2020). Nordhavn will pursue the DGNB Platinum Certification on the urban districts and buildings scheme and has currently received the Urban District

pre-certification for a 26.2 ha, the Traelastholm, Sundmolen and Levantkaj Vest districts. (DK-GBC-4, 2020). Among the five qualities that the certification scheme evaluates, the Socio-functional quality was the second highest, with 85,7 points. (DGNB, 2020). The following table summarizes the liveability concepts of the project, as explained by the stakeholders mentioned below.

TABLE 6 –NORDHAVN LIVEABILITY CONCEPTS IN PRACTICE

Research & Interview	Cobe	Energy Lab	By & Havn
	Rune Boserup Project Director To know about the plan and design practice of liveability and people-centric design.	Lucile Julia Sarran Erhvervs ph.d Energy Lab	Susan West Kommunikationskonsulent
Outcome:	Liveability concepts status	On site measurements	Community management
In practice	*Protection against flooding *Employment possibilities *Mobility	*On site all energy infrastructures measurements (i.e. electricity, thermal, transport), Low energy buildings, and additional relevant data as for example weather data.	• Nabomøder
To be covered	*Green areas *Clean Air	*Occupant comfort in buildings measurement *Central energy system	
Not intended	*Security against crime *Affordable housing		

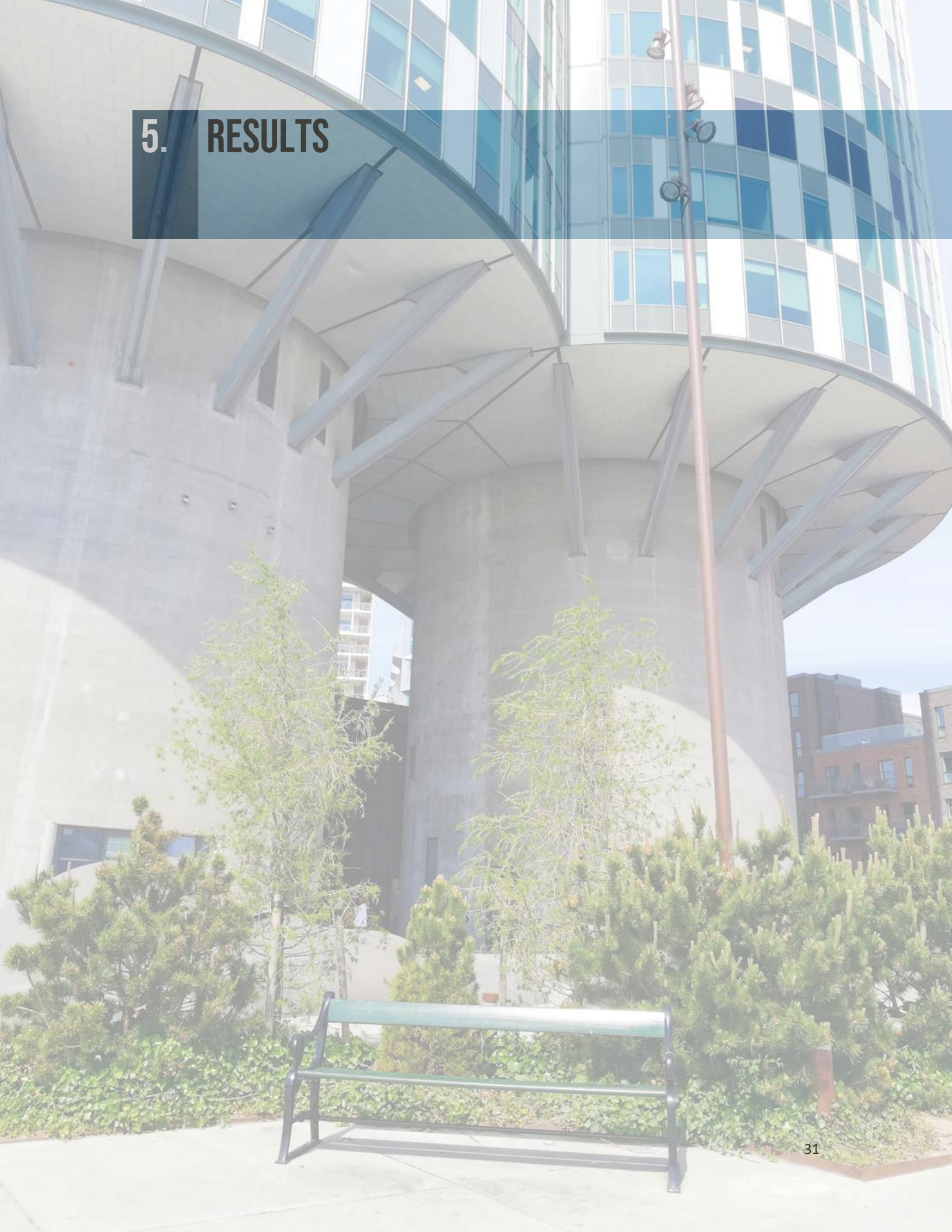
Nordhavn has developed strategies in all the three pillars of sustainability and aims for a people-centric design. It is after the first stage of development that many positive changes are arising for the masterplan. Through neighbouring meetings, the planning and design firms are now incorporating into the design practices more values for liveability; for example, more green spaces. The project area also has on-site measurement at the district scale. These measurements are related to the energy system in the project and the overall smart technologies implemented. After analysing the applicability of the seven liveability concepts, three have a direct implementation on the first project phase, 2 are to be incorporated in future stages of development due to users demands, and 2 are not considered. Detailed information about Nordhavn's project description, the interviews conducted and the additional data gathered is included in the appendix section (See page 105). A detailed

summary of current strategies for the post-occupancy evaluations the project has are included in the Appendix section page 105.

4.5 Methodology Summary

This chapter presented the research methodology. Phase one method compares, interlink and integrates survey reports results with criteria evaluated on green building certifications to design the liveability principles. Phase two utilises Sustainability framework for indicators design by Mclaren (1996), POE literature and designs a three-area evaluation to create the liveability indicators. Phase three method utilizes an evaluation on a case study to assess the tool usability. The next chapter presents the resulting elements after conducting these methodologies.

5. RESULTS



5. Results: Design of a POE Tool for Urban Districts

This chapter integrates the knowledge obtained in the Literature Review and the research methodologies defined in the previous chapter. The first part is the Liveability Principles definition (see page 32). These analyses, interlink and interprets the concept, the measurement and the practice of liveability. The second part is Indicators Framework Design (see page 37) and Liveability Indicators (see page 43). This structures the process to create the indicators and the resulting final set of indicators that are the measurement instruments for liveability. The third and last part is the POE tool for liveability at the urban districts (see page 51). It analyses the tool usability through a case study evaluation and elaborates about tool improvements.

5.1 Liveability Principles Definition

This subsection presents this research interpretation of how liveability is understood and contextualized by the areas concept, measurement and practice. The *concept*, through the analysis of existing surveys reports and city tools to understand what the peoples' demands are. The *measurement*, through the analysis of green building certification standards, to understand what the certification schemes are evaluating for plan and design of social practices. The *practice*, through a case study analysis, to know how liveability transits from plan and design to implementation.

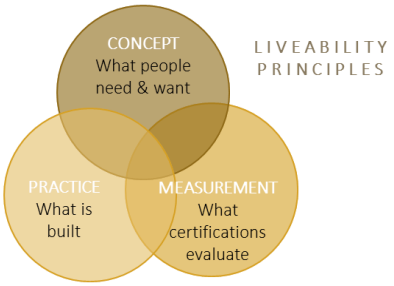


FIGURE 4 - LIVEABILITY PRINCIPLES INTEGRATION

As departing point, a liveability framework is created to establish this research categories of liveability. The resulting category list is in accordance in topic with the seven key priority factors identified in the survey report Creating Liveable Cities Together.

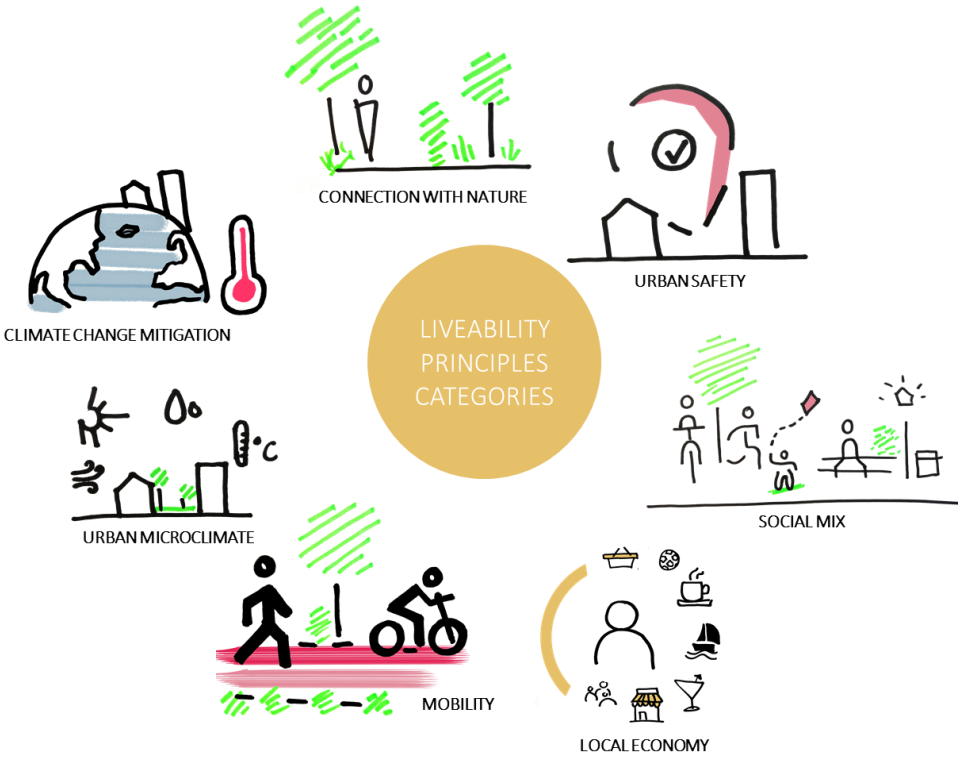
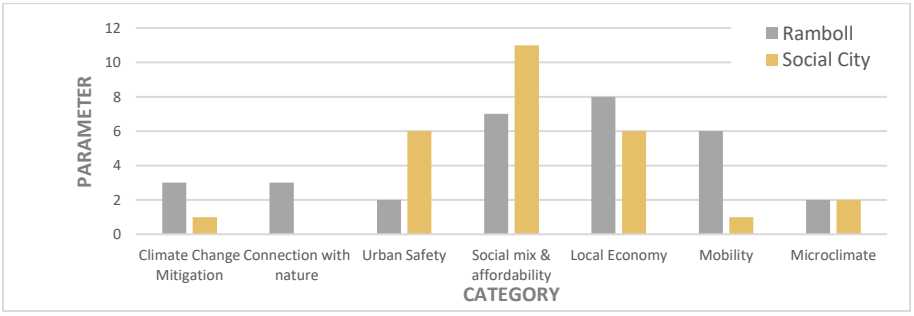


FIGURE 5 - LIVEABILITY PRINCIPLES CATEGORIES

Liveability concept

A comparison is made between Rambøll's Survey Report and Social City Index tool described in the section Liveability Concept: What people demands. The intent is to understand the relevance of the Liveability Framework Categories (**Error! Reference source not found.**) among them. The comparison analysis table (Appendix section Table 15 – Interpretation of Liveability by ConceptTable 15) integrates the number of parameters, the parameters description, and the liveability principles category on which they rely. It was found that even with the same scale of evaluation, the included parameters and the categories they relate to, differ among city surveys. The results are summarized in the following table.

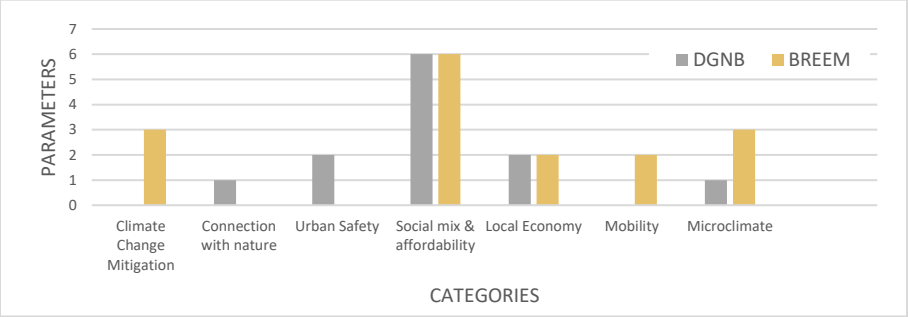
TABLE 7 – LIVEABILITY CATEGORIES RELEVANCE AMONG THE CONCEPT



Liveability measurement

A comparison is made among the DGNB and the BREEAM certification schemes for urban scale. The intent is to extract the parameters that could be relevant for the Liveability Principles and the parameters among them that rely within the established categories. The comparison analysis table integrates the Liveability principles Category, the number of parameters, the theme area as defined by the certification is the parameter embedded, the parameter as named in the certification scheme, the parameter objective, the physical space of the urban scale project on which this factor can be intervened; and how is it measured. The two certification schemes integrate their parameters within the liveability categories, as presented below. The complete analysis and comparison table can be found in Appendix section Table 17.

TABLE 8 – LIVEABILITY CATEGORIES RELEVANCE AMONG GREEN BUILDING CERTIFICATIONS



Liveability practice

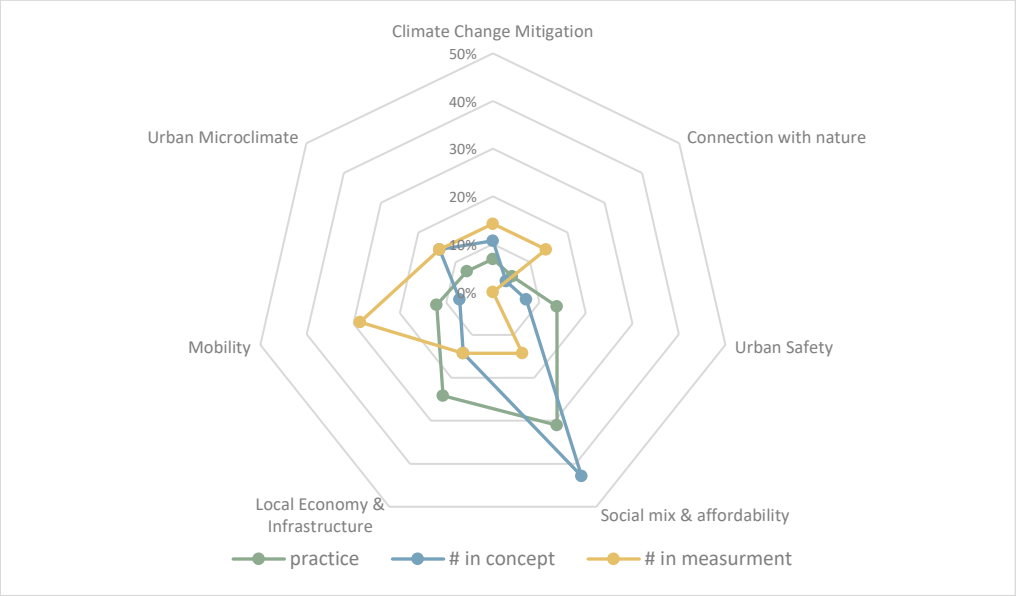
For liveability practice, it was not developed a comparison but a categorization of the project qualities within the defined Liveability Categories. This analysis incorporated the number of values for liveability the project has, its practice in the project, the physical area on which the practice was intervened and, an example or reference in the project. The complete analysis can be found in the Appendix section Table 18. The following table, represents the current Liveability practice in the project Nordhavn, as defined by the stakeholders interviewed.

TABLE 9 – LIVEABILITY CATEGORIES RELEVANCE FOR THE PRACTICE

Comparison

The liveability principles interlink and integrate the citizen's demands, what green building certification schemes evaluate and what planners & designers do. The spiderweb below puts together the summary for each analysis area: concept, measurement and practice. It generates an overall comparison of the liveability categories relevance within the defined liveability framework.

TABLE 10 – COMPARISON OF THE LIVEABILITY CATEGORIES RELEVANCE IN THE CONCEPT, MEASUREMENT AND PRACTICE



The spiderweb shows that Social Mix and affordability category is the one with a predominance of parameters for the concept and measurement, representing 31% and 43% accordingly. This tells about the great correlation between liveability and social sustainability. However, liveability goes beyond what is categorized within social sustainability. It comprehends areas related to economic and ecologic development too. This illustrative representation is also an example of the different understanding among the concept, the measurement and the practice of what makes a place liveable. However, beyond comparing and understanding its variations, the intention is to integrate liveability principles from these three-area sources, as detailed below.

Liveability Principles Results

The parameters within the liveability principles are defined by the repetition of keywords "parameters" is the three presented lists: Concept, Measurement, Practice. The resulting list of Liveability principles is the integration of the identified parameters among these three areas. The list of Liveability principles includes seven categories and 21 parameters. The categories are as presented above: Climate Change Mitigation, Connection with nature, Urban Safety, Social-Mix and Affordability, Local Economy, Mobility, and Urban Microclimate. The list will be the base to generate the indicators for the POE Tool for Liveability in Urban Districts.

TABLE 11 – LIVEABILITY PRINCIPLES

VALUE FOR LIVABILITY	CATEGORY	PARAMETER
v1	Climate Change Mitigation	Flooding and Storms
v2		Waste management
v3		Heat island Snow Other environmental impacts
v4		Green energy
v5	Connection with nature	Green areas
v6		Blue areas
v7		Wild nature & Biodiversity
v8	Urban Safety	Appealing streets and public space
v9		Trafic
v10	Social mix & affordability	Housing price & Affordability
v11		Diversity and community
v12	Local Economy & Infrastructure	Employment opportunities
v13		Flexibility & Functional Integration
v14		Urban services
v15	Mobility	Connectivity
v16		Collective mobility
v17		Active mobility
v18		Road infrastrucutre
v19	Urban Microclimate	Air
v20		Noise
v21		Light

On this research phase 1, there were identified and integrated the key values “parameters” for the different areas analysed: concept, measurement and practice. The Liveability principles combine categories and parameters. Together, they result in the framework that responds to the first research question How the qualities that enhance liveability at the urban district’s scale can be defined for a local context? The proposed method aims to go beyond theoretical definitions. This research suggests that the qualities that enhance liveability can be defined firstly, by the local residents themselves by surveying people’s needs and wants. Secondly, by investigating existing metrics for evaluation that address those areas with a sustainability approach, as it is the case of the green building certifications that have already embedded in their schemes the resulting topics from the survey. Thirdly, to combine the first two with an analysis of what has already done in the built environment. Lastly, to interlink the similar parameters among the three. The interlink of concept, measurement and practice can result in a list of feasible to impact, to measure and to build qualities that can enhance liveability. The next subsection will elaborate on the process of designing the Liveability indicators framework.

5.2 Liveability Indicators Design

This subsection presents the process and results on how to elaborate the liveability indicators, as metrics for evaluation for the liveability principles. The first step was to generate a framework, and the second step to design the indicators based on what was defined in the framework, as presented below.

5.2.1 Framework Design for Liveability Evaluation

The Liveability indicators framework design combines the best practices in the theory of Indicators Design and POE, reviewed in Chapter 2 (See page 10). The liveability indicators framework design also integrates the liveability principles created in the previous subsection. As inspired by Maclaren (1996) and combined with the POE methodology reviewed, the following lines present the process of 9 steps and their content that define this indicators framework.

A. Definition of urban sustainability goals

The purpose of this indicator's framework is to evaluate the liveability performance on urban districts.

B. Scoping

The target audience

The target audience for its usage are specialists, such as city planners and urban designers, project owners, facility managers and green building specialists.

Purpose

The purpose is to evaluate liveability performance in Urban Districts utilizing the liveability principles. Liveability is defined in this framework as the urban sustainability goal, to understand how the built environment is meeting the peoples demand for liveability.

Number of indicators

There will be created a reduced and representative set of indicators considering one indicator per category, to go in-depth into the design of the indicators. This set intends to be easily replicable and adaptable to other scales and contexts "regardless of differences in their situational context or their sustainability goals" (Mclaren, 1996).

Temporal and spatial bounds

Inspired by the levels of POE presented in chapter 2(See 10), the intention of this evaluation framework is to rely on the category Diagnostic. It will correlate physical environmental measure to subjective occupant response measures. (Christensen, 2019)

The spatial bound is the physical context, the "space between buildings" in the urban districts. Which means that streets, open public space, the building shape and its impact on the surrounding open areas are going to be centre of this evaluation.

The temporal bound refers to the data inputs. All data combined must be produced in the same year, being these from the user experience and satisfaction aspects, or data inputs from statistics or any other measurement. The indicators will focus on measurements that can be made during operations when construction processes are finished and at least after one year- four seasons of use. The calculations will be related to the public space and private but common outdoor areas of an urban scale project, as well as the mass volumes and their impact on the use of public areas. The temporal and spatial bounds might be modified on the individual indicator scale if needed for the measurement.

C. Selection of appropriate indicator framework

The selected framework for the design of the indicators is Goal-based with the creation of "one or more indicators for each goal or combination of goals" (Mclaren, 1996). Inspired by this author, this indicator framework "requires the identification of sustainability goals for a community". As it is designed on this research, the goal is to measure Liveability by the areas defined on the Liveability principles. The categories are Climate Change Mitigation, Connection with nature, Urban Safety, Social-Mix and Affordability, Local Economy, Mobility and Urban Microclimate. The 21 parameters within the Liveability principles will be the base for the indicators topic (see Table 11).

D. Definition of indicators selection criteria

For this framework, the selection criteria for the representative set of indicators is established as follows:

D.1 Repetition among the analysed areas: Concept, Measurement and Practice, its relevance to the needs, measurement and practice of liveability: how many times is the parameter repeated in the three of them. (see Table 12)
D.2 Responsive to change and adaptable to other urban district qualities.
D.3 Accurate and accessible data that has availability over time and that is understandable by potential users.
D.4 Effective to collect and use, easily managed by any of the interest groups mentioned above.

E. Identification of the Set of Potential Indicators

The potential set of indicators is defined by the parameters within the Liveability principles. There are in total 21 values for liveability. These values involve specialized knowledge by experts: in this case, the certifications reviewed, the local surveys reports and the practice of liveability.

F. Evaluation of indicators and final set selection

The 21 parameters of the liveability principles are assessed against the selection criteria defined in point no *4 - Definition of indicators selection criteria*. The resulting set includes a representative indicator per each category that meets the criteria designed. The parameters that "meet" the criteria mentioned above are the ones with the higher number of repetitions among the three-areas (Concept, Measurement and Practice).

TABLE 12 - INDICATORS FINAL SET SELECTION

VALUE FOR LIVABILITY	CATEGORY	PARAMETER	D1 repetition			Other criterias		
			# IN CONCEPT	# IN MEASUREMENT	# IN PRACTICE	D 2	D 3	D 4
v1	Climate Change Mitigation	Flooding and Storms	1	2	1	x	x	x
v2		Waste management	2					x
v3		Heat island & snow / Other environmental impacts		1		x		
v4		Green energy	1		1			x
v5	Connection with nature	Green areas	1	1		x	x	x
v6		Blue areas	1		1		x	x
v7		Wild nature & Biodiversity	1	1		x		
v8	Urban Safety	Appealing streets and public space	6	2		x	x	x
v9		Trafic	2	-		x	x	x
v10	Social mix & affordability	Housing price & Affordability	5	3	1	x	x	x
v11		Diversity and community	11	7	1	x		
v12	Local Economy & Infrastructure	Employment opportunities	4	1		x	x	x
v13		Flexibility & Functional Integration	1	1	1	x		x
v14		Urban services	9	1		x	x	x
v15	Mobility	Connectivity	2		1	x		
v16		Collective mobility	2	2		x	x	x
v17		Active mobility	2	2	1	x	x	x
v18		Road infrastrucutre	1	1		x	x	x
v19	Urban Microclimate	Air	1	2	1	x	x	x
v20		Noise	2	2		x	x	x
v21		Light		1		x		

G. Assessment criteria: Areas for measurement, Data collection

G1. Calculation and index value

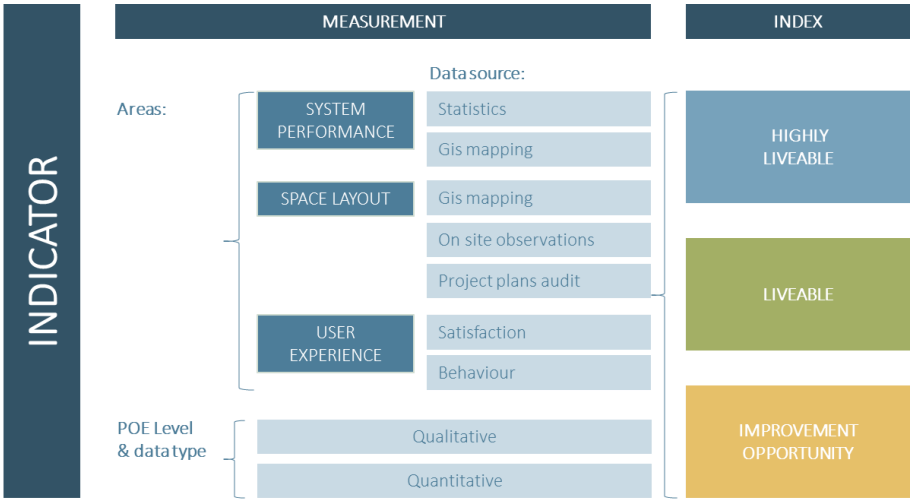


FIGURE 6 – Indicators Assessment Criteria

Three-area evaluation

Each indicator measurement will be integrated by the following three areas: System Performance, Space Layout, and User Experience. The intention is to compound an evaluation that puts together these three to understand their correlations and analyse their variations when they are presented. See Figure 6.

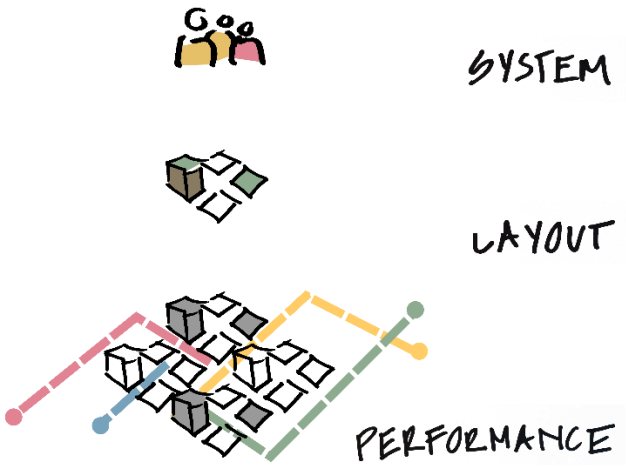


FIGURE 7 - THREE-AREAS OF ANALYSIS

Area one: System performance

Evaluates the criteria change over time, to understand its trends over the years and performance variations. It assesses the correlation of the area of analysis, in this case, the district, to the city equivalent, to understand if the criteria are performing in better standards than the local averages. For this evaluation mean, the data collection sources will be demographic data, local statistics or

project owner generated ones, GIS evaluation with either available public or private data and if available or on-site physical monitoring. Depending on the data source, data will be either qualitative or quantitative; with the preference to develop quantitative results for it.

Area two: Space Layout

Evaluates the built environment of the district, and how the area is physically looking after construction and over the years. For this evaluation mean, the data sources will be GIS, On-site observations or field study trips and when available, project plans audits. Depending on the data source, data will be with a mix approach, either qualitative or quantitative.

Area three: User experience

Evaluates how the residents, workers or visitors experience the everyday life, if they are satisfied with the qualities of the district, and their behaviour and preferences. For this evaluation mean, the data collection sources will be surveys, interviews or reports with results on users experience in the project area. Depending on the data source, data will be either qualitative or quantitative.

G2. Metrics for evaluation within the three-areas of evaluation

The equations designed for each of three areas are the result of the literature research, where different means for evaluation and calculations were reviewed for the various parameters. The equations and individual indicator index values are reference of DGNB, BREEAM and the Twelve Quality Criteria evaluation methods.

Each area (system, layout and experience) can earn up to 5 points individually. The indicator grade will be expressed by:

$$Average = \sum Points\ earned\ on\ (systems\ performance + Space\ layout + User\ Experience)$$

The resulting value will reflect the liveability level in the urban district. The index values determine the overall rank for each indicator and in total. The index values are “highly liveable”, “liveable”, and opportunity for improvement.

Highly liveable
High standard of liveability. Sum of district qualities in System, Layout and Experience results in a grade equal or higher than 4.

Liveable
Meet standard for liveability. Sum of district qualities in System, Layout and Experience results in a grade equal or higher than 3.

Improvement opportunity
The project should consider improvement strategies. Sum of district qualities in System, Layout and Experience results in a grade lower than 3.

H. Indicator Assessment structure

An indicator summary card is designed. Each of these will contain the following description:

- General information: Name, indicator number, parameter and liveability category it belongs to.
- Description: intents and relevance for liveability
- Areas that measure: System, Layout, Experience
- Data source and POE level (Quantitative, Qualitative)
- Index value: highly liveable, liveable, Improvement possibility

I. Assessment of indicators performance

There will be an evaluation of one case study to identify improvement opportunities on the indicators design and usability.

5.2.2 SET OF LIVEABILITY INDICATORS

The resulting seven indicators designed after the framework previously presented are presented below. Each indicator is shown in a summary card, which contains the indicator's general information, description, areas that measure: System, Layout, Experience, data sources, POE level, and lastly, index value.

Indicator 1. Climate Change Mitigation

Indicator name		Safe storm and rain experience	
Indicator No		1	
Category		Climate Change Mitigation	
Parameter		Flooding and Storms	
Why it matters for liveability			
Climate change and its environmental impacts in cities as increased amount of everyday rain, call for rethinking of design for storm protection, water management and the way land cover is treated. At the building and urban area level, there are several options for compensatory measures that reduces the risk of the inhabitants of the area. This indicator evaluates the correlation of the existing design measures against storms and flooding, the user experience and the wind trends over the years.			
Areas that evaluate		Data source	Type
Systems performance	x	Statistics or Demographic data	QT
Space Layout	x	On-site observations	QL
User Experience	x	Survey or interviews	QL
Measurement			
A. Evaluate the average winds recorded		Local average wings above, within or below the national average.	1, 3 or 5 points
B. Evaluates the space between buildings protection for storms and flooding.		Sum of measures and systems for leakage, detention, delay, divert, evaporation, seepage, collection and use of rainwater.	Sum of 5 points
C. Evaluate the user experience during storm events		Q1. Vulnerability due to storm and rain Q2. Observation of flooding in the area	(Q1+Q2) /2
Calculation		(A + B + C) / 3	
Index values			
Highly liveable	5		
Liveable	3		
Improvement posibility	1		

Indicator 2. Connection with nature

Indicator name		Green spaces availability and use	
Indicator No		2	
Category		Connection with nature	
Parameter		Green areas	
Why it matters for liveability			
Every new urban area is related directly or indirectly to its surrounding existing ones, and how the urban structure interacts with the surroundings is from great importance. The presence of nature elements is of great important for biodiversity preservation and human wellbeing. A beautiful and diverse nature increases the quality of life, the value of the district through its green and nature experiences. The presence of green has a direct correlation also with climate impact and microclimate. Green areas in cities help to renew air and improve air quality. More plants in the cities can contribute to cleaner air. A cleaner result of nature in cities has a direct impact on health and wellbeing. It can reduce stress, the risk of obesity, depression, anxiety and bipolar disorders. Therefore, this indicator analyses the performance of existing green areas and their impact on occupant's wellbeing and enjoyment.			
Areas that evaluate		Data source	Type
Systems performance	x	GIS Mapping	QT
Space Layout	x	On-site observations	QL
User Experience	x	Survey or interviews	QL
Measurement			
A. Green availability and access		Green coverage ratio: Walking distance of greenspace Green space per inhabitant	(M1+M2) /2
B. Quality of greenery in public spaces.		M1. Proportion in public space M2. Presence in different types of green M3. Greenery quality	(M1 + M2+ M3)/ 3
C. Experience and Satisfaction		Q1. View and proximity to green Q2. Green mantainance	(Q1+Q2) /2
Sum Calculation		(A + B + C) / 3	
Index values			
Highly liveable	5		
Liveable	3		
Improvement posibility	1		

Indicator 3. Urban Safety

Indicator name		Safe and attractive public space	
Indicator No		3	
Category		Urban Safety	
Parameter		Appealing streets and public space	
Why it matters for liveability			
The occupant's wellbeing and their will to participate in social life is determined by how the urban area is experienced. There is a great correlation among attractiveness and urban safety, and the more visited the spaces are, the safer they become as they are more observed. The safeness of an area impacts its attractiveness. Likewise, Appealing streets and public spaces can increase trust and reduce crime. Therefore, the emphasis of this indicator is to understand the level of attractiveness in correlation to safety in the public space.			
Areas that evaluate		Data source	Type
Systems performance	x	Statistics or Demographic data	QT
Space Layout	x	GIS Mapping	QT
User Experience	x	Survey or interviews	QL
Measurement			
A. Crime numbers and the tendency for immediate surrounding.		M1. Number of criminal acts M2. Tendency compared to local	(M1 + M2) / 2
B. Physical conditions that increase the feeling of safety.		M1. Openness & high degree of visibility M2. Buildings Ground floor with mixed-use M3.Ground floor occupancy M4. Maintenance-friendly buildings & outdoor furniture	(M1+M2+M3+M4)/ 4
C. Experience and Satisfaction		Q1. Feeling of safety Q2. Lighting atmosphere	(Q1+Q2) / 2
Sum Calculation		(A + B + C) / 3	
Index values			
Highly liveable	5	Highly liveable	
Liveable	3	Liveable	
Improvement posibility	1	Improvement posibility	

Indicator 4. Social mix & affordability

Indicator name		Public life that enables social cohesion	
Indicator No		4	
Category		Social mix & affordability	
Parameter		Diversity and community	
Why it matters for liveability			
Social interaction results in social cohesion that can also contribute to higher stability and resilience. Great diversity is considered as an element of social sustainability; by ensuring a balanced mix of housing typologies, spaces, services and functions. The urban scale projects bring together people from different age and social groups by creating quality outdoor public areas as meeting places for enjoyment. An urban area with a high population density should thus offer its residents larger open spaces, as these will shape the framework of the urban life that is lived. Through this, culture, history and diversity can be created. Therefore, the public space must enable different types of social interaction and must provide comfort and attractiveness to people that stay on it or the ones that move thorough them throughout the day and throughout the year.			
Areas that evaluate		Data source	Type
Systems performance	x	GIS Mapping	QT
Space Layout	x	On-site observations	QL
Experience	x	Survey or interviews	QL
Measurement			
A. Creation of inclusive public life		Proportion of inclusive public space by hectare	1 to 5 points
B. Enabling the conditions to stay		M1. Sitting options M2. Options for talking and listening M3. Opportunity to perform diverse activities M4. Universal access M5. Welcoming all age groups	1 to 5 points
C. Satisfaction and behaviour		Q1. Frequency of use Q2. Level of satisfaction	(Q1+Q2)/2
Sum Calculation		(A + B + C) / 3	
Index values			
Highly liveable	5		
Liveable	3		
Improvement posibility	1		

Indicator 5. Local economy

Indicator name		Variety and connectivity to social and commercial infrastructure	-
Indicator No		5	
Category		Local Economy & Infrastructure	
Parameter		Flexibility & Functional Integration	
Why it matters for liveability			
Local economic stability supports long term financial sustainability. The urban dynamics demand an area that can be continuously adapted to market development, with a balanced mix of housing offers and different uses. What characterizes the functional mix is an urban development project that firstly, enables the existing local qualities and culture, secondly, enables a balance of resources and demands through an optimal location, and lastly, enables diversity for social and business life attractiveness. Land use and population growth must be correlated, as an excessive concentration of urban growth in certain areas can result in adverse health and social consequences. Functionality and attractiveness are also determined by universal access and proximity to essential services. Identity and social cohesion can be enhanced by good infrastructure as the conditions that when in proximity, facilitate daily life activities of residents and users. Access to local services also impacts wellbeing by active mobility and stress reduction, less congestion and noise due to traffic, and cleaner air by reduced particulate pollution.			
Areas that evaluate		Data source	Type
Systems performance	x	GIS Mapping	QT
Space Layout	x	Project Plans audit	QT
User Experience	x	User Experience	QL
Measurement			
A. Connectivity		A. Convenient access to social and commercial infrastructure	5. BI>.7 3. BI>.4 1. BI>.2
B. Berry Index (DGNB) Land use share		B. Share and diversity of land use	5 to 1 points
C. Satisfaction and Behaviour		Q1. Satisfaction with existing variety Q2. Activities user performs in the project area within a walking distance	(Q1+Q2/ 2)
Sum Calculation		(A+B + C) / 3	
Index values			
Highly liveable	5		
Liveable	3		
Improvement posibility	1		

Indicator 6. Mobility

Indicator name		Convenience for active mobility	
Indicator No		6	
Category		Mobility	
Parameter		Active mobility	
Why it matters for liveability			
Active mobility in cities is a great way to combat challenges like congestion and pollution. It also has direct impact on human wellbeing than can result in reduced stress, healthy and active lifestyles. Active mobility is convenient when it is safe, efficient, connecting, barrier free and flexible for different interests. The more convenient it is perceived by the users, the more likely it will be that they will consider it as their preferred mobility option. Street design and furniture increases the attractiveness of moving on foot. Therefore, this indicator assesses the physical qualities and their impact on the user experience for active mobility preference.			
Areas that evaluate		Data source	Type
Systems performance	x	Statistics or Demographic data	QT
Space Layout	x	On-site observations	QT
User Experience	x	Survey or interviews	QL
Measurement			
A. Registered active mobility accidents		Relation of local to city accidents average	5, 3 or 1 point
B. Layout conditions for active mobility		M1. Weather shelter M2. Safe crossroads M3. Active mobility first M4. Openness and visibility	From 1 to 5 points
C. Behaviour,experience		Q1. Transport mean Q2. Commuting time	Q1+Q2/ 2
Sum Calculation		A + B + C / 3	
Index values			
Highly liveable	5		
Liveable	3		
Improvement posibility	1		

Indicator 7. Microclimate

Indicator name		wind comfort	
Indicator No		7	
Category		Urban Microclimate	
Parameter		Air	
Why it matters for liveability			
Microclimate has a direct impact on wellbeing. The space between buildings must enable attractive opportunities for daily and seasonal use. Air, as one of the components of the microclimate, is directly correlated to the sensing experience. The intensity of the wind also depends on how far one is from the coast (DMI, 2019). High wind speeds can create uncertainty for pedestrians, cyclists, and people gathered in public space. High wind speeds can be altered by the built environment, as the structure of the city physical elements affects the aerodynamics of the air. The wind mechanical effect is related to the speed of the wind. While the thermal effect is related to whether the cooling effect of the wind feels uncomfortable; involving air temperature, humidity, solar radiation and the person physical activity. Therefore, spaces must provide protection that enable comfort and safety.			
Areas that evaluate		Data source	Type
Systems performance	x	Statistics or Demographic data	QT
Space Layout	x	On-site observations	QT
User Experience	x	Survey or interviews	QL
Measurement			
-		-	-
A.Local wind speeds		The number of days per year on which alarm levels are exceeded.	1 to 5 points
B. Building volumes impact		M1. Buildings height variation measured by floors M2. Minimization of distance between buildings M3. Variation of street throughout its length. M4. Vegetation to diffuse wind flow.	(M1+M2+M3+4)/4
C. Experience and usability of public space		Q1. Experienced strong winds Q2. Public space use throughout the year	Q1+Q2/ 2
Sum Calculation		A + B + C / 3	
Index values			
Highly liveable	5		
Liveable	3		
Improvement posibility	1		

A detailed version of the measurement framework is included in the Appendix Section Liveability indicators metrics for evaluation (See page 91). As presented in this subsection, a framework on how to define indicators is designed by putting together the knowledge acquired through the POE and indicators literature study. On the design of the indicators, the holistic level of measurement by the three-areas of evaluation, is the result of curiosity for exploring a POE in a higher level, on which results can rely in a mixed data approach, but with a predominance of quantitative values. The resulting seven indicators metrics for evaluation were defined by the green building certification DGNB and BREEAM, by extrapolating calculations applicable to the plan and design practices, to the operational way of measuring them. The next subsection presents the Tool usability evaluated in an urban district case study.

5.3 POE Tool for Liveability at Urban Districts

5.3.1 Case Study Evaluation

The tool usability is evaluated in a case study. As mentioned in the section methodology section 4.6 (Page 27), the case study project is Nordhavn District. The case study data sources are explained in section methodology (page 22). Information about the specific data source and the findings for each indicator and its three-areas of evaluation are illustrated with charts, photos, quotes, maps and graphics. These can be found in appendix section Results: Case Study Evaluation Appendix (See page 105).

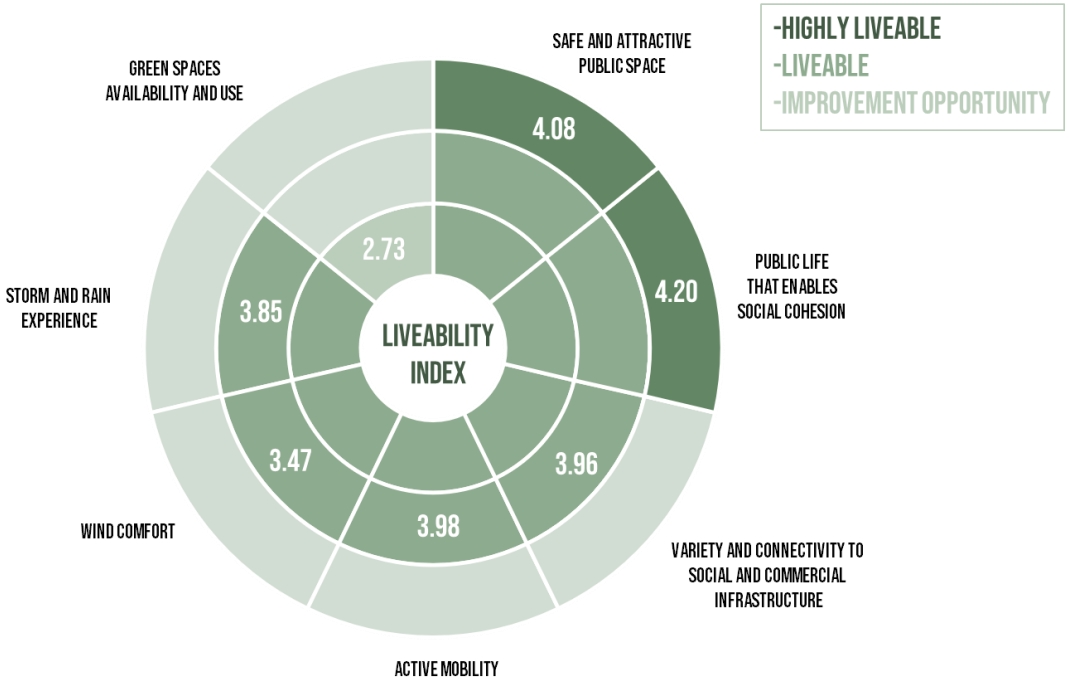


FIGURE 8 - LIVEABILITY INDEX FOR CASE STUDY

Liveability Impact Reporting

The table below shows the findings for the project evaluated. For each indicator is presented the points obtained by area of measurement and indicator average grade earned, as well as an overall project performance which is the average of the seven indicators grades.

TABLE 13 - CASE STUDY LIVEABILITY PERFORMANCE

CASE STUDY EVALUATION					
Project	Nordhavn				
Results	3.8	liveable			
Indicator	System	Layout	experience	grade	Index value
Safe storm and rain experience	5.0	3.0	3.6	3.85	liveable
Green spaces availability and use	3.0	1.7	3.5	2.73	Improvement opportunity
Safe and attractive public space	3.0	5.0	4.3	4.08	highly liveable
Public life that enables social cohesion	3.7	5.0	3.9	4.20	highly liveable
Variety and connectivity to social and commercial infrastructure	4.7	4.3	2.9	3.96	liveable
Convenience for active mobility	5.0	3.5	3.4	3.98	liveable
wind comfort	5.0	2.3	3.1	3.47	liveable
	4.2	3.5	3.5	3.8	

Nordhavn District was analysed to assess its liveability performance. Table 13 provides the grade obtained per indicator, which is compounded by the average of points earned by each area of evaluation. An index value is provided at the individual indicator and the general framework level. The project resulting grade was 3.7 points, which rank it as "liveable" meeting standards for liveability.

Liveability impact trends on indicators

It can be understood through this evaluation that the same urban design strategies impact the liveability categories in different ways. This results in a variation of the level of liveability among indicators. In the case of Nordhavn, while the project performed as highly liveable in some indicators, it had the opportunity for improvement in others, even if the indicators evaluated the same physical area. As presented in Figure 9, Nordhavn qualities are more oriented to distinguish it through its safe and attractive public space with conditions that enable a public life that enables social cohesion. (indicators 3 and 4 respectively). On the other hand, Green spaces availability and use is the indicator that has opportunities for improvement.

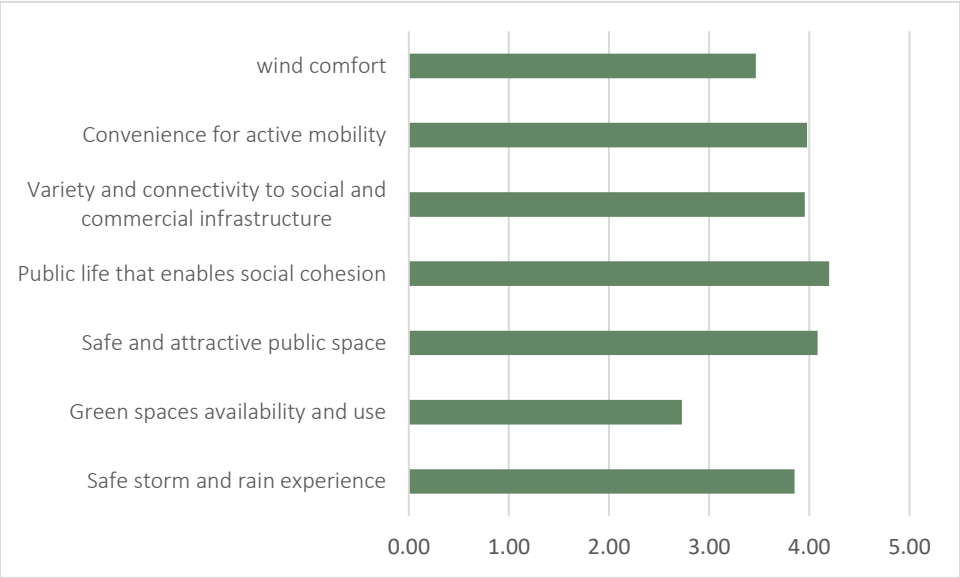


FIGURE 9 – CASE STUDY: LIVEABILITY PERFORMANCE BY CATEGORY

The district performance understood by the three-area of evaluation

A three-area evaluation for each indicator assisted in connecting the three-areas, to deeper understand their correlations or to investigate the variation among the trends (system), the built environment (layout) and the user experience. To analyse the variations among the three areas allows identifying improvement opportunities either in the built environment or through programs and projects that could enhance the project area performance.

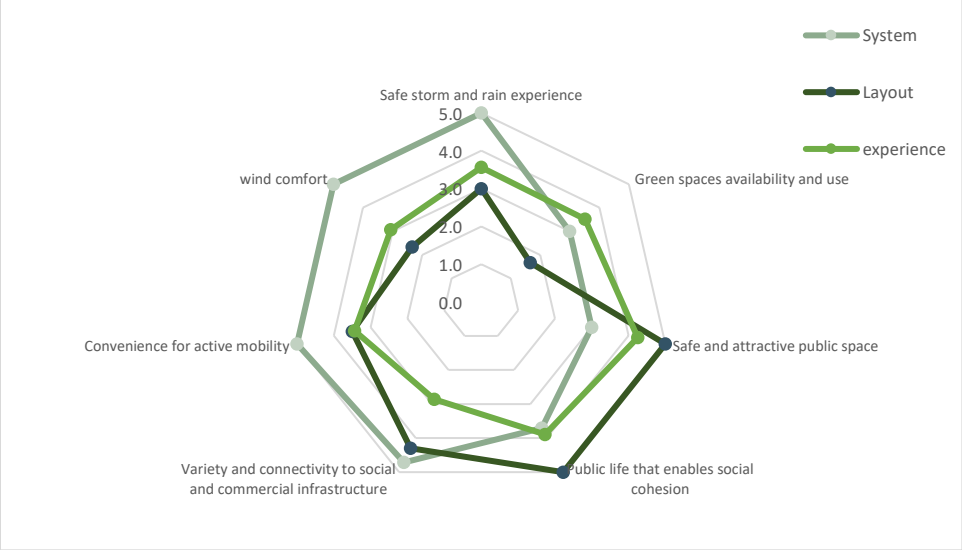


FIGURE 10 – CASE STUDY LIVEABILITY PERFORMANCE

An example of this is appreciated in the spiderweb above. The results in the indicator Green spaces availability and use are varied by area. The built environment (layout) is under the standard for liveability with a grade of 1.7 resulting in “improvement opportunity” due to lack of presence of green elements in the public space or access to green spaces. The user’s experience, however, graded “liveable” obtaining 3.5 points and tells that users are satisfied with the maintenance of the existing

green space and that they can see a green element from their home or office windows. The System value ranked “liveable” obtaining 3 points, combining measurement for convenient, walkable access to green areas and the availability in the district in comparison to the available on the city (green space/inhabitant). If measuring these three areas independently, it could be concluded that there is a significant lack of green structure if one only focuses, for example, on the layout. But this three-area evaluation allows understanding the correlations, for instance, that even if the current available green public space is limited people are satisfied with it, and with the other options the area provides, for example, its direct proximity to the water. With this stated, it can be stated that a three-area analysis allows gaining an in-depth understanding of the performance.

Insights into actions

Even if already finished the first phase of development and with more of 2,500 inhabitants, Nordhavn is still a project under development. Hence, many of the qualities on which it is currently grading low are going to be integrated with the further project phases. Many strategies could be incorporated for the layout grade of 1.7 “improvement opportunity” in the indicator Green spaces availability. For instance, more public green space can be incorporated into the subsequent project areas to develop. This way, the proximity to green areas assessed on the “system” area can improve the overall grade. On this project, in particular, the project stakeholders are already undertaking actions and measurements for improvement. During the interviews conducted, it was learned about some areas for improvement that the project is to implement in further stages. Another option is to rethink the existing public space and integrate more green structure to it.

Indicator performance sample

VARIETY AND CONNECTIVITY TO SOCIAL AND COMMERCIAL INFRASTRUCTURE

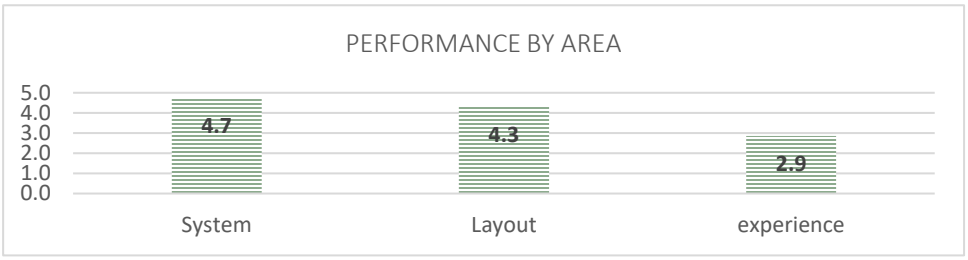
Grade	*Interpretation*
Highly liveable Liveable Improvement opportunity	"It is an area still underdevelopment..." (Survey respondent) Even if recently developed, the district has now the qualities than enhance the economic local development, in the topic of Variety and connectivity to social and commercial infrastructure. At the district level, there are already several opportunities for diverse activities within a walking or shot cycling distance. However, satisfaction can always be improved, a 56% of the survey respondents coincide that they are satisfied, but not very satisfied with the current offers. This mainly due to the reason that is a fairly new area and many of other city functions haven't installed themselves there yet but will be incorporated.

Why it matters for liveability

Local economic stability supports long term financial sustainability. The urban dynamics demand an area that can be continuously adapted to market development, with a balanced mix of housing offers and different uses. What characterizes the functional mix is an urban development project that firstly, enables the existing local qualities and culture, secondly, enables a balance of resources and demands through an optimal location, and lastly, enables diversity for social and business life attractiveness. Land use and population growth must be correlated, as an excessive concentration of urban growth in certain areas can result in adverse health and social consequences.

Functionality and attractiveness are also determined by universal access and proximity to essential services. Identity and social cohesion can be enhanced by good infrastructure as the conditions that when in proximity, facilitate daily life activities of residents and users. Access to local services also impacts wellbeing by active mobility and stress reduction, less congestion and noise due to traffic, and cleaner air by reduced particulate pollution.

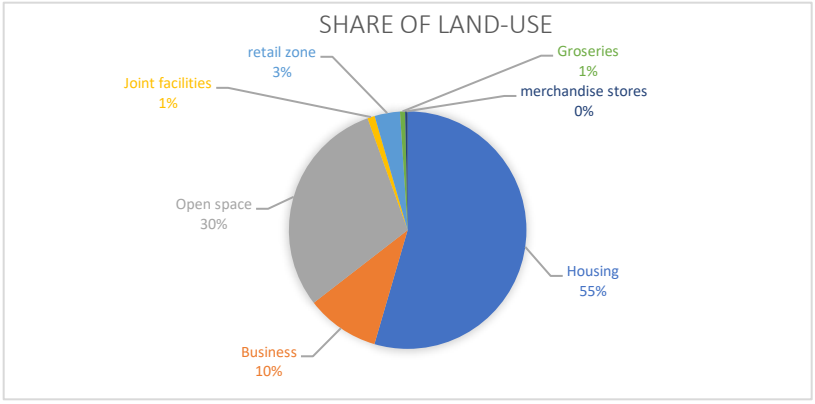
Areas evaluated	*Data sources*		*Type*
Systems performance	GIS Mapping	(KK, 2019)	QT
Space Layout	Project Plans audit	Århusgadekvarteret – Lokalplan (KK-2, 2018)	QT
User Experience	Survey	Primary source	QL
Measurement	*Topic*		*Points*
A. Connectivity	A. Convenient access to social and commercial infrastructure		4.7
B. Berry Index (DGNB) Land use share	B. Share and diversity of land use		4.3
C. Satisfaction and Behaviour	Q1. Satisfaction with existing variety Q2. Activities user performs in the project area within a walking distance		2.9
Sum Calculation	(A+B + C) / 3		3.96



Additional Evidence

Systems performance

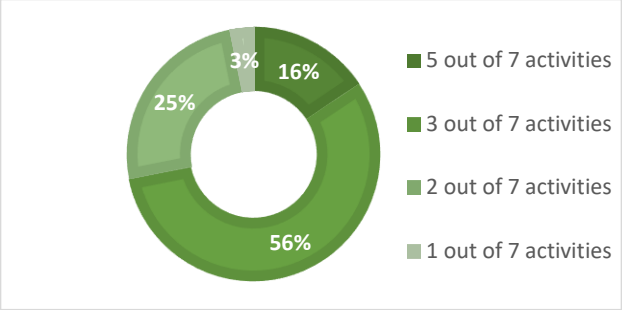
Space layout



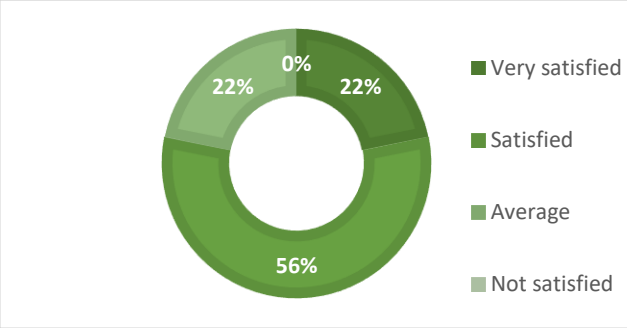
Survey

Q1. Which of the following activities do you perform in the area within a 10 minutes' walk? (select all applicable ones)

-Use Educational facilities (daycare, schools)
-Use of clubs(elderly, youth, art), library
-Shop in the area (kiosk, supermarket, butikk and shopping centre)
-Use of health facilities (practitioner, apotek, hospital)
-Use of services like a bank, post service, other services
-Use for leisure and cultural activities: cultural house, religious gatherings, social gathers in a restaurant, bar, cafe; Use of public space and recreational activities: green spaces, water, nature areas, squares
-Use of sports facilities (outdoor and indoor)



Q2. Are you satisfied with the availability of social and commercial infrastructure within walking distance? Very satisfied, Satisfied, Average, Not satisfied



5.3.2 Tool Usability: Improvements to Evaluation Tool

There were identified some limitations and improvement opportunities in the use of the indicators during the case study evaluation.

Indicators three-areas of evaluation

Firstly, the evaluation means for systems performance were designed considering that there is publicly available data at the district scale. There was the challenge of not having access to district level statistics. Therefore, adjustments, assumptions and interpretation of statistics needed to be made. An example of it is indicator *No. 6-Convenience for active mobility*. On it, the system performance evaluation was related to the trends in the registered local accidents for active mobility. Nowadays, the relation of the district accidents can only be measured if surveys estimate it or if there are private sources for district-related measurements about it. Since there was no district-related information on it, an estimation was made from the proportion of the city accidents. For further use of the tool, either district-level statistics need to be generated or estimations can be used again. On this indicator in particular, it was decided not to change the evaluation mean " district accidents proportion in relation to the city ones" as even if not proven due to the lack of available data, one cannot state the city active mobility safety by analysing only everything as a whole, as the conditions, the infrastructure and the affluence of use are very varied along with the different city districts.

Secondly, on the layout evaluation, most of the data collection was meant to be from on-site observations; this means, visiting the project area and walk through it to respond questionnaires related to the physical features of the districts. The on-site observations represent a qualitative measurement. The intend to conduct these is to observe the physical conditions of the built environment and their overtime change. The on-site observations results are highly subjective, as there can be presented significant variations among the grading given by either experts or professional familiar with the field of planning and urban design, or if it is provided by a user with no relation of this expertise field. The best fit found on how to adapt the layout grading was to combine the on-site observations with project plans audit. Then, quantitative data can be incorporated, and the resulting grade can become a fairer measurement. An example of this is the indicator No. 4-Public life that enables social cohesion. This indicator requires to observe qualities of the public space and how many spaces with these characteristics are available in the district (units per hectare). Such characteristics are the variation on type: Open private spaces, open public spaces, playgrounds, promenades, squares, landscape park; the different uses: recreation, sports, gastronomic use, room for various unplanned and unexpected uses; the available urban furniture and equipment: seating areas, bicycle parking areas, public transport stops, lighting, and lastly, how welcoming are they for all users and age groups. These four characteristics-means for evaluation can be observed on a field study, but the availability per hectare requires to measure areas either in project plans or city maps. Therefore, the best-identified way to come up with a fair way of evaluating it was to combine on-site observations and project plans audit. The availability per hectare was measured in project plans.

Lastly, it was generated a survey for the user experience evaluation. The propose was to come up with at least two questions per indicator, one related to satisfaction, and another one related to behaviour and preferences. The intend to make it a quantitative assessment with closed-ended questions resulted in a numerical understanding not so flexible for people's opinion. Some of the surveys were collected directly by interviewing the residents in the district. Enabling conversation allows us to learn about how particular lifestyles result in different experience of the same project area. For example, when evaluating the indicator no 3. Safe and attractive public space, 97% of the people responded they feel either super safe or safe in the district area. However, when having conversations with the neighbours, it was learned about the impact of the popularity of the public space and the inconvenience it could cause for neighbours. One of them mentioned about early morning walk to do bathing in the waterfront and having to walk around broken glass bottles result of people's party in the waterfront area, which is highly popular in summer times. Even if the overall maintenance and cleanness were highly ranked by most of the residents, being a user that experience the public space early in the mornings can provide a very different picture. An idea on how to improve the responses related to the user's experience is to look ad demographic profiles of the residents and to try to have a representative poll of answers on the surveys, on which more interest and profiles can be reflected, to have a greater understanding of the experience of all age groups and interests throughout the day and year usage of the space.

Data collection and analysis

The data collection was a significant process and required to look at many varied sources, as the indicators evaluate three different areas. The data analysis and calculations do not represent significant complexity, but if there is no access to data sources, then the calculations or data analysis becomes unreliably. On the analysed case study, the project owner develops yearly POE. This data availability assisted in understanding patterns throughout the years and allowed access to district-level data. But in many other districts in the city, there are no ongoing evaluations, and it could be difficult to get access to district-level statistics as for example on the indicator *No. 6-Convenience for Active Mobility* where it is pretended to estimate the correlation of active mobility accidents on the district level. Consequently, the tool usability is highly dependent on the availability of district level public or private data.

Adjustments made to the indicators

On the indicator *No. 1-Safe storm and rain experience,* the layout evaluation was resumed. Initially, the strategies for storm and flooding were listed separately. After understanding the high correlation of them, it was decided to have a layout evaluation that assesses storm and flooding together. As mentioned before, it was required to adjust some indicators and incorporate project plans audit, to result in a reliable way of grading the Layout through the on-site observations combined with numerical values that support the grade obtained. Another example of this is the indicator *No. 7-Wind comfort*. This indicator evaluates on layout the relation of building height to the street width, as well as the street variation throughout its length. The first element has as unit value a proportion and the second one meters. For this, it was required to consult maps and project plans to give a realising understanding of the parameters.

To summarise, even if there were difficulties in collecting the data, the tool was possible to utilise on this case study. The tool provided a holistic overview of the project, assessing its sustainability qualities in terms of liveability, resulting in a high correlation of liveability and sustainability.

6. DISCUSSION

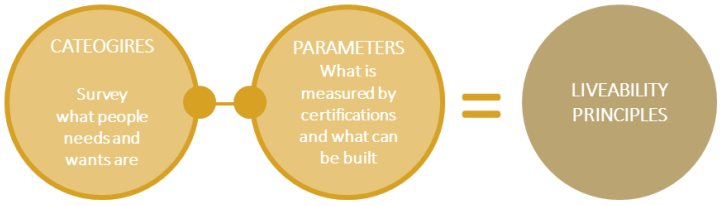
6. Discussion

6.1 Response to Research Questions

Research question Phase 1	Research question Phase 2	Research question Phase 3
How the qualities that enhance liveability at the urban district's scale can be defined for a local context?	How can these qualities be evaluated to understand liveability performance in urban districts?	How liveable are urban districts planned under sustainability premises?

How the qualities that enhance liveability at the urban district's scale can be defined for a local context?

There were reviewed city survey reports that show the understanding of citizens concept of liveability and green building certification schemes that present what is evaluated on social sustainability in the plan and design of urban-scale projects. Reviewing the literature allowed to explore different methodologies on how to assess social aspects of life in cities. Altogether, permitted to design a process on creating local context "liveability principles". As suggested by this research project, this process to define "Local Liveability" require understanding what people's needs and wants in their urban daily life, and to investigate existing metrics for evaluation that address those areas with a sustainability approach. To summarize, the "liveability principles" are the qualities of the built environment that enhance liveability at the local level. These integrate seven categories on what people relate to a liveable place. The 21 parameters identified, which are the resident's demands, can be shaped by the built environment and can be measured with a great sustainable approach. The content of these categories and parameters are related to the local area, which means that relevance could vary to another context. However, the methodology to determine the categories and parameters for liveability at the local level could present great replicability opportunity.

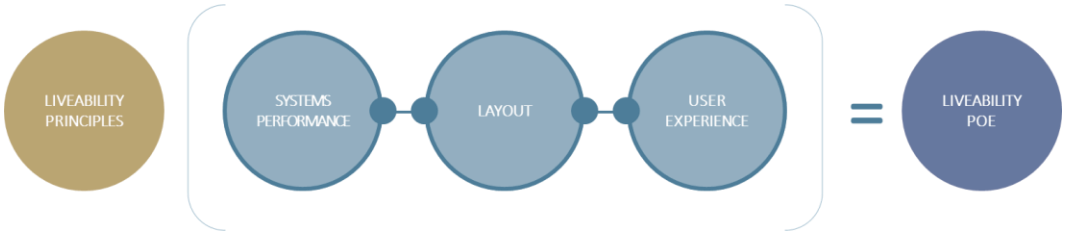


As stated before, this research suggests that the qualities that enhance liveability can be defined firstly, by the local residents themselves by surveying people's needs and wants. Secondly, by investigating existing metrics for evaluation that address those areas with a sustainability approach, as it is the case of the green building certifications that have already embedded in their schemes the resulting topics from the survey. Thirdly, to combine the first two with an analysis of what has already done in the built environment. Lastly, to interlink the similar parameters among the three. The interlink of concept, measurement and practice can result in a list of feasible to impact, to measure

and to build qualities that can enhance liveability. The next subsection will elaborate on the process of designing the Liveability indicators framework.

How can these qualities be evaluated to understand liveability performance in urban districts?

This research recommends a holistic approach to evaluate liveability performance, by the interlink of the three-areas of evaluation. The three-areas of evaluation are the systems performance throughout the years, the built environment or layout change during its use, and the peoples experience, their behavior and satisfaction level on the place. Altogether, provide a systemic approach that correlates different data means that are typically analysed separately. This research presents a sample of seven indicators designed in the topic area of seven parameters defined in phase one. These seven indicators combined three-areas of evaluation, different data inputs and result in an average liveability index.



How liveable are urban districts planned under sustainability premises?

The resulting liveability index value for this case study indicates a great correlation of the sustainability practices certified by green building certification systems and this liveability framework. The high correlation of liveability and sustainability is also due to the fact that the indicator's measurement criteria relies mainly on the green building certifications extrapolation of the calculations applied to the plan and design practices, to the operational way of measuring them. All in all, it can be said that the urban districts planned under sustainability premises are liveable.

6.2 KEY KNOWLEDGE OBTAINED

As introduced in the literature review, it is only through post-occupancy evaluations on any type that impact measurement can be done. It is a fact that certifications validate the project's approach and on paper strategies, but a continuous evaluation allows us to understand if the standards and goals are being met. POE, as presented, has different levels of evaluation. By assessing this project with this three-area evaluation approach, it has been learned that POE relying on individual systems or merely on experience, doesn't provide a full picture or the integration of what is built, how it performs over the years and how people experience it.

Importance of the Urban Districts scale

A POE at the Urban Districts scale could assist in improving everyday urban life by continuously enhancing the natural and built environment. As urban scale projects take many years to be developed, doing a POE in an early stage of an urban district development assists in understanding not only performance but in improving qualities that will be built throughout the future development phases. In existing districts, it could allow continuous improvement and the possibility to tackle directly areas that need change.

Understanding the performance at the district level allows us to identify which are the interactions between household and city scales. Therefore, it is mainly at the district level that city actions can be directly taken. Before being part of a large community and city, we belong to smaller communities as neighbours, co-workers, local users of facilities or members of groups. If the neighbourhood performance is good, there is very likely that the city will be impacted by it.

POE tool for liveability in Urban Districts

The created POE with a holistic approach allows us to understand how the different systems perform and interact. The evaluation tool generated can serve as performance evaluation that enables either operations or future planning and design improvements in both new construction and existing one. As a tool, it can assist in decision-making strategies for improvement in the spaces between buildings for optimal people-centric urban design. After concluding this research, it can be said that it is possible to evaluate the qualities for the liveability of the space in between buildings at the urban district scale. However, evaluating the urban district scale and not building o city scale can be challenging on where to define the boundaries for the metrics of evaluation, as some qualities of the household, neighbourhood and city scale can be overlapped. For example, when conducting the surveys, having the option to find residents and people that work in the area, which experience the everyday life qualities of the districts; or also, to consider frequent visitors. Thus, it was key to identify what can be measured for the space between buildings that is not already measured at the household level, and that can provide more specific and detailed values than the city scale. An example of it is the understanding of the microclimate, affecting by its direct surroundings, and varying at the city scale due to the different conditions on the different district areas. Also, to learn not only about

satisfaction but about preferences and behaviour can allow us to understand more in-depth about the lifestyles and possibly shape them towards sustainable ones.

Usability of a POE for urban districts

At the urban districts scale interventions, there are several stakeholders involved throughout the development stages. For this reason, it considered that even if the results could be useful for all of the stakeholders' activities, there could be some groups with a particular interest in it. For instance, the tool could assist municipalities in assessing in a detailed level how the different city areas perform, with their diverse natural and built qualities, uses and users. With this, particular strategies, renovations or allocation of resources could be distributed differently. Also, it was identified in the case study that the project owner conducts POE evaluations with the purposes of reporting and improvement. All of them rely in different assessment methodologies and approach. So, another example of the tool usability could be as the project owner KPIs-Key performance indicators for the different project interventions they have. This could result in a unified, structured evaluation mean that can be replicable to different districts. It is a fact that many spaces in between buildings are being renovated nowadays with a more people-centric approach and these interventions are planned and designed by local firms. Therefore, the tool could also serve to identify continuous improvement for planning and design firms solutions. On all of the examples, data collections or access would be determinant on the quality of the assessment.

Validity, reliability and scalabiltiy

The calculation means are robust, as they are based on existing measurements within the certifications and other criterions reviewed in the literature, but not designed by the author of this research project. However, the index values for assigning a grade were designed by the author of this master thesis, considering the standard of the certification scheme as the target value for highly liveable places and providing variation in grade depending on how close or far the project number results in comparison to the reference value.

The methodology pursued to design this tool is easy to adapt for a tool creation in other contexts. The tool itself can be adapted to different contexts' realities, as the category areas, even if defined at the local context, represent values for liveability that are applicable for international contexts. The relevance of some indicator's topic may vary depending on the local conditions. For example, the climate change mitigation category contains parameters related to different events. In the local context, wind experience and flooding represent the topic areas that are more relevant for climate events. Nonetheless, in areas on which other types of events are more common, such as earthquakes, more considerable attention could be put to design evaluation means for it. That is why it is recommended on this research to first design principles at the local scale and then design the means to evaluate them, as what makes a place liveable is not the same for a different context. The calculations contained within each indicator can also be easily measured in the same way in other sites, as the reference index values rely mainly on the city and national comparisons.

Barriers into opportunities

The limitation on the tool usability can be the data availability to evaluate the urban districts, as many of the sources need to be statistics, and sometimes there is no publicly available data for it. But as it is through observation, data collection and analysis that improvements can be made, this could represent the opportunity to shape more emphasis on at district scale statistical analysis.

The urban scale interventions, such as new districts development or renovation of existing urban areas, present the great challenge of aligning different stakeholder's interests. A great example of it is the sustainability practices in the local context. The DGNB certification first adaption to the local market – Denmark, was released in 2012. So far, it has been a continuous dialogue among stakeholders to come up with speaking the same language of sustainability. The progress by now is that the certification is widely accepted in the construction market, as is perceived now as a standard of sustainability and not as a distinction label. The same way, Liveability concept could be directly linked to all construction practices and could directly result in efficiency or improvements. For instance, the fact that a place that is attractive and convenient to bike through will make more people jump into a bike and change their mobility behaviour. This transition could directly relate to reduced emissions, lower construction operation and maintenance of road infrastructure and healthier lifestyles. As experienced with this POE framework designed for Liveability, the term goes beyond social areas and relates to sustainability spheres. This enables the great opportunity to generate POE as integrative systems, on which for example all resources flow impact, infrastructure development can be understood of the improvement on the quality of life and not only on efficiency or waste reduction.

6.3 FUTURE STUDIES

For tool improvements, further comparison among certified projects could be made to come up with a more representative response to the third research question, in the topic of assessing the correlation of liveability in urban districts planned under sustainability premises. Another option is to generate a tool that creates indicators for all the parameters and not only a sample of them. The seven indicators are a sample of the creation and use of the tool for liveability, but do not provide the full assessment of what liveability is.

The analysis made relied mainly upon excel calculations that put together all the data inputs from the three-areas of evaluation. There is the potential to link these measurements into a GIS tool, smart meters or machine learning, that allows to automate and integrate the calculation of these indicators.

Since liveability is a fairly new concept, the liveability impact could be further studied and understood as an SROI- social return of investment, as a way to capture and express in monetary value the liveability practice.

7. CONCLUSION

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This research project defined what the liveability principles are for the local context of the study, Denmark. These principles contain 21 parameters of the built environment that can assess liveability performance at the urban district's scale. With this, a POE tool in the topic of liveability in urban districts was designed. The tool comprehends seven indicators that assess liveability with a holistic approach. The categories of assessment are Climate Change mitigation, Connection with nature, Urban safety, Social mix & affordability, Local economy & Infrastructure, Mobility and Urban microclimate. A case study evaluation was conducted to learn about the usability of the tool. The case study results ranked as "liveable" which indicated that good design and operation practices, combined with the local microclimate conditions, provide the atmosphere for enjoyment and well-being in the district level. Three research questions were presented. The first one is about how to determine liveability at the local level, having as response the design of the liveability principles. The second one introduced the possibility to design a POE in the topic of liveability, and the result is the indicators framework that integrally evaluates systems performance, the layout and the user experience. The last question referred to the sustainability approach in urban planning and design practices, and its correlation to make liveable places. Through the case study, it was found that there is a high correlation on these two, which can enable the question now if liveability or people-centric practices can shape sustainable behaviours.

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8. REFERENCES

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**All the non-referenced materials, are developed by the author of this thesis project*

9. APPENDIX

9. APPENDIX

Appendix navigation

This project appendix provides detailed information about the work done. The content is structured as following:

9.1 Analysis and design	Supporting materials for liveability principles definition • Data Analysis and interpretation • Liveability principles integration Supporting materials for indicators design • Liveability indicators metrics for evaluation • Liveability indicators evaluation survey
9.2 Case Study	Supporting materials for Case study description Supporting materials for Case study evaluation

9.1 Analysis and Design Appendix

The detailed information about the numerical and empirical assessment for the liveability principles definition is integrated here.

9.1.1 Data Analysis & Interpretation: Liveability Concept

The comparison table of the Rambøll Liveable Cities Survey and the Social City Index integrates: 1. Number of parameters, 2. Parameter description, and 3. Liveability Principles Category on which it relies.

TABLE 14 – ANALYSIS OF LIVEABILITY BY CONCEPT

Source	1. # of parameters	2. Parameter description	3. Liveability principles category	Weight or relevance in source
Rambøll Liveable Cities Survey	v 1	Clean Air	Urban Microclimate	0.74
	v 2	Sense of security against crime	Urban Safety	0.73
	v 3	Easy to get to / from the city	Mobility	0.7
	v 4	Access to affordable housing	Social mix & affordability	0.7
	v 5	Proximity to green areas in neighbourhood	Connection with nature	0.68
	v 6	Sense of security in traffic	Urban Safety	0.65
	v 7	Getting around on foot	Mobility	0.64
	v 8	Getting around by bike	Mobility	0.64
	v 9	Good employement opportunities	Local Economy & Infrastructure	0.58
	v 10	Variety in shopping options	Local Economy & Infrastructure	0.57
	v 11	Getting around by public transportation	Mobility	0.55
	v 12	Good health care services	Local Economy & Infrastructure	0.53
	v 13	Proximity to wild nature	Connection with nature	0.53
	v 14	Opportunities for changing between different transport types	Mobility	0.51
	v 15	Proximity to blue areas / water	Connection with nature	0.51
	v 16	Low level of traffic noise	Urban Microclimate	0.49
	v 17	Good schools	Local Economy & Infrastructure	0.45
	v 18	Good elderly care	Local Economy & Infrastructure	0.44
	v 19	Getting around by car	Mobility	0.44

		v 20	A broad variety of leisure activities	Social mix & affordability	0.42
		v 21	Protection aganist flooding	Climate Change Mitigation	0.41
		v 22	A broad variety of cultural activities	Social mix & affordability	0.4
		v 23	Good opportunities for higher education	Local Economy & Infrastructure	0.39
		v 24	Actions targeted recycling of waste	Climate Change Mitigation	0.39
		v 25	A vibrant city life	Social mix & affordability	0.38
		v 26	Good day care	Local Economy & Infrastructure	0.35
		v 27	Many activities in my neighbourhood	Social mix & affordability	0.29
		v 28	The city's ability to attract big events	Social mix & affordability	0.29
		v 29	Strong community in my neighbourhood	Social mix & affordability	0.29
		v 30	Actions enabling you to get green energy through power sockets	Climate Change Mitigation	0.27
		v 31	Good terms of entrepenership	Local Economy & Infrastructure	0.17
Social City Index	household index	v 1	Housing burden	Social mix & affordability	
		v 2	Price per m2	Social mix & affordability	
		v 3	Rental costs per m2 per year	Social mix & affordability	
		v 4	Diversity	Social mix & affordability	
		v 5	Homelessness	Urban Safety	
		v 6	Surplus capacity	Social mix & affordability	
		v 7	Average m2 per person	Social mix & affordability	
		v 8	Daylight	Urban Microclimate	
		v 9	Noise pollution	Urban Microclimate	
		v 10	Quality of property	Social mix & affordability	
		v 11	Satisfaction with housing	Social mix & affordability	
	Nei	v 12	Assaults reported	Urban Safety	

		v 13	Homicide rates	Urban Safety	
		v 14	Safety	Urban Safety	
		v 15	traffic deaths	Urban Safety	
		v 16	Trust in others	Urban Safety	
		v 17	Meeting places	Social mix & affordability	
		v 18	Public Space	Social mix & affordability	
		v 19	Recreation	Social mix & affordability	
		v 20	Waste handling	Climate Change Mitigation	
		v 21	After-school care	Local Economy & Infrastructure	
		v 22	Degree of relationships	Not applicable	
		v 23	Involuntary loneliness	Not applicable	
		v 24	Public Debate	Not applicable	
		v 25	Voluntariness	Not applicable	
		v 26	Without job or education	Local Economy & Infrastructure	
	City	v 27	National elections	Not applicable	
		v 28	Perception of having a say	Not applicable	
		v 29	Perception of participation	Not applicable	
		v 30	Employment rate	Local Economy & Infrastructure	
		v 31	Primary school	Local Economy & Infrastructure	
		v 32	Secondary school	Local Economy & Infrastructure	
		v 33	Tertiary Education	Local Economy & Infrastructure	
		v 34	Transportation	Mobility	

The following table summarizes the analysed content above:

TABLE 15 – INTERPRETATION OF LIVEABILITY BY CONCEPT

Liveability Categories	Rambøll Liveable Cities Survey		Social City Index		Concept total	
	concepts	weight	concepts	weight		
Climate Change Mitigation	3	10%	1	4%	4	7%
Connection with nature	3	10%	0	0%	3	5%
Urban Safety	2	6%	6	22%	8	14%
Social mix & affordability	7	23%	11	41%	18	31%
Local Economy & Infrastructure	8	26%	6	22%	14	24%
Mobility	6	19%	1	4%	7	12%
Urban Microclimate	2	6%	2	7%	4	7%
	31	100%	27	100%	58	100%

9.1.2 Data Analysis & Interpretation: Liveability Measurement

The DGNB: Urban Districts and BREEAM Communities comparison table 20 integrates the following: Liveability principles Category, 1. Number of parameters, 2.On which theme area defined by the certification is the parameter integrated, 3. Parameter as named in the certification scheme, 4. Parameter objective, 5. The physical area of the urban scale project on which this factor can be intervened; and 6. How is it measured.

The following table interprets and summarize the analysed content:

TABLE 16 – INTERPRETATION OF LIVEABILITY BY MEASUREMENT

Liveability Principles	DGNB		BREEAM		Measurement total	
	concepts	weight	concepts	weight		
Climate Change Mitigation	0	0%	3	19%	3	11%
Connection with nature	1	8%	0	0%	1	4%
Urban Safety	2	17%	0	0%	2	7%
Social mix & affordability	6	50%	6	38%	12	43%
Local Economy & Infrastructure	2	17%	2	13%	4	14%
Mobility	0	0%	2	13%	2	7%
Urban Microclimate	1	8%	3	19%	4	14%
	12	100%	16	100%	28	100%

TABLE 17 – ANALYSIS OF LIVEABILITY BY MEASUREMENT

Certification Scheme	Liveability principles category	1. # of parameters	2. Theme	3. Parameter	4. Objective Benefit for Livability	5. Which is the physical area of the urban scale project on which this factor can be intervened?	Qualitative mesurement	Quantitative measurement	Oher?
DGNB	Social mix & affordability	value 1	Diversity and Structure	SOC 1.1 Social and functional diversity	Great diversity is considered an element of social sustainability. High social cohesion can also contribute to higher stability. Ensure a diverse type of housing, spaces, services and functions	Buildings and their use, space between buildings, social mix,	Concepts to strengthen the mixed use and the local economy and business.	Distribution of housing and other functions	
	Social mix & affordability	value 2		SOC 1.2 Social and commercial infrastructure (*Knockout-kriterier)	Functionality and attractiveness are also determined by universal access to a number of essential services.	Distances between places and their accesibility		Location charts, development plans, tables and calculations	The range of offers, the distance measured by the maximum transport time.
	Urban Safety	value 3	City-life quality	SOC 2.1 Safety	How the urban area is experienced and used. The safety of the area impacts attractiveness.	Space between buildings	Previous reports of crime in the area	plans, technical shits	technical installations, material selection and outdoor space planning.
	Social mix & affordability	value 4		SOC 2.2 City life	Urban space shapes the framework of urban life that is lived. It forms culture, history and diversity. The urban space enables different types of social interaction and must provide comfort and attractiveness to people that stay in public spaces or the ones that move through them throughout the day and throughout the year.	Public space		Simulation, plans	1. social interaction, is evaluated based on the extent of development with common use, diversity and flexibility in the use of public space and diversity among users. 2. The second category, identity creation, is assessed on how the public spaces are integrated with each other, with the construction and with other elements of the urban area. 3. The last category, comfort in the public space, evaluates how the urban space is arranged in terms of microclimate, temperatures, light and wind conditions. The evaluation is based on detailed plans and simulation of e.g. wind conditions.
	Urban Microclimate	value 5		SOC 2.3 Noise reduction	Many people live in areas with unacceptably high noise levels, which results in a significant reduction in quality of life.	Urban area	points are awarded on the basis of onequalitative assessment for measures that may limit the effect of urban noise.	Estimates and measurements presentedo n noise maps	Noise levels are considered specifically from road and rail traffic as well as air traffic and in general in central public areas.The level of noise in the urban area with differentiation between limit values for day and night. How large parts of the gross floor area (BEA) are exposed to noise assessed based on Danish reference and limit values.

Certification Scheme	Liveability principles category	1. # of parameters	2. Theme	3. Parameter	4. Objective Benefit for Livability	5. Which is the physical area of the urban scale project on which this factor can be intervened?	Qualitative mesurement	Quantitative measurement	Oher?
DGNB	Social mix & affordability	value 6	Function and Adaption	SOC 3.1 Provision of open land	High level of social and recreational life which is easily accessible to all residents. The supply of free land is under pressure as urbanization rises. But if cities must evolve while maintaining their 'liveability', the recreational free space is a necessity.	the relationship between the built-up area and the open space, the type of open space and access to it, both within the project area and outside. public and private open spaces		x	The proportion of public and private free space compared with the city's total gross floor area (BEA). Public land outside the area quantitatively, and what proportion of the project area that is considered to have direct access to these open spaces.
	Urban Safety	value 7		SOC 3.2 Availability	High freedom of movement and an appropriate for all persons regardless of age, and any mobility, sensory or cognitive impairments	Primary in the urban area, transport roads, buildings and recreational areas	Documentation of involvement, an accessibility audit as well as plans and photo documentation		How availability is determined in the final plan The planning process is evaluated based on the degree of user involvement and participation, while the final plan is evaluated from access to specific facilities, such as school and public transport for people with disability.
	Local Economy & Infrastructure	value 8		SOC 3.3 Flexibility	Social, demographic and economic changes can change the framework conditions overtime for an urban area. In order for the urban area to become or remain attractive and functional, it must also have a high level of application flexibility. Planning flexibility and planning future development, but also on how changed use of open spaces, city spaces, buildings, and infrastructure can be managed.		Drawings, plans, guidelines for the area and examples of flexible concepts where relevant		It is evaluated whether a long-term phase concept exists where changed framework conditions can be handled already during the planning phase, and evaluates how robust the final concept is to be able to handle changing framework.
	Connection with nature	value 9	Aesthetics / connectivity	SOC 4.1 Urban integration Landscape integration	A new urban area is rarely isolated from the existing and surrounding area. 1. Focus on how the new urban area is part of the overall planning for the existing and surrounding area - from regional plans to local mobility plans. 2. how the existing landscape is included in the new, whether green belts and streams are continued, and how the urban structure works in interaction with the surroundings. 3. Functional integration, whether the new urban area contributes to new features, increase use and value.	Buildings, green space, public space, roads	documentation of the planning, including detailed plans, photo documentation and relevant descriptions and opinions.		The new area as a part of the overall existing, Green structure continued, New features increase use and value.

Certification Scheme	Liveability principles category	1. # of parameters	2. Theme	3. Parameter	4. Objective Benefit for Livability	5. Which is the physical area of the urban scale project on which this factor can be intervened?	Qualitative mesurement	Quantitative measurement	Oher?
DGNB	Social mix & affordability	value 10	Aesthetics / connectivity	SOC 4.2 Urban design	The identity and attractiveness of an urban area can be physically influenced through the design of public spaces, infrastructure and area buildings. The focus is on how the urban area is experienced on the human scale and integrated concepts for urban development in architectural, aesthetic and functional qualities.	Buildings, green space, public space, roads	plans, design guidelines, and reelevant description		Plans for urban design within the publicly accessible outdoor spaces, infrastructure and architecture. The qualities are documented on the basis of described design guidelines and can be supplemented with brief and relevant data.
	Local Economy & Infrastructure	value 11		SOC 4.3 Use of existing structures	By using existing structures, it is possible to save resources in development. The integration of existing structures can play a critical role in the development of urban life and urban space.	Public space, buildings?	aerial photo, maps and data for the existing area and documentation of the continuation of the new urban area		
	Social mix & affordability	value 12		SOC 4.4 Art in public space	To increase cultural qualities and diversity. Promotion of art that is accessible to everyone in the public space, and thus can contribute to the experience of an urban area.	Public Space, buildings, construction barriers.	relevant plans, contracts and announcements	whether financial means are provided for the export of the arts based on the gross margin area	The criterion considers both permanent and temporary projects. It s evaluated of initiatives, including communication that engages the public

Certification Scheme	Liveability principles category	1. # of parameters	2. Theme	3. Parameter	4. Objective Benefit for Livability	5. Which is the physical area of the urban scale project on which this factor can be intervened?	Qualitative mesurement	Quantitative measurement	Oher? All information contained here is taken directly from the BREEAM Communities manual (BRE, 2017)
BREEAM	Local Economy & Infrastructure	value 1	Local economy	STEP 1 SE01 - Economic impact	To increase economic wellbeing by ensuring that the development attracts inward investment creates jobs and complements and enhances existing economic activity in the local area and surrounding economy.	Master plan			"Economic study. This study should be focused on understanding how the proposed development can enhance the economic well-being of future occupants. It should also ensure that the development complements and enhances existing economic activity in the local area."
	Not applicable	value 2		STEP 3 SE17 - Training and skills	To ensure that the development contributes to the local area by enhancing skills and training opportunities.		x		"Promote and contribute to a legacy of local training and skills opportunities. (..) This credit involves creating long-term training and skills opportunities which continue beyond the planning and construction phase of the development."
	Social mix & affordability	value 3	Social wellbeing	STEP 1 SE02 - Demographic needs and priorities	To ensure that the development plans for the provision of housing, services, facilities and amenities are based upon the local demographic trends and priorities.	Master plan	Documentary evidence of consultation outcomes		"The scope of the proposed development, including housing mix, community facilities and employment opportunities, has been informed by a review of the current demographic profiles and future trends of the local area. (...) The community and appropriate stakeholders are consulted on the local needs and requirements that are desired as part of the proposed development"
	Social mix & affordability	value 4	Social wellbeing	STEP 2 SE05 - Housing provision	To minimise social inequalities and foster a socially inclusive community by ensuring appropriate housing provision within the development.	Masterplan	1 A copy of the local needs investigation report (or equivalent). A copy of design specifications or the masterplan or relevant site plans.		"The housing types and tenures for the development are determined based on the needs in the local area. Demographic needs and priorities) and any information held by the local authority regarding the type and tenure of housing required in the area. 2. The developer and local authority agree on specific levels of housing provision for different types and tenures. 3. The developer commits to achieving (or requiring a subsequent developer to make) minimum best practice space standards in all housing in the development. 4. The different tenures are distributed across the development, and different tenure types are integrated."

Certification Scheme	Liveability principles category	1. # of parameters	2. Theme	3. Parameter	4. Objective Benefit for Livability	5. Which is the physical area of the urban scale project on which this factor can be intervened?	Qualitative mesurement	Quantitative measurement	Oher? All information contained here is taken directly from the BREEAM Communities manual (BRE, 2017)
BREEAM	Social mix & affordability	value 5	Social wellbeing	STEP 2 SE06 - Delivery of services, facilities and amenities	To ensure essential facilities are provided and that they are located within a reasonable and safe walking distance.		A safe and convenient pedestrian route must have the following characteristics: Safe crossing points are provided at appropriate locations and intervals. At the point of crossing, the road must also be well-lit, and there should be a clear line of sight for at least 300m in each direction. For larger developments with a high number of public users or visitors, pedestrian pathways must be signposted to public transport nodes. On roads with a speed limit of 30mph or higher, there is a clearly defined footpath. The footpath is designed with consideration of all users, including the disabled, elderly and children. On roads with low traffic levels and a speed limit of 20mph or below, it is acceptable for the pedestrian route to use the road carriageway. A footpath width of >900mm.	Distance should be measured via a safe and convenient pedestrian route from the main building entrances of the residential or non-domestic building and facility A maximum acceptable walking distance is provided in TM04 – Access to public transport. It is defined as the following distances: ≤ 650m in an urban development ≤ 1300m in rural development. This is the furthest that people should be expected to walk to reach local facilities.	"The list of local needs and requirements from SE02 – Demographic needs and priorities used to confirm which services, facilities and amenities will be provided on the site and to what timescales. (…) All services, facilities and amenities have a time scale for a provision that has been agreed with the local authority and are located within walking distance of all dwellings via a safe and convenient pedestrian route."
	Social mix & affordability	value 6	Social wellbeing	STEP 2 SE07 - Public realm related to SE08 - Microclimate	To encourage social interaction by creating comfortable and vibrant spaces in the public realm.	Public space Space between building Ground floor use on buildings	design specifications and/or the masterplan or relevant site plans. the microclimate study and a copy of design specifications and/or the masterplan or relevant site plans.		"1.Consultation 2. The public realm is designed to allow multiple uses for different users, including children, the elderly and disabled people with consideration given to safety, comfort, disturbance and security. 3. The design of the public realm takes account of connectivity throughout the development and into the surrounding area, encouraging new movement and activity. Evidence from the microclimate study is used to influence the design of the public realm. 9. The local identity of the area is strengthened through the design of social spaces. This is accomplished by incorporating information from community consultation. 10. For mixed-use development, a mix of uses on the ground floor encourages a sense of vibrancy. Design measures should: encourage frequent use promote activity overspill (e.g. café) to the street allow views both out and in."
	Local Economy & Infrastructure	value 7	Social wellbeing	SE09 - Utilities	To provide easy access to site service and communications infrastructure, with minimal disruption and need for reconstruction, and to allow for future growth in services.		x		"For the purposes of this issue, services include heating, cooling, power, water, sewerage and communications. (…) The development will aim to minimize the number of access points for services, taking into account: the scale and density of the development links to the existing infrastructure ease of access for maintenance. (…) 2. The following service providers have committed to coordinate the installation of related infrastructure, as relevant: gas, electricity, water/sewerage, telecommunications/internet, heat and cooling".

Certification Scheme	Liveability principles category	1. # of parameters	2. Theme	3. Parameter	4. Objective Benefit for Livability	5. Which is the physical area of the urban scale project on which this factor can be intervened?	Qualitative mesurement	Quantitative measurement	Oher? All information contained here is taken directly from the BREEAM Communities manual (BRE, 2017)
BREEAM	Mobility	value 8	Social wellbeing	STEP 2 SE11 - Green infrastructure (This issue relates to the criteria in SE07 – Public realm, LE04 – Enhancement of ecological value and SE10 – Adapting to climate change)	To ensure access to high-quality space in the natural environment or urban green infrastructure for all.	Public Space, Private open space	Green Infrastructure Plan	A maximum walking distance is provided in 'TM04 – Accessto public transport'. It is defined as the following distances:≤ 650m in an urban development OR ≤ 1300m in a rural development.	"Consultation Green Infrastructure Plan The masterplan is designed to allow all residents to be within walking distance of greenspace via a safe and convenient pedestrian route."
	Mobility	Value 9	Social wellbeing	STEP2 SE12 - Local parking	To ensure that parking is appropriate for the expected users and well integrated into the development.		Design specifications and a copy of the masterplan or relevant site plans.		"The consultation considers parking in relation to the following: size and type of the development expected levels of car ownership/visitor numbers to the development expected levels of other vehicle use on-site (e.g. cycles, delivery vehicles, motorcycles, mobility scooters,etc.) acceptable distances between parking and residences /facilities the extent to which private car journeys can be replaced by more sustainable modes(walking, cycling, public transport) or by other arrangements(such as home delivery of shopping) the need to use land efficiently the provision of public transport (…) Parking is integrated into the development without allowing it to dominate the space or interfere with the cyclist, pedestrian and vehicle movement. (…) Examples of integration of parking into the development include but are not limited to: small scale, dispersed parking throughout developments use of trees and hedges to prevent full exposure of the vehicles to the view from the street entrances to underground car parking should not dominate the streets and footpaths.(…) Entrance ramps should be integrated within the pedestrian area using appropriate detailing and materials."

Certification Scheme	Liveability principles category	1. # of parameters	2. Theme	3. Parameter	4. Objective Benefit for Livability	5. Which is the physical area of the urban scale project on which this factor can be intervened?	Qualitative mesurement	Quantitative measurement	Oher? All information contained here is taken directly from the BREEAM Communities manual (BRE, 2017)
BREEAM	Social mix & affordability	value 10	Social wellbeing	STEP 3 SE14 - Local vernacular	To ensure that the development relates to the local character while reinforcing its own identity.		X Design specifications and/or masterplans or relevant site plans.		"A review of the proposed development site and surrounding area is undertaken to establish the local character. (...) 2. Consultation has taken place between the local authority, developer, community representatives and other stakeholders. As a minimum, the consultation considers the following: building materials, building colour, architectural style, building heights and forms, continuity between building style within the development and the surrounding area, the ability of residents to personalise their dwelling. (...) 3. The results of the consultation have been analysed in conjunction with the outcome of the local character review to determine the key elements to be implemented in the design of the site."
	Social mix & affordability	value 11	Social wellbeing	STEP 3 SE15 - Inclusive design	To create an inclusive community by enhancing accessibility for as many current and future residents as possible.	transport interchanges transport methods housing and buildings public realm open spaces sports and recreation spaces highways footpaths and cycle ways	copy of the inclusive design and operational management strategy.		"An inclusive design and operational management strategy are produced at the outset of the development including issues of accessibility, inclusion and emergency for all occupants and visitors, with specific consideration to people's wellbeing, age, gender, ethnicity, beliefs and disability-related needs. (...) 2. Consultation and recognised national and local guides are used to inform the inclusive design and operational management"
	Climate Change Mitigation	value 12	Environmental conditions	STEP 1 SE03 - Flood risk assessment	To ensure that the development takes account of flood risk and, where it is present, takes appropriate measures to reduce the risk of flooding to the development and the surrounding areas.	Master plan	x		"A site-specific flood risk assessment is carried out in accordance with current best practice and planning policy and includes as a minimum: risk and consequences of flooding from all sources on the site and from the site to the surrounding area and how the risks will be managed changes in flood risk due to climate change. (...) Where there is a medium or high risk of flooding from any part of the development, the development has been designed to minimise flood risk on-site and off-site. (...) A site-specific flood risk assessment. The flood zone or zones for the development are determined in accordance with current best practice and planning policy. A commitment is made to incorporate the recommendations."

Certification Scheme	Liveability principles category	1. # of parameters	2. Theme	3. Parameter	4. Objective Benefit for Livability	5. Which is the physical area of the urban scale project on which this factor can be intervened?	Qualitative mesurement	Quantitative measurement	Oher? All information contained here is taken directly from the BREEAM Communities manual (BRE, 2017)
BREEAM	Urban Microclimate	value 13	Environmental conditions	STEP1 SE04 - Noise pollution	To ensure that the development is designed to mitigate the impacts of noise. This includes mitigation from existing sources of noise, reducing potential noise conflicts between future site occupants, and protecting nearby noise-sensitive areas from noise sources associated with the new development.	Master plan. Landscapes or buildings where the occupiers are likely to be sensitive to the noise created by the new development, including: 1. Residential areas 2. Hospitals, health centres, care homes, doctors surgeries etc. 3. Schools, colleges and other teaching establishments. 4. Libraries 5. Places of worship 6. Wildlife areas, historic landscapes, parks and gardens. 7. Located in an area recognised as having outstanding natural beauty, scientific or ecological interest (e.g. Area of Outstanding Natural Beauty or a Site of Special Scientific Interest). 8. Any other development that can be considered noise sensitive.	X	X	"A noise impact assessment has been carried out by a suitably qualified acoustician to determine the sources and nature of existing noise on and around the site. (…) All noise attenuation measures recommended in the noise impact assessment report are incorporated into the site layout of the masterplan. (…) Building locations and orientations within the masterplan have been informed by the noise impact assessment to ensure that the effects of external noise on building occupants are minimised and that potential conflicts between site occupants are reduced. "
	Urban Microclimate	value 14		STEP 2 SE08 - Microclimate	To ensure the development provides a comfortable outdoor environment through the control of climatic conditions on a microscale	Squares, Space between buildings, considering the following: temperature and thermal comfort solar exposure (sky viewand shadowing) air direction, movement and speed dust and pollution acoustic environment. Snowbuildup and ice	A design specifications or the masterplan or relevant site plans	The microclimatic study or simulation and the associated level of detail should account for the use (including frequency or demand) and function of outdoor spaces when determining the favourable microclimatic conditions. For example where the space will be used as an outdoor eating area, then additional measures should be taken to ensure the comfort of occupants through the provision of solar shading.	"A microclimatic simulation or study shows the effect of urban morphology on the external microclimate of the development and surrounding area. (…) The development is designed to minimise adverse conditions, including negative microclimatic factors. (…) An appropriate and diverse range of favourable microclimatic conditions have been created throughout the development to cater for a wide range of personal preferences. (…) The design of public space optimises microclimatic conditions throughout the year. (…) The location and design of pedestrian and cycling routes take full account of microclimatic conditions."

	Climate Change Mitigation	value 15		SE10 - Adapting to climate change	To ensure the development is resilient to the known and predicted impacts of climate change.	Impacts of climate change considered should include: increased temperatures (including the heat island effect) flood risk increased weather volatility impacts on water resources changes in ground conditions: snowbuild up and ice.	2 Design specifications and/or a copy of the masterplan or relevant site plans.		"Demonstrate how the risks will be managed and reduced through the use of 'win-win.' measures. These measures deliver benefits in addition to climate change adaptability. This could include: Reducing more than one impact of climate change. For example, helping to reduce the heat island effect whilst also reducing flood risk. Reducing the contribution of the development to climate change. Providing additional sustainability, economic or wellbeing benefits. For example, using drainage techniques that may also increase biodiversity or improve water quality ."

Certification Scheme	Liveability principles category	1. # of parameters	2. Theme	3. Parameter	4. Objective Benefit for Livability	5. Which is the physical area of the urban scale project on which this factor can be intervened?	Qualitative mesurement	Quantitative measurement	Oher? All information contained here is taken directly from the BREEAM Communities manual (BRE, 2017)
BREEAM	Climate Change Mitigation	value 16	Environmental conditions	STEP 2 SE13 - Flood risk management	To ensure that the development takes account of flood risk and, where it is present, takes appropriate measures to reduce the risk of flooding to the development and the surrounding areas.	Green structure, buildings and roads. One or more components built to manage surface water run-off to prevent flooding and pollution, including wet ponds, infiltration basins, detention basins, swales, reed beds, pervious(porous or permeable) paving soakaways, rainwater harvesting, filter strips, filter drains and trenches with or without perforated pipes, green roofs, underground attenuation storage.	detailed documentary evidence showing the design methods used to reduce the peak rate of run-off to pre-development rates	Details of the permeability characteristics of the site pre-development and post-development (e.g. infiltration tests etc. where appropriate) peak rates of run-off (L/s) calculations for a 1 in 100 year event, pre- and post-development, including an allowance for climate change over the development lifetime the pre-development volume of run-off (m^3)for a 1 in 100 year 6 hour event the additional volume of run-off (m^3)for a 1 in 100 year 6 hour event caused by the development without mitigation measures the additional volume of run-off (m^3)with the proposed mitigation	
	Urban Microclimate	value 17		STEP 3 SE16 - Light pollution	To ensure that the lighting on site is designed to reduce light pollution.		x		Refer to recognised standards for the Design of Street Lighting.

9.1.3 Data Analysis& Interpretation: Liveability by Practice

The table below presents the summarized values for liveability on the project case study. This analysis incorporated the number of values for liveability the project has, its practice in the project, the physical area on which the practice was intervened and, an example or reference in the project.

TABLE 18 -ANALYSIS OF LIVEABILITY BY PRACTICE

Source/ project stakeholder	1. # Values for Livability	Concept approach (1. Yes, .5 Partially, 0 no)	Liveability concept	2. Project Practice	3. Which is the physical area of the urban scale project on which this practice was implemented?	4. Example or reference in project
NORDHAVN / COBE	value 1	1	Climate Change Mitigation	Rainwater management. Rainwater directed to the harbour instead of into the sewer system.	Green structure, outdoor areas and roads	
	value 2	0.5	Connection with nature	Contact with water	A promenade A private garden / open space A public space / square	Sandkaj Vej
	value 3	0	Social mix & affordability	Social mix. New and varied apartment typologies.	Buildings	To be developed
	value 4	1	Local Economy & Infrastructure	Mixed use . 40% - 60% max are offices. It also includes, shops, supermarkets and other facilities.	Masterplan	
	value 5	1	Mobility	Connectivity within islets and rest of the city	A promenade A corridor A green space	Green Loop, islets
	value 6		Mobility	Active and Collective mobility first. To limit car traffic and enhance infrastructure for pedestrian and bicycles.	Central Parking Garage Green corridor	Green Loop
	value 7	0.5	Urban Microclimate	Electrification of on shore power in cruise terminals	Masterplan	

NORDHAVN / B&H	Value 8	1	Social mix & affordability	Community development: Nabomøder	No physical area	
NORDHAVN / ENERGY LAB	Value 9	0.5	Climate Change Mitigation	On site Energy meters	By harbour facility	Energy Lab

9.1.4 LIVEABILITY PRINCIPLES INTEGRATION

The following table presents the Liveability principles distribution: the categories relevance on the three analysed areas: concept, measurement and practice.

TABLE 19 - LIVEABILITY PRINCIPLES DISTRUBUTION

Liveability Principle	Concept	measurement	practice
Climate Change Mitigation	7%	11%	14%
Connection with nature	5%	4%	14%
Urban Safety	14%	7%	0%
Social mix & affordability	31%	43%	14%
Local Economy & Infrastructure	24%	14%	14%
Mobility	12%	7%	29%
Urban Microclimate	7%	14%	14%

9.1.5 LIVEABILITY INDICATORS METRICS FOR EVALUATION

The following table details the integration of the indicators and their calculation means.

TABLE 20 - INDICATORS METRICS FOR EVALUATION

Value for Livability	Liveability Principle	Parameter	Indicator	Reference	Why it matters?	Type of Indicator		Area to measure	Data source	Measurement	
						Quantitativ	Qualitative			How it is measured?	Benchmark / Index value
v1	1. Climate Change Mitigation	Flooding / Storms	Safe storm and rain experience	MIL 1.5 Ydre miljøpåvirkninger TEK1.3 Regnvandshåndtering	Climate change and its environmental impacts in cities as increased amount of everyday rain, call for rethinking of design for storm protection, water management and the way land cover is treated. At the building and urban area level, there are several options for compensatory measures that reduces the risk of the inhabitants of the area. This indicator evaluates the correlation of the existing design measures against storms and flooding, the user experience and the wind trends over the years.	x		Systems performance	Statistics or Demographic data	A. Evaluates average winds recorded Nearest meteorological measurement station has recorded average winds higher or lower than the national average +/- 10%. Risk is measured combined with landscape roughness. 1= There has been experiencing over the past 3 years mean wind speeds that are more than 10% above the national average. 3 = There has been experiencing over the past 3 years average wind speeds that lie within for +/- 10% of the national average. 5 = There has been experiencing over the past 3 years mean wind speeds that are more than 10% below the national average.	1, 3 or 5 points
							x	Space Layout	On-site observations	B1. Evaluates the space between buildings protection for storms and flooding. Which of the following strategies is observed in the project area? (gives 1 point each and sum up maximum to 5 points) M1. Boundary elements. The area is protected from storms and flooding by enclosing it with, i.e. buildings as a shelter, difference in levels, or outdoor furniture and design as a barrier against water masses. M2. Compact development & low building heights. In the neighbourhood predominate freestanding and compact buildings as for example single-family homes or buildings with less than 3 floors height, as the height of the buildings increase the wind load. M3. Uniformity in building heights. Uniform building height prevails in the project area to create an even distribution of the impact from strong winds (+/- 1 floor variation) M4. Water retention. The overflow is controlled and retained by rainwater delay basins—I.e. enclosed wetlands for extreme quantities of water. M5. Raising the construction area so that the lower floor can be kept free from floodings. Buildings of great importance are placed higher in the terrain. M6. Green as catchment or terrain cultivation areas M7. Any other observed measures and systems for leakage, detention, delay, divert, evaporation, seepage, collection and use of rainwater M8. Roof slope. A <30° roof slope is avoided, as this help to form high negative pressure during a storm and the roof can be blown off. (Flat roofs are ok) M9. Small enclosures avoidance. The development avoids the creation of small enclosures such as houses gardens.	Sum of 5 points
							x	User Experience	Survey or interviews	C. Evaluates the user experience during storm events Q1. Have you experienced feeling vulnerable when walking, cycling, or staying in the public space areas when it is raining, or there is a big storm? 0= very often, 1 often, 3=rarely 5= Never Q2. Have you observed minor flooding in the area, for example the accumulation of water by the roads? 0= very often, 1 often, 3=rarely 5= Never	(Q1+Q2) /2

Value for Livability	Liveability Principle	Parameter	Indicator	Reference	Why it matters?	Type of Indicator		Area to measure	Data source	Measurement	
						Quantitative	Qualitative			How it is measured?	Benchmark / Index value
v5	2. Connection with nature	Green areas	Green spaces availability and use	SOC 2.2 Byliv SOC2.2.3.1 Basiskomfort SOC 4.1 Bymæssing integration TEK2.1.2.1 Naturlige grønne områder TEK2.1.2.2 Fritvoksende ikke plejekrævende beplantning MIL 1.4.2 Biofaktor og artsmangfoldighed (60 EP)	Every new urban area is related directly or indirectly to its surrounding existing ones, and how the urban structure interacts with the surroundings is from great importance. The presence of nature elements is of great important for biodiversity preservation and human wellbeing. A beautiful and diverse nature increases the quality of life, the value of the district through its green and nature experiences. The presence of green has a direct correlation also with climate impact and microclimate. Green areas in cities help to renew air and improve air quality. More plants in the cities can contribute to cleaner air. A cleaner result of nature in cities has a direct impact on health and wellbeing. It can reduce stress, the risk of obesity, depression, anxiety and bipolar disorders. Therefore, this indicator analyses the performance of existing green areas and their impact on occupant's wellbeing and enjoyment.	x		Space Layout	On-site observations	B. Quality of greenery in public spaces. M1. Proportion of greenery in public space 5 points = > 80% of the surface is planted 3 points = 40-80% of the surface is planted 1 points = 39<is planted M2. Presence of variety greenery along with the project. One of the combinations of any of the following types of surfaces (Gives one point each, 1 to 5 points in total) 1. Mowed grass 2. Natural grass or Natural meadows 3. Landscape planting or plants pots 4. Roof or facade planting 5. Area covered by its own compost M3. Quality of greenery. Availability in as many of the following types. (Gives one point each, 1 to 5 points in total) 1. Scrub and shrubs under two meters 2. Scrub and shrubs over two meters 3. Wood and forestry plantations 4. Individual trees 5. Designed landscape	(M1 + M2+ M3)/ 3
				SE11 - Green infrastructure			x	Systems performance	GIS Mapping	A. Access to green spaces M1. The masterplan is designed to allow all residents to be within walking distance of a green space via a safe and convenient pedestrian route. ≤ 650m in an urban development OR ≤ 1300m in a rural development Urban areas: ≤ 650m = 5 points, ≤ 850m = 3 points, ≤ 1000m=1 points Quantity of green spaces M2. Green space per inhabitant (m2/hab) or per built up area (%). 5 points= higher than City average, 3 points= equal to city average, 1 point = lower than City average	(M1+M2) /2
				(Ramboll, 2018)			x	User Experience	Survey or interviews	C. User experience Q1. If you work or live in the area, Can you see a tree or any kind of greenery (a tree, green area, or plants) from your home or office window? (Yes, or No) Q2. Do you consider the available green spaces have sufficient cleanliness and gardening throughout the year? (Yes or No)	(Q1+Q2) /2

Value for Livability	Liveability Principle	Parameter	Indicator	Reference	Why it matters?	Type of Indicator		Area to measure	Data source	Measurement	
						Quantitative	Qualitative			How it is measured?	Benchmark / Index value
v8	Urban Safety	Appealing streets and public space	Safe and attractive public space	DGNB SOC 2.1 Tryghed SOC3.2.3 Projekteret/udført tilgængelighed TEK2.1.1.3 God teknik og belysning TEK2.1.3.1 Hærværkssikret TEK2.1.4.1 Hærværkssikrede bygninger TEK2.1.4.2 Bygninger, der er åbne eller har en høj grad af sigtbarhed	The occupant's wellbeing and their will to participate in social life is determined by how the urban area is experienced. There is a great correlation among attractiveness and urban safety, and the more visited the spaces are, the safer they become as they are more observed. The safeness of an area impacts its attractiveness. Likewise, Appealing streets and public spaces can increase trust and reduce crime. Therefore, the emphasis of this indicator is to understand the level of attractiveness in correlation to safety in the public space.	x		Systems performance	Statistics or Demographic data	A. Crime numbers and the tendency for immediate surrounding. M1. The number of yearly criminal acts registered in the local area in relation to the registered ones in the city. 5 points= Lower than local area, 3 points= In accordance with local average 1= 1-10% higher than local area, 0=+10% higher than local area M2. Tendency compares the project area numbers to the registered in 2 previous years. 5 points= Reduction in crime, 3 points= Same as before 1 point= Increase in crime	(M1 + M2) / 2
						x		Space Layout	GIS Mapping	B. Physical conditions that increase the feeling of safety. M1 . Openness & high degree of visibility. The design and volumes provide a high degree of visibility trough transparent materials or openness (5= yes, 1 = No) M2. Buildings Ground floor with mixed-use. Is the ground floor of the surrounding buildings destined to other uses? (i.e. offices, retail, restaurant, shop, cafe) 5 points = >80% is intended for other uses, 3 points = >50% is intended for other use, 1 point= >30% is intended for other use. M3.Ground floor occupancy. The proportion of occupied vs empty other use areas. 5 points= All available occupied, 3 points= >50% occupied 1 point= >30% occupied) M4. Maintenance-friendly buildings & outdoor furniture in the public space. 5 points= The materials in both: building facades and outdoor furniture looks clean or can be easily cleaned and do not present vandalism or damage. 3 points = The materials on either the building facades or the outdoor furniture look clean and do not present vandalism or damage. 1 point= The materials present existing vandalism or damage	(M1+M2+M3+M4)/ 4
				12 QC GEHL			x	User Experience	Survey or interviews	C. User experience Q1 . How would you rate your feeling of personal safety "protection" in the public space? Very safe, Safe, Neither safe nor unsafe, Unsafe Q2. When walking, cycling our staying outside at night (in the public space), how would you rate the existing outdoor lighting and the atmosphere it creates? I think there is enough lighting that is inviting to stay out. I think there is sufficient lighting; however, I prefer not to stay out. I think there is not enough lighting and it doesn't feel safe to stay.	(Q1+Q2) / 2

Value for Livability	Liveability Principle	Parameter	Indicator	Reference	Why it matters?	Type of Indicator		Area to measure	Data source	Measurement	
						Quantitative	Qualitative			How it is measured?	Benchmark / Index value
v11	Social Mix and Affordability	Social diversity and community creation	Public life that enables social cohesion	DGNB SOC 1.1 Social og Funktionel mangfoldighed (SOC 1.1.3 Generationsblanding, SOC 1.1.4 Mødesteder udendørs, SOC 1.1.7 Anvendelsesandel) Soc 3.2 Tilgængelighed	Social interaction results in social cohesion that can also contribute to higher stability and resilience. Great diversity is considered as an element of social sustainability; by ensuring a balanced mix of housing typologies, spaces, services and functions. The urban scale projects bring together people from different age and social groups by creating quality outdoor public areas as meeting places for enjoyment. An urban area with a high population density should thus offer its residents larger open spaces, as these will shape the framework of the urban life that is lived. Through this, culture, history and diversity can be created. Therefore, the public space must enable different types of social interaction and must provide comfort and attractiveness to people that stay on it or the ones that move thorough them throughout the day and throughout the year.	x		Systems performance	GIS Mapping	A.Creation of inclusive public life through social interaction. The relation of the availability of spaces for gathering and neighbourhood land area. Public Space characteristics must be by the following: Variety in type: Open private spaces, open public spaces, playgrounds, promenades, squares, a landscape park Uses: Recreation, sports, gastronomic use, room for various unplanned and unexpected uses Equipment: Seating areas, bicycle parking areas, public transport stops, lighting Users: all age groups.	5. 1 unit every 5 ha 3. 1 unit every 8 ha 1. Complemented in a radiuos of 350 m, only applicable to projects smaller than 10 ha
				GEHL 12 quality criteria GEHL - Age and gender tally			x	Space Layout	On-site observations	B. In the project public space selected for analysis, observe and respond to the following questions: <u>M1. Seating options</u> 1. Which of the following seating options does the project provide? .33 points There are primary seating such as benches or chairs .33 points There are secondary seating such as stairs, seat wall, sculptural elements that serve for it or the edge of a fountain .33 points There are adequate non-commercial seating options so that sitting does not require spending money <u>M2. Options for talking and listening/ hearing</u> 2. Is it evident that you have the option to sit together and have a conversation here? 1 point yes, 0 points no <u>M3. Options for diverse activities</u> 3. Are there options to play, exercise, to be active in the space and to perform other activities? 1 point yes, 0 points no <u>M4. Universal Access</u> 4. Does the area provide universal access? Can a person with a wheelchair or a person walking with a stroller have access to the area? 1 point yes, 0 points no <u>M5. Welcoming all age groups</u> 5. Does the place attract users from different age groups? Which of the following do you observe in the area? (no gender distinction) .14 points_ Seniors ages above 65 .14 points_ Adults (ages 25-64) .14 points_ Young adults (ages 15-24) .14 points_ Kids (Kids ages 5-14) .14 points_ Large groups(9+ people) .14 points_ People with disabilities .14 points_ Families with small children (toddlers ages 0-4)	1 point each question
				SOC 1.1.5 Sikring af mangfoldigheden gennem deltagelse			X	User Experience	Survey or interviews	C. User Experience Q1. How frequently do you visit the project public space, namely _, _ and _? (5= Once a week or more, 3= Once every two weeks, 1= Once a month 0 = Never Q2. How would you rate the public space in terms of availability and design (5= excellent, 3= Good, but could be a better design, 1=Fair, but there should be more public space, 0= Poor	Participants experience vs total inhabitants

Value for Livability	Liveability Principle	Parameter	Indicator	Reference	Why it matters?	Type of Indicator		Area to measure	Data source	Measurement	
						Quantitative	Qualitative			How it is measured?	Benchmark / Index value
v13	Local Economy	Flexibility / Functional mix	Variety and connectivity to social and commercial infrastructure	DGNB 14 OKO 2.1 Lokaløkonomisk DGNB SOC 1.2 Social og kommerciel infrastruktur ØKO2.1.3 Mangfoldighed,	Local economic stability supports long term financial sustainability. The urban dynamics demand an area that can be continuously adapted to market development, with a balanced mix of housing offers and different uses. What characterizes the functional mix is an urban development project that firstly, enables the existing local qualities and culture, secondly, enables a balance of resources and demands through an optimal location, and lastly, enables diversity for social and business life attractiveness. Land use and population growth must be correlated, as an excessive concentration of urban growth in certain areas can result in adverse health and social consequences. Functionality and attractiveness are also determined by universal access and proximity to essential services. Identity and social cohesion can be enhanced by good infrastructure as the conditions that when in proximity, facilitate daily life activities of residents and users. Access to local services also impacts wellbeing by active mobility and stress reduction, less congestion and noise due to traffic, and cleaner air by reduced particulate pollution.	x		Space Layout	Project Plans audit	B. Share and diversity of land use Existing different forms of use in the neighbourhood. Calculation and breakdown of areas (gross floor areas) in percentage Berry-indeks = 1 - (type(1)²+type(2)²+type(3)² …. +type(x)²) The resulting value will be among 0 and 1, the closer it approaches 1, the more diverse the urban area is.	5. BI>.7 3. BI>.4 1. BI>.2
						x		Systems performance	GIS Mapping	A. Convenient access to social and commercial infrastructure. Transport distance (m) or transport time(minutes) on foot, by bike or by public transport. Soc 1.2.1 Children care and education institutions preschool, primary and high school, vocational, university Soc 1.2.2 Facility's for special users playground, youth club, senior club, cultural house, citizen service, library Soc 1.2.3 Purchasing opportunities food store, Kiosk, supermarket, store shopping center, butikker Soc 1.2.4 Health facilities Practitioner, Emergency room, Apotek, General hospital, other health facilities Soc 1.2.5 Service offerings Bank, postal service, hairdresser, Recycling centers, other services Soc 1.2.6 Culture Facilities Cultural house, international house, religious gatherings, restaurant, bar, café, recreational facilities i.e. club Soc 1.2.7 Sports facilities sports hall, outdoor sports trails for racing bike, running routes, etc; Swimming pool(indoor or outdoor), fitness center, climbing wall or skating area. 5 points = DGNB standard, 3 points = max25% higher than standard, 1 point = max 40% higher than standard	5 points = DGNB standard 3 points = max25% higher than standard 1 point = max 40% higher than standard
							x	User Experience	Survey or interviews	C. User experience Q1. Which of the following activities do you perform in the area within a 10 minutes' walk? (select all applicable ones) -Use Educational facilities (daycare, schools) -Use of clubs(elderly, youth, art), library -Shop in the area (kiosk, supermarket, butikk and shopping centre) -Use of health facilities (practitioner, apotek, hospital) -Use of services like a bank, post service, other services -Use for leisure and cultural activities: cultural house, religious gatherings, social gathers in a restaurant, bar, cafe; Use of public space and recreational activities: green spaces, water, nature areas, squares -Use of sports facilities (outdoor and indoor) (5= 5 out of 7, 3= 3 out of 7, 1=2 out of 7) Q2. Are you satisfied with the availability of social and commercial infrastructure within walking distance? Very satisfied, Satisfied, Average, Not satisfied	(Q1+Q2/2)

Value for Livability	Liveability Principle	Parameter	Indicator	Reference	Why it matters?	Type of Indicator		Area to measure	Data source	Measurement	
						Quantitative	Qualitative			How it is measured?	Benchmark / Index value
			Convenience for active mobility	MES LIV TEK 3.4 CYKLISME TM03 - Cycling network	Active mobility in cities is a great way to combat challenges like congestion and pollution. It also has direct impact on human wellbeing than can result in reduced stress, healthy and active lifestyles. Active mobility is convenient when it is safe, efficient, connecting, barrier free and flexible for different interests. The more convenient it is perceived by the users, the more likely it will be that they will consider it as their preferred mobility option. Street design and furniture increases the attractiveness of moving on foot. Therefore, this indicator assesses the physical qualities and their impact on the user experience for active mobility preference.	x		Systems performance	Statistics or Demographic data	Traffic safety - Active mobility Reported accidents for bicycle and on foot. 5 points - Local area accidents are lower than the city average 3 points - Local area accidents are in accordance with the city average 1 point - Local area accidents are no mo than 10% higher than the city average	5, 3 or 1 point
				TEK3.1.7 TEK3.1.8			x	Space Layout	On-site observations	B. Layout conditions for active mobility Respond to each of the questions. (Yes = 5 points, Partially = 3 points and No=0 Points M1. Weather Shelter. Can you observe any elements that serve as weather protection for the sidewalks and bicycle lanes? (For example trees, shelter structures, etc.? M2. Safe crossroads. Are there sufficient road signs that enable safety in crossroads? M3. Active mobility first. Are there physical elements that do not limit but enhance and prioritize mobility in the forms of walking, using a wheelchair, or pushing a stroller? (For example, bumps in crossroads, wide walking paths, separated bicycle lanes?) M4. Openness and visibility. Is it evident how to move through the space without having to take an illogical detour? If people are at the edges of the space, can we still relate to them as people or are they lost in their surroundings?	From 1 to 5 points
				MES LIV			x	User Experience	Survey or interviews	C. User experience Q1. Which of the following better describes your main mean of transport? (Car, Public Transport, Bike, On foot) (5=on foot and bike, 3. public transport, 1 car) Q2. How long is your commuting time to work, studies or any other daily activities? (10 min, 20, 30 min) (5=10 min, 3=20min, 1=30min)	Q1+Q2/ 2

Value for Livability	Liveability Principle	Parameter	Indicator	Reference	Why it matters?	Type of Indicator		Area to measure	Data source	Measurement	
						Quantitative	Qualitative			How it is measured?	Benchmark / Index value
value 17	Microclimate	Air - wind flow	wind comfort	DGNB MIL 1.3.1 Vindkmbfort og sikkerhed	Microclimate has a direct impact on wellbeing. The space between buildings must enable attractive opportunities for daily and seasonal use. Air, as one of the components of the microclimate, is directly correlated to the sensing experience. The intensity of the wind also depends on how far one is from the coast(DMI.DK) . High wind speeds can create uncertainty for pedestrians, cyclists, and people gathered in public space. High wind speeds can be altered by the built environment, as the structure of the city physical elements affects the aerodynamics of the air. The wind mechanical effect is related to the speed of the wind. While the thermal effect is related to whether the cooling effect of the wind feels uncomfortable; involving air temperature, humidity, solar radiation and the person physical activity. Therefore, spaces must provide protection that enable comfort and safety.	x		Space Layout	On-site observations	B. The b3uilding, space between buildings and vegetation. Analyze the geometrical structure of buildings, space between buildings & landscape planting. M1. Buildings height variation measured by floors 5 . Homogeneous building heights 3. 1-2 floors variations 1. 3-5 floors variations 0. Higher variations M2. Minimization of the distance between buildings ratio - Relation among building height(H) and street width(B) 5. Ratio H to B is >2, high shutter effect 3. Ratio 1/2 <HB < 2 , lip effect 1. Ratio HB < 1/2, turbulence M3. Variation of the street throughout its length. Variation in street condition, direction and orientation in relation to wind courses, and when does it occurs. 5. Every 100 meters 3. Between 100 and 250 meters 1. Over 250 meters. M4. Vegetation to diffuse wind flow. Greenery coverage along with street courses. 5. Dense vegetation along with street courses 3. Scattered vegetation 1. Lawn areas and open spaces.	(M1+M2+M3+4)/4
				SOC2.2.3.2 A Vindkomfort LIV CITIES PAPER, Ind Sust Cities,		x		Systems performance	Statistics or Demographic data	A. Registered local wind speeds. The number of days per year on which alarm levels are exceeded. * 5 m/s or above - Mechanical effect is experienced. If not high frequency, there are no problems with wind comfort in parks, waiting for areas, street cafes and playgrounds. * 10 m / s or above - Pedestrians travel with difficulty. Allowed in areas for short stays High wind speed above 13 and frequency > 1%. * 15 m/s or above - Pedestrians are at direct risk of accidents. Frequency > 1%, Unpleasant, troublesome wind protection Index. 1 point. 80% of the areas register within high wind speed 3 points. 50% of the areas are within high wind speed 5 points 25% of the areas are within high wind speed	1. 80% of the areas register within high wind speed 3. 50% of the areas are within high wind speed 5. 25% of the areas are within high wind speed

				12 QC GEHL			x	User Experience	Survey or interviews	C. Experience Regarding the walking paths, the squares, the promenade and green and blue areas. Q1. Have you experienced that the public space or walking traits become very windy and result impossible to stay or walk through there? 0= very often, 3 Often, 1=rarely 5= Never Q2. Do you spend time in any of the public spaces at different times of the year? Yes, all 4 seasons (5), Most of the time, 2 -3 seasons(3), One season(1), one season (0)	Q1+Q2/ 2

9.1.6 OCCUPANTS EVALUATION SURVEY

GENERAL QUESTIONS

Gender
Male
Female
I prefer not to state

What's your age group?
<15 years
15-24 years
25-45 years
46-64 years
> 65 years

What best describes your connection to the area (click all that apply)
Neighbour / Resident,
Work
Visitor
Other

For how long have you lived/worked in Nordhavn?
< 1 year
1-2 years
>2 years
Not applicable

This survey aims to assess the Liveability at the neighbourhood scale. The intend is to learn about your experience as a user of the public space (promenade/corridor, park/green area, waterfront, plaza), and when walking or cycling in the area.

Climate Mitigation

1. Have you experienced feeling vulnerable when walking, cycling or staying in the public space areas when it is raining or there is a big storm?

Very often
Often
Rarely
Never

2. Have you observed minor flooding in the area, as for example the accumulation of water by the roads?

Very often
Often
Rarely
Never

Connection with nature

3. Can you see a tree or any kind of greenery (a tree, green area or plants) from your home or office window?

Yes
No

4. Do you consider the public green spaces have sufficient cleanliness and gardening throughout the year?

Yes
No

Urban Safety

5. How would you rate your feeling of personal safety “protection" in the public space?

Very safe
Safe
Neither safe or nor unsafe
Unsafe

6. When walking, cycling our staying outside at night (in the public space), how would you rate the existing outdoor lighting and the atmosphere it creates?

I think there is enough lighting that is inviting to stay out
I think there is sufficient lighting, however I prefer not to stay out
I think there is not enough lighting and it doesn’t feel safe to stay.

Social mix & affordability

7. How frequently do you visit any of the project public spaces, namely Göteborg Plads, Sandkaj Vej, legeplads, Konditaget Lüders?

At least once a week or more
At least once every two weeks
At least once a month
Never

8. How would you rate the public space in terms of availability and design ?

Excellent, I am very satisfied with them
Good, could be better designed
Fair, but there should be more public space
Poor

Local Economy & Infrastructure

9. Are you satisfied with the availability of social and commercial infrastructure within a walking distance?

Very satisfied
Satisfied

Average
Not satisfied

10. Which of the following activities do you perform in the area within a 10 minutes' walk? (select all applicable ones)

-Use Educational facilities (daycare, schools)
-Use of clubs(elderly, youth, art), library
-Shop in the area (kiosk, supermarket, butikk and shopping center)
-Use of health facilities (practitioner, apotek, hospital)
-Use of services like bank, post service, other services
-Use for leisure and cultural activities: cultural house, religious gatherings, social gathers in restaurant, bar, cafe; Use of public space and recreational activities: green spaces, water, nature areas, squares
-Use of sport facilities (outdoor and indoor)

Mobility

11. Which of the following describes your main mean of transport?

Car
Public Transport (metro, train, s-train)
Bike
On foot
Other

12. How long is your commuting time to work, studies or any other daily activities?

10 min
20 min
30 min

Urban Microclimate

13. Have you experienced that the public space or walking traits become very windy and result impossible to stay or walk through there?

Very often
Often
Rarely
Never

14. Do you spend time in any of the public spaces at different times of the year?

Yes, all 4 seasons
Most of the time, 3 seasons
Sometimes, 2 seasons
one season

BAGGRUNDSPØRGSMÅL

Hvad er dit køn?
Mand
Kvinde
Vil ikke oplyse

Hvad er din alder?
<15 år
15-24 år
25-45 år
46-64 år
>= 65 år

Hvad er din relation til Nordhavn? (Vælg alle det passer)
Jeg bor her
Jeg arbejder her
Jeg studerer her
Jeg besøger
Andet

Hvor lang til har du boet/arbjejdet i Nordhavn?
< 1 år
1-2 år
>2 år
Ikke gældende

HOVEDSPØRGSMÅL - LIVEABILITY

Spørgeskemaet har til formål at undersøge Nordhavn og hvordan dets beboere og brugere opfatter nabolaget. Dette indebærer dit perspektiv på det offentlige rum såsom parker, promenade, havnefront osv. Samt din ageren ved at gå og cykle i området.

1. Hvor ofte besøger du et af følgende områder? (Göteborg Plads, Sandkaj Vej, Hamborg Plads and Sankt Petersburg Plads)

Jeg besøger områderne en gang om ugen
Jeg besøger områderne to gange om måneden
Jeg besøger områderne en gang om måneden
Aldrig

2. Bruger du de offentlige rum alle årstider eller kun enkelte?

Jeg bruger de offentlige rum alle årstider
Jeg bruger de offentlige rum halvdelen af året
Jeg bruger kun det offentlige rum om sommeren

3. Hvordan vil du vurdere design og udseende af det offentlige rum?

Jeg er meget tilfreds med udseenedet af det offentlige rum

Jeg synes det er ok men kunne godt været designed bedre
Jeg synes det er ok men kunne godt været designed bedre og der mangler flere offentlige rum
Jeg er ikke tilfreds med udseendet af det offentlige rum

Natur

4. Hvis du bor eller arbejder i Nordhavn, kan du se et træ eller andet grønt fra dit vindue?

Ja
Nej

5. Synes du at de grønne områder bliver vedligholdt gennem året?

Ja
Nej

Mobilitet

6. Hvilke følgende aktiviteter som er tilgængelige for dig indenfor cirka 10 minutters gang? (vælg alle der passer på din situation)

- Uddannelse og Børneinstitutioner
- Klubber (f.eks. Ungdomsklub, Ældrecenter/seniorklub, kulturhus, Borgerservice / bibliotek)
- Indkøbsmuligheder (f.eks. kiosk, supermarked, andre butikker)
- Sundhedsfaciliteter (f.eks. Praktiserende læge, apotek, hospital, andre sundhedsfaciliteter)
- Servicetilbud (f.eks. bankservice, postservice, frisør, andre servicetilbud)
- Kultur og mødesteder (f.eks. Kulturinstitutioner, foreninger, religiøse samlingssteder, restaurant, bar, cafe, fritidsfacilitet, grønne omrade)
- Sportsfaciliteter (f.eks. sports idrætshal, Svømmehal, Fitnesscenter, Skaterbane)

7. Hvordan vil du vurdere din tilfredshed omkring tilgængeligheden af social og kommercial infrastruktur?

Meget tilfreds
tilfreds
Delvist
ikke tilfreds

8. Hvordan transporterer du dig rundt I byen generelt?

Bil
Metro, tog, S-tog, bus
Cykel
Jeg går

9. Hvor lang tid burger du på daglig pendling mellem arbejde eller studiet?

10 minutter
20 minutter
30 minutter

Tryghed

10. Hvordan vil du vurdere belysningen og atmosfæren om natten når du f.eks. cycler, går eller opholder dig udenfor?

Jeg synes der er tilstrækkeligt med lys og jeg har det fint med at opholde mig udenfor
Jeg synes der er tilstrækkeligt med lys men jeg foretrækker ikke at opholde mig udenfor om natten
Jeg synes ikke der er tilstrækkeligt med lys og det føles ikke sikkert at opholde sig udenfor

11. Har du oplevet stærk blæst ved cykling eller gågang i Nordhavn der har gjort det svært at bevæge sig videre af samme rute?

Aldrig
Sjældent
Ofte
Meget ofte

12. Har du følt dig udsat i forbindelse med stærk regn og storm i det offentlige rum så som gågader eller parker?

Aldrig
Sjældent
Ofte
Meget ofte

13. Har du observeret mindre oversvømmelser i området, som for eksempel vand i vejsiden?

Aldrig
Sjældent
Ofte
Meget ofte

14. Hvordan vil du vurdere sikkerheden i det offentlige rum?

Meget sikkert
Sikkert
Neutral
Usikkert

9.2 CASE STUDY

9.2.1 NORDHAVN CASE STUDY – LITERATURE REVIEW AND INTERVIEWS

The case study research is detailed in the following page. The content includes project description, project factsheet and interviews.

TABLE 21 – NORDHAVN SUMMARY

Urban scale project type	Masterplan or renovation of existing urban areas.
Year	2009 Competition, 2012 on site works started.
Project Area:	360 ha total
Phase 1 Area	26.2 ha
Project Reference:	COBE, structure plan design and development.
Project characteristic	DGNB Urban Districts Pre-Certified "People first Design"
Client	By&Havn
Main collaboration	Københavns Kommune, Rambøll
Sustainability Approach:	Equally balanced among the sustainability pillars
Liveability design principles & concepts	1. People-centric approach 2. Right doze of public space 3. Diversity of opportunities and functions
Liveability key practices	1. Sandkaj Promenade 2. Green Loop
Post-occupancy measurements:	1. Energy Lab 2. Nabomøder by By og Havn
Contact person:	Rune Boserup
Website:	https://cobe.dk/place/nordhavn, https://byoghavn.dk/

Interview & Research
Interview 1
Contact person: Rune Boserup, project director.
Date 13/03/2020, Kl. 9

The urban scale interventions put into practice concepts of liveability through plan and design, and in some cases also during the operational phase of the intervention.
The intend of the interview is to understand which the liveability key values are as understood by project developers, planners and designers', and how is liveability practiced and transformed into physical assets in the urban scale interventions. The interview content covers the following:

1. The project was selected as case study due to its sustainability efforts. Does the project approach sustainability with equal efforts and interest on its three pillars: economic, ecologic or social? If not, which one is prioritized and why?

Rune Boserup commented that Nordhavn is holistic masterplan, where in terms of sustainability efforts everything goes together without trying to prioritize one pillar more than the others. However, he mentions that as architects and urban planners there is a tendency to focus on the social aspects because there is where they can really make an impact through spaces creation with strong analysis and understanding of people needs and wants. Space with these characteristics are implemented in between buildings or public space that allow to diversify these neighbourhoods from others. In terms of the economic sustainability, he recalls that with the planning and design approach, something popular becomes wanted and valuable; so, it goes in co-dependency with the characteristics of social sustainability. There is great environmental sustainability approach at the building and at the city scale interventions. Due to regulations and building codes standards, there are many strategies that enhance this pillar on the building scape; as for example, insulation on buildings and their materials. Transport and mobility play a key role of environmental sustainability at the city scale, as for example, through green mobility and infrastructure. Nordhavn has currently under construction the 'Green loop', which is the corridor connecting local mobility means to the city ones: it includes the metro line 4, bicycle lanes and walking infrastructure. It enables the connection between neighbourhoods - islets in Nordhavn, other district functions and activities, and to other areas in the City of Copenhagen. In terms of roads for other vehicles there are narrow ones and not too many parking spots in total.

2. If existent, what are the key design principles or concepts for liveability in the project?

The intend is to make social spaces that sum up the following principles. How they are carried out and how it is shaped into urban solutions varies among the project.

a. People-centric approach plan & design.
b. Right doze of public space – by investigating the amount of public space in comparable neighbourhoods in Copenhagen, what kind of space they are, their size, distribution and activities to be performed there and in the areas nearby.
c. Diversity of opportunities and functions

3. Which are the main practices or physical assets that represent best these concepts of liveability in Nordhavn? Why this practice matters or how does it enhance the liveability of the space?

Sandkaj Promenade

Sandkaj is a 425m long and 12m wide promenade with a variety of urban life functions for everyone (Sangberg, 2009). It is a place of recreational urban space and unifying course where the district meets the water. Is quite popular place for young people and activities during the summer.

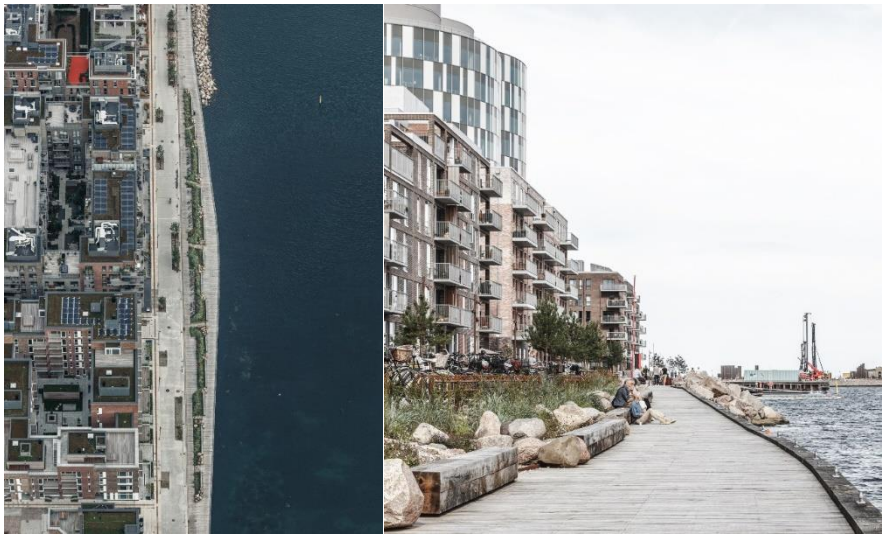


FIGURE 11 - SANDKAJ: NEW ATTRACTIVE URBAN SPACE

Taken from SANGBERG.COM

The green loop – five-minute city.

Transport in the project area intends to enhance the convenience of active mobility. It prioritizes pedestrian and bicycle infrastructure, followed by collective and green transport means and lastly maintaining opportunities for passive mobility. The green loop connects spaces and recreational areas, integrate the different functions and facilitate the mobility to other areas in the city.

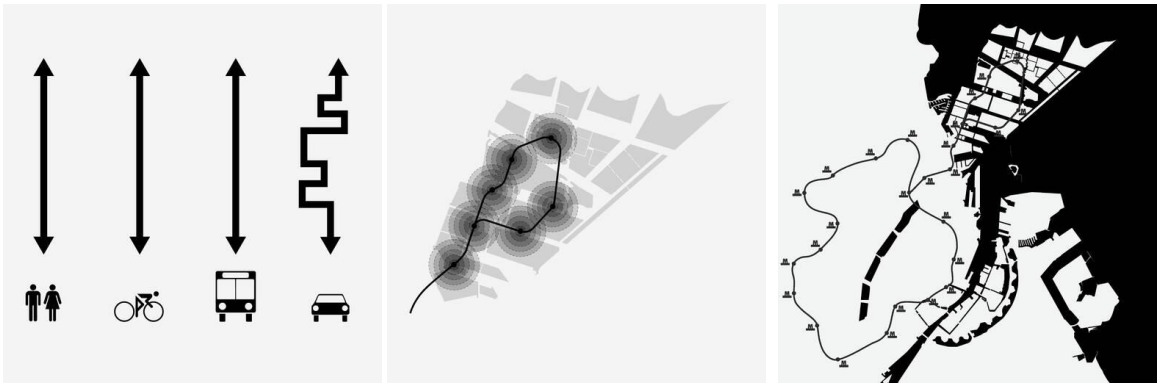


FIGURE 12 - THE GREEN LOOP CONCEPT

Taken from COBE.DK

4. Is there any post occupancy impact/improvement measurement or evaluation? If so, What were the key take aways'? what is being made with results? Improvement of their existing area or for future ones? Are the surveys recurrent?

There is a neighbour's survey called Etnografisk beskrivelse af Århusgadekvarteret – Ethnographic description of Århusgadekvarteret, Nordhavn (Nomadisk af Natur, 2016). This was made by Nomadisk af Natur in September 2016 for By & Havn. The survey summarizes the user experience in Nordhavn: Why the residents have chosen to live there, how they experience their neighbourhood and what hopes they have for the future development in the area. The key values people outline is the sense of a big city close to nature. The primary reasons for moving to Nordhavn is the proximity to existing urban fabric and its connection to the rest of the city, the air quality and the proximity to water, and its multifunctional spaces where they can find city life and shops just downstairs of their apartments. As mentioned by Boserup, the survey has also served to be a design guide for future islets to be developed in the area.

5. Is there any during operations program for community participation on the decision making for neighbourhood improvement?

There are recurrent neighbours' meetings (Nabomøder) organized by By&Havn. On the monthly meetings they discuss on 'themed tables' about needs and wants in topic of new construction in the area and their project plans, operations and maintenance activities, preferred functions for the area such as green areas, stores, fitness centres, etc. On the most recent neighbours meeting, some of the table's topics where the topics were: Traffic Safety, Parking, & Metro and Leisure & City Space, Parks & Harbour Life (By og Havn, 2020)

6. Is there any during operations quantitative measurement for liveability?

Boserup commented about Energy lab's work and the possibility for them to have some measurement. Further research was made to know about Energy Lab. Energy Lab coordinate the district scale energy system, the smart and green solutions in Nordhavn as for example: smart solutions for heating, local district heating, Electric vehicle chargers and solar panels. (Enery Lab, 2020). Its research projects result in local energy efficiency implementations accompanied with on-site measurements. The topic areas included within the 'work packages' Nordhavn has are: WP1: Project Management, WP2: Data and Measurements, WP3: Smart Energy Buildings, WP4: Smart Network Services, WP5: Thermal Infrastructure, WP6: Electricity Infrastructure, WP7: Transportation Infrastructure, WP8: Multi-carrier Energy System Operation and market, WP9: Information and Visibility, WP10: Smart Components.
The work package no. 2 comprehends on-site meters that will allow local data in the topics above mentioned topic areas are real-time and historic data from infrastructures -electricity, thermal, transport, Low-energy buildings and others such as weather data, forecasts. (Enery Lab, 2020)

7. From the following liveability concepts, state the following:

TABLE 22 – NORDHAVN – THE LIVEABILITY CONCEPTS IN PRACTICE. DETAILED

Liveability Concept	Is it approached in Nordhavn Phase 1?	How?	Which project phase?
1. Protection against flooding	Yes	Rainwater directed to the harbour instead of into the sewer system.	Planning and design phase
2. Green areas	Partially.	Not a lot of green was planned and built for the first phase. However, it has a great connection with water. A general strategy of elements to incorporate green areas it in future islets are: -Promenade -Courtyards -New Public Space and Parking garage	-Planning, design and construction and operations, as people is demanding more green structures and this is resulting in changing projects qualities to increase the green in them.
3. Security against crime	Not directly.	It is addressed at the general level but with no particular strategy. However, there are not elements you can hide behind, there is good lighting conditions, and public space is active, with people using them during the day.	Not applicable
4. Affordable housing	No.	It is about to change in future development of islets. Originally: 50% private owners 50% rental apartments with 95 sqm per unit.	Plan, design, operations.
5. Employment possibilities	Yes.	The project has mixed use approach, on which 40% are offices, max 60%. It also includes, shops, supermarkets and other facilities.	Planning and design
6. Mobility	Yes.	There is a big approach to limit car traffic and enhance infrastructure for pedestrian and bicycles. The general strategies: Central Parking Garage and the Green Loop.	Planning and design
7. Clean air	Not directly	By&Havn has a project of electrification of the onshore power in cruise terminals, to improve air quality.	During operations.

Interview & Research
Case Study: Nordhavn
Neighbouring meetings: By&Havn
Contact person: Susan West Norsker, Communications Consultant
Date 14/04/2020, via email.
Interview 1

1. Is this practice existing in all of By&Havn projects alongside Nordhavn?

By & Havn holds a neighbouring meeting in Nordhavn twice a year. The meetings cover all development areas in Nordhavn (Aarhus Street Quarter, Sundmolen, Marmormolen and Oder Nordhavn). For the meetings, we select the most current topics, this could be for example, new development projects or an 'issue' with traffic safety, garbage, visitors or locals bathing there or any other topics of interest among the occupants.

Parallel to the neighbouring meetings, large and small development projects are running in Nordhavn, where residents and landowners' associations have the opportunity to get involved. During 2020, for example, we will launch a major citizen involvement project around a new nature park in North Harbour. Here, the residents of Nordhavn will be invited to a separate meeting about the park, where they have the opportunity to come up with ideas and input for the development of the nature park. We have briefed on at the last two neighbouring meetings held in September 2019 and in March 2020 about the park project and the opportunity to get involved in the development of the park.

2. Who or what determines the topics to cover on each of the ‘themed tables’?

In By & Havn, we receive inquiries from the residents of Nordhavn every day, either by email or telephone. These inquiries are a good indicator of what topics are relevant to the residents and to which they would like to have answers. Several of the topics at the themed tables are selected based on citizens daily inquiries.

In addition, we also select 'the topics' based on what positive themes we would like to 'highlight' ourselves - and what the residents have been looking forward to hearing. These can be new projects in culture, sports, shops or the completion of roads, canals, urban spaces, housing, etc.

During the meeting last September, for example, we talked about Kronløbsøen, which is a new large development project in Nordhavn, where a new islet is being established. This project is due to be completed in 2023. Construction work was very noisy at first, and therefore it was a topic of great interest. Now, Kronløbs Island has its own communications department.

3. Are the meetings informative or for co-creation / participatory planning?

The neighbouring meetings are a mixture of information and dialogue at the theme tables. The goal is for residents to become informed about what By & Havn is doing - and for us to get knowledge

about what the residents wish or any ideas they have for Nordhavn. Of course, not all desires can be fulfilled, but we try to improve wherever possible.

As there are many actors in the development of Nordhavn, we also invite other stakeholders to the neighbouring meetings so that they can help answer the residents' questions. By & Havn is not responsible for all development projects in Nordhavn. For example, we have assigned several roads and places to the landowners' associations, which are then responsible for the operation and development of these areas.

4. Which kind of summarization of the meetings is made, by who and with whom (stakeholders) is shared?

After each neighbouring meeting, we compile a summary of the central questions & answers that were discussed at the themed tables. We publish the summary on the City & Harbour website and on our social media.

5. How are neighbours' suggestions and demands incorporated on the overall project? What kind of impact have these meetings on 1. Changing operations, 2. Modifying the existing areas developed or 3. Updating future construction plans in Nordhavn? Could you provide an example?

We are very keen to listen to the wishes of the residents for the development of Nordhavn, but of course we cannot meet all demands: Here are presented a few examples, which arise from neighbouring meetings and our ongoing dialogue with the residents and the landowners' associations:

- Hamburg Square in the Aarhus Street neighbourhood was originally planned without greenery, but only with a small fountain. Based on the input from the residents, a new plan has been made so that the space is instead designed with a green bed in the middle with trees and plants. There is an existing tree in the square which we are moving to the green bed, where it will be preserved and better protected.
- A general improvement around Sandkaj and the Marble Mill bathing areas and the visitors that come there. Signs with information on rules for bathing and staying at the waterfront were set, alongside the upgrading the emptying of waste bins, temporary public toilets and changing facilities etc.
- Additionally, we receive and attend inquiries regarding corrective actions in operational features, as for example broken street lighting, greenery renovation, etc.

6. How are you engaging the community participation in the meetings? who is invited?

All residents and others with an interest in Nordhavn are invited via By&Havn e-newsletter. We also advertise in local newspapers and on our social media.

7. Is there any survey made to Nordhavn inhabitants/occupants? If yes, the following questions apply:

There are several different studies where the residents of By&Havn are included together with other groups. This applies for example, to a study on transport behaviour in Copenhagen.

In addition, there are figures and statistics about Nordhavn and Nordhavn residents, which we subtract from Statistics Denmark; as for example, age groups, income level etc.

9.2.2 Results: Case study Evaluation Appendix

Project general information

This appendix section includes all the details about the case study evaluation. three tables are presented per each indicator. Each table contains the evaluation made within the area Systems performance, Layout Design and User experience.

Project Data					
City Scale					
Population Copenhagen 2019			633021		
Area			8978	hectare	
District					
Project:	Nordhavn	Phase 1			
Inhabitants		2500			
Phase area		114917,75	m2		
		11,491775	ha		
Built Area		29371	m2		
*Table of areas (m2)		area	green	other	trees
Goteborgs plads		5920	53		
Playground		918,5	189		
SandkajVej			289		
Århusgade					
Helsinkigade					

References
Statistics Denmark byoghavn.dk/nordhavn/ *As measured on project plans, provided by COBE. Measurements on this analysis here are not official ones.

Demographic profile of survey respondents

The figure below presents the profiles of Nordhavn survey respondents. 66% of the surveys were conducted online through google forma, while re rest were directly responded in the project area during the case study visits.

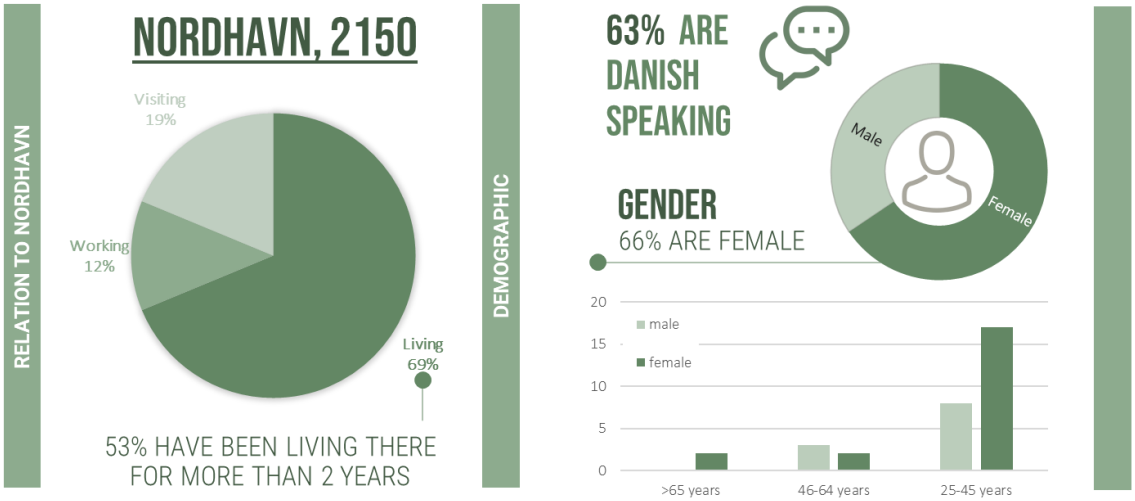


FIGURE 13 - DEMOGRAPHIC PROFILE OF SURVEY RESPONDANTS

9.2.3 INDICATOR 1

1. Safe storm and rain experience	
Systems performance	5

A. Evaluates average winds recorded

Nearest meteorological measurement station has recorded average winds higher or lower than the national average +/- 10%. Risk is measured combined with landscape roughness.

1= There has been experiencing over the past 3 years mean wind speeds that are more than 10% above the national average.

3 = There has been experiencing over the past 3 years average wind speeds that lie within for +/- 10% of the national average.

5 = There has been experiencing over the past 3 years mean wind speeds that are more than 10% below the national average.

Area of Analysis							Points
Local average winds	unit	year	National average winds	unit	year	relation	5
3.9	m/s	2019	4.6	m/s	2019	84.8%	-15.2%
3.7	m/s	2018	4.5	m/s	2018	82.2%	-17.8%
4.1	m/s	2017	4.8	m/s	2017	85.4%	-14.6%

Reference and notes:

(DMI, 2019)

* Due to lack of information at the district level of analysis, the city and the national scale are taken as comparison parameters.

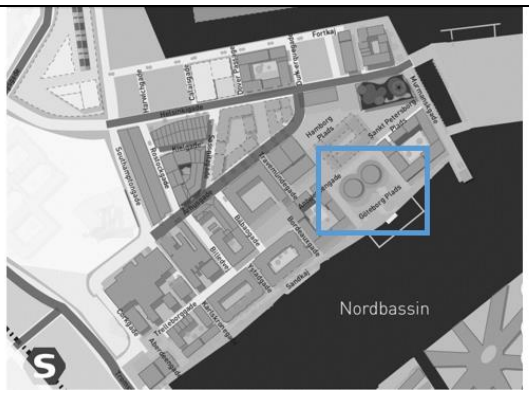
1. Safe storm and rain experience	
Space Layout – On-site observation	3

B1. Evaluates the space between buildings protection for storms and flooding.
Which of the following strategies is observed in the project area? (gives 1 point each and sum up maximum to 5 points)

M1. Boundary elements. The area is protected from storms and flooding by enclosing it with, i.e. buildings as a shelter, difference in levels, or outdoor furniture and design as a barrier against water masses.
M2. Compact development & low building heights. In the neighbourhood predominate freestanding and compact buildings as for example single-family homes or buildings with less than 3 floors height, as the height of the buildings increase the wind load.
M3. Uniformity in building heights. Uniform building height prevails in the project area to create an even distribution of the impact from strong winds (+/- 1 floor variation)
M4. Water retention. The overflow is controlled and retained by rainwater delay basins—I.e. enclosed wetlands for extreme quantities of water.
M5. Raising the construction area so that the lower floor can be kept free from flooding's. Buildings of great importance are placed higher in the terrain.
M6. Green as catchment or terrain cultivation areas
M7. Any other observed measures and systems for leakage, detention, delay, divert, evaporation, seepage, collection and use of rainwater
M8. Roof slope. A <30° roof slope is avoided, as this help to form high negative pressure during a storm and the roof can be blown off. (Flat roofs are ok)
M9. Small enclosures avoidance. The development avoids the creation of small enclosures such as houses gardens.

Strategy	Description	Points
		3
M1	Boundary elements The square has on its perimeter urban furniture as the form of sculptural seating elements.	1
M6	Green as catchment There is planted small proportions of greenery in the square that could serve as absorption area. Some of the roofs have greenroofs	1
M8	Roof slope The rooftops in the surrounding buildings are flat.	1

Additional evidence



Area of analyis: Göteborgs Plads


M6. Green as catchment

M6 and M8. Flat and green roof tops

1. Safe storm and rain experience		
User Experience	Survey	3,6

Q1. Have you experienced feeling vulnerable when walking, cycling, or staying in the public space areas when it is raining or there is a big storm?
0= very often, 1 often, 3=rarely 5= Never
Q2. Have you observed minor flooding in the area, as for example the accumulation of water by the roads?
0= very often, 1 often, 3=rarely 5= Never

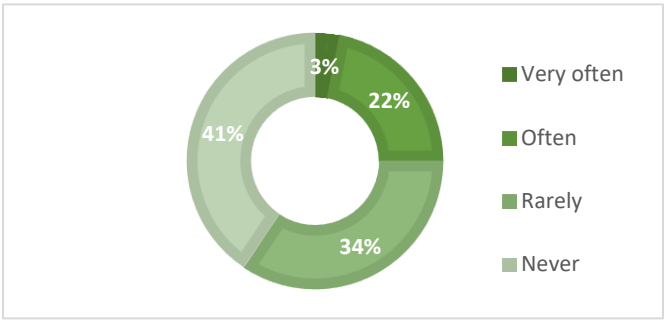
Results

Q1	3,3	Points
Q2	3,8	Points

Additional Evidence

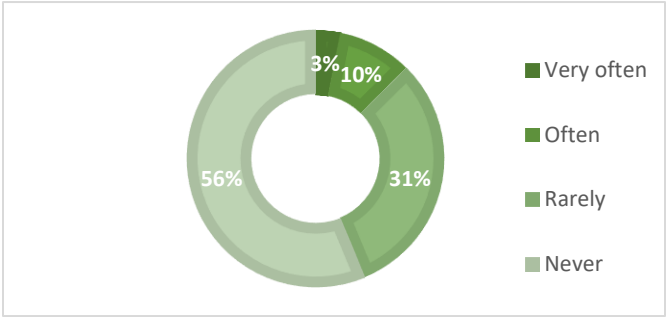
Q1. Have you experienced feeling vulnerable when walking, cycling, or staying in the public space areas when it is raining or there is a big storm?

Very often	1
Often	7
Rarely	11
Never	13



Q2. Have you observed minor flooding in the area, as for example the accumulation of water by the roads?

Very often	1
Often	3
Rarely	10
Never	18



9.2.4 INDICATOR 2

2. Green spaces availability and use		
Systems performance	GIS Mapping	3

A. Access to green spaces

M1. The masterplan is designed to allow all residents to be within walking distance of a green space via a safe and convenient pedestrian route. ≤ 650m in an urban development OR ≤ 1300m in a rural development
Urban areas:
≤ 650m = 5 points, ≤ 850m = 3 points, ≤ 1000m=1 points

Quantity of green spaces
M2. Green space per inhabitant (m2/inhab) or per built up area (%).
5 points= higher than City average, 3 points= equal to city average, 1 point = lower than City average

Area of Analysis: Whole project Area

Measurement			Points
M1	Walking distance to green		3
	5≤ 650m	The project has access to existing green areas, but the pedestrian route is not the most convenient, as one has to go through tunnels under the railway station. The total distance is 550 with a seven min walk	5

M2 Quantity of public green space in the project

	Green space	units	inhabitants	m2 / inhab		1
CPH	14122806	m2	633021	22.3m2		
Nordhavn	531	m2	2500	0.2m2		
			14708			

Additional Evidence

References and notes:

*The green areas in the district are calculated with plans audit. Although the project area accounts green private space, this is not considered as it is internal to the buildings and with limited access to residents.

*The green areas for the municipality of Copenhagen are counted in GIS with the map Grønt Område from KK Kort

(By&Havn, By&Havn, 2019)

2. Green spaces availability and use		
Space Layout	On-site observations	1.67

B. Presence of greenery in public spaces.

M1. Proportion of greenery in public space
5 points = > 80% of the surface is planted
3 points = 40-80% of the surface is planted
1 points = 39<is planted

M2. Presence of variety greenery along with the project. One of the combinations of any of the following types of surfaces (Gives one point each, 1 to 5 points in total)
1. Mowed grass
2. Natural grass or Natural meadows
3. Landscape planting or plants pots
4. Roof or facade planting
5. Area covered by its own compost

M3. Quality of greenery. Availability in as many of the following types. (Gives one point each, 1 to 5 points in total)
1. Scrub and shrubs under two meters
2. Scrub and shrubs over two meters
3. Wood and forestry plantations
4. Individual trees
5. Designed landscape

Strategy	Description	Points
		1.67
M1	Proportion In Göteborgs Plads, the greenery (Plants and trees) are only allocated on limited areas and represent less than 39% of the surface area	1
M2	Variety The square has lanscape planting only.	1
M3	Quality The identified types in the square are: Scruh and shrubs under 2 m, Individual trees, Designed landscape	3

Additional Evidence

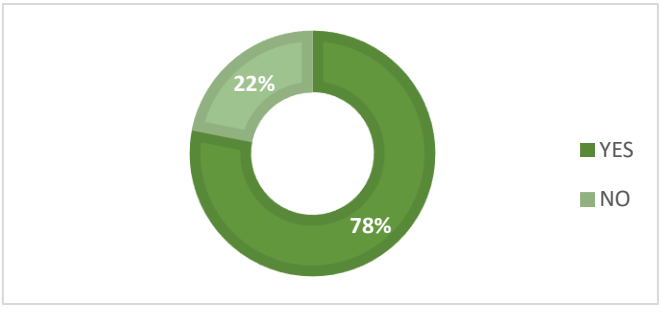
Area of Analysis: Göteborgs Plads

Existing green

2. Green spaces availability and use		
User Experience	Survey or interviews	3.5.
C. User experience Q1. If you work or live in the area, Can you see a tree or any kind of greenery (a tree, green area, or plants) from your home or office window? (Yes, or No) Q2. Do you consider the available green spaces have sufficient cleanliness and gardening throughout the year? (Yes or No)		
Results		
Q1	3.91	Points
Q2	3.13	Points
Additional evidence		

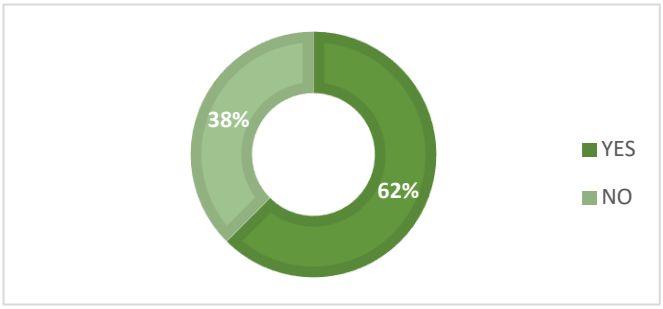
Q1. Can you see a tree or any kind of greenery (a tree, green area, or plants) from your home or office window?

YES	25
NO	7



Q2. Do you consider the available green spaces have sufficient cleanliness and gardening throughout the year?

YES	20
NO	12



9.2.5 INDICATOR 3

3. Safe and attractive public space		
Systems performance	Statistics or Demographic data	3

A. Crime numbers and the tendency for immediate surrounding.

M1. The number of yearly criminal acts registered in the local area in relation to the registered ones in the city.
5 points= Lower than local area, 3 points= In accordance with local average 1= 1-10% higher than local area, 0=+10% higher than local area

M2. Tendency compares the project area numbers to the registered in 2 previous years.
5 points= Reduction in crime, 3 points= Same as before 1 point= Increase in crime

Area of Analysis							Points
M1	Number of criminal acts in topic of vandalism		2019	inhab	rate		3
		Copenhagen	2479	633021	255.35		
		National	21603	5827463	269.75		
		Frederiskberg	257	104987	408.51		
M2	Tendency		2017	2018	2019		
		City scale	2411	2295	2479		3
				-116	184	34	

Reference

*Frederiksberg, as neighbour municipality, is used a reference to learn about variations among cities. Denmarkas a national reference.
(DST, 2019)
(DST-2, 2019)

3. Safe and attractive public space		
Space Layout	On-site observations	5

B. Physical conditions that increase the feeling of safety.

M1 . Openness & high degree of visibility. The design and volumes provide a high degree of visibility trough transparent materials or openness (5= yes, 1 = No)

M2. Buildings Ground floor with mixed-use. Is the ground floor of the surrounding buildings destined to other uses? (i.e. offices, retail, restaurant, shop, cafe)

5 points = >80% is intended for other uses, 3 points = >50% is intended for other use, 1 point= >30% is intended for other use.

M3.Ground floor occupancy. The proportion of occupied vs empty other use areas.

5 points= All available occupied, 3 points= >50% occupied 1 point= >30% occupied)

M4. Maintenance-friendly buildings & outdoor furniture in the public space.

5 points= The materials in both: building facades and outdoor furniture looks clean or can be easily cleaned and do not present vandalism or damage.

3 points = The materials on either the building facades or the outdoor furniture look clean and do not present vandalism or damage.

1 point= The materials present existing vandalism or damage

Strategy	Description	Points
		5
M1	Ground floor for mixed-use On two of the sides, the ground floor is all for mixed-use. On one of the other sides, there is a big local unused. The last side is open to the waterfront. Considering three of the sides, all of it is designated for mixed-use.	5
M2	Ground floor occupancy There are 8 plots on the ground floor for commerce use. All of them are occupied but not all of them open (Due to Covid-19)	5
M3	Mantainance There are no surfaces with existing vandalism or damage, and the outdoor furniture materials are resistant to fire and can be easily cleaned.	5
M4	Openness and high degree of visibility. There is a high degree of visibility from every angle of the square. As it has on the sides some restaurants, it is frequently used and observed.	5

Additional Evidence

Area of Analysis: Göteborgs Plads

3. Safe and attractive public space		
User Experience	Survey or interviews	4.25

C. User experience

Q1 . How would you rate your feeling of personal safety "protection" in the public space? Very safe, Safe, Neither safe nor unsafe, Unsafe

Q2. When walking, cycling our staying outside at night (in the public space), how would you rate the existing outdoor lighting and the atmosphere it creates?
I think there is enough lighting that is inviting to stay out.
I think there is sufficient lighting; however, I prefer not to stay out.
I think there is not enough lighting and it doesn't feel safe to stay.

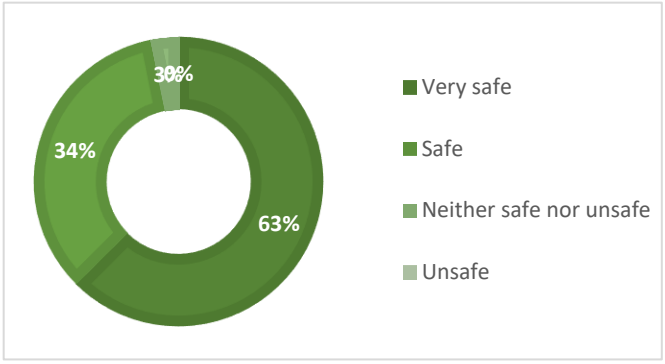
Results

Q1	4.1875	Points
Q2	4.3125	Points

Additional evidence

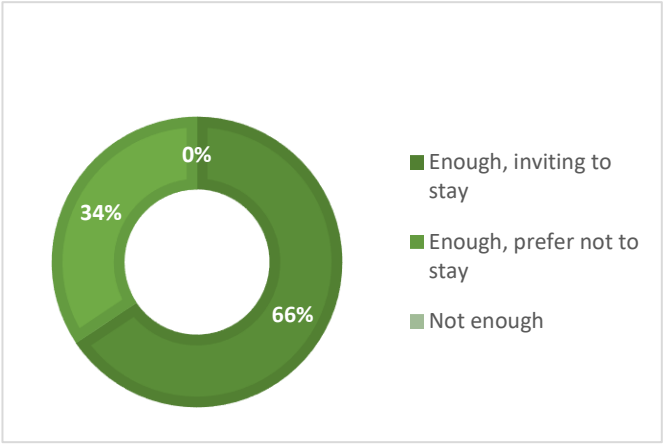
Q1. How would you rate your feeling of personal safety “protection" in the public space?

Very safe	20
Safe	11
Neither safe nor unsafe	1
Unsafe	0



Q2. When walking, cycling our staying outside at night (in the public space), how would you rate the existing outdoor lighting and the atmosphere it creates?

Enough, inviting to stay	21
Enough, prefer not to stay	11
Not enough	0



9.2.6 INDICATOR 4

4. Public life that enables social cohesion		
Space Layout	On-site observations	5

B. In the project, public space selected for analysis, observe and respond to the following questions:

M1. Seating options

1. Which of the following seating options does the project provide?

.33 points There are primary seating such as benches or chairs

.33 points There are secondary seating such as stairs, seat wall, sculptural elements that serve for it or the edge of a fountain

.33 points There are adequate non-commercial seating options so that sitting does not require spending money

M2. Options for talking and listening/ hearing

2. Is it evident that you have the option to sit together and have a conversation here?

1 point yes, 0 points no

M3. Options for diverse activities

3. Are there options to play, exercise, to be active in the space and to perform other activities?

1 point yes, 0 points no

M4. Universal Access

4. Does the area provide universal access? Can a person with a wheelchair or a person walking with a stroller have access to the area?

1 point yes, 0 points no

M5. Welcoming all age groups

5. Does the place attract users from different age groups? Which of the following do you observe in the area? (no gender distinction)

.14 points_ Seniors ages above 65

.14 points_ Adults (ages 25-64)

.14 points_ Young adults (ages 15-24)

.14 points_ Kids (Kids ages 5-14)

.14 points_ Large groups(9+ people)

.14 points_ People with disabilities

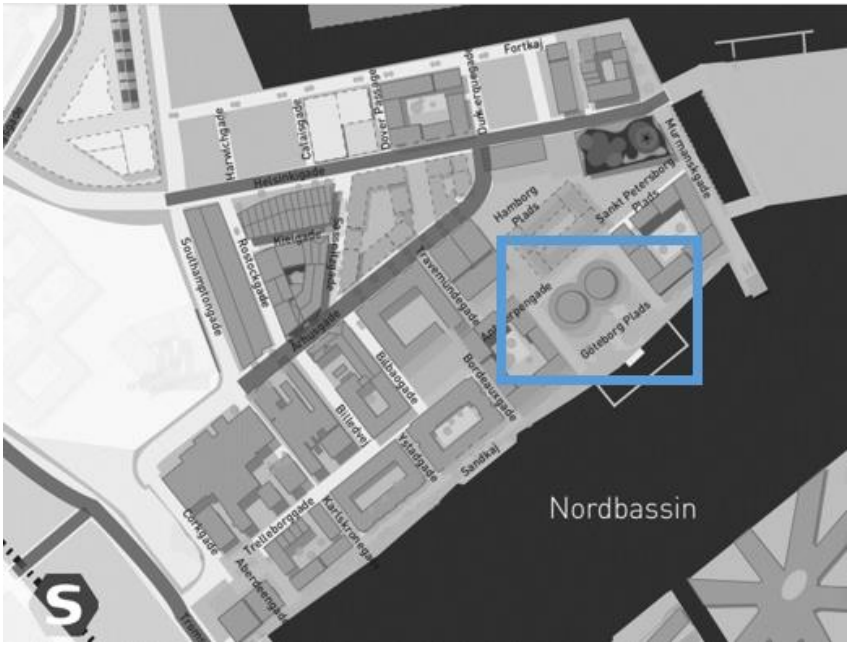
.14 points_ Families with small children (toddlers ages 0-4)

			5
Strategy		Description	Points
B1. Seating options			1
0.34	Yes	There is one bench on the square	
0.33		There are sculputral elements in shape of rocks on which people can sit	
0.33	Yes		
B2. Options for talking and listening/ hearing			1
1	Yes	There are several areas surrounded either by green or urban furniture that can be quiet places that can enable a conversation.	
	No		
B3. Options for diverse activities			1

			Yes, it is a vast open space on which people can stand, kids, play soccer and run	
1	Yes		around the area, people can walk through there to other destinations, etc.	
	No			
B4. Universal access				1
			The square has no change on its level, so ramps are not needed. One with a	
1	Yes		stroller or with a wheelchair will not experience difficulties related to this.	
	No			
B5. Welcoming all age groups			7	1
1	Yes	Seniors ages above 65		
1	Yes	Adults (ages 25-64)		
1	Yes	Young adults (ages 15-24)		
1	Yes	Kids (Kids ages 5-14)		
1	Yes	Large groups(9+ people)		
1	Yes	People with dissabilities		
1	Yes	Families with small children (toddlers ages 0-4)		

Additional Evidence

Göteborgs Plads location



4. Public life that enables social cohesion					
Space Layout	GIS Mapping				3.7

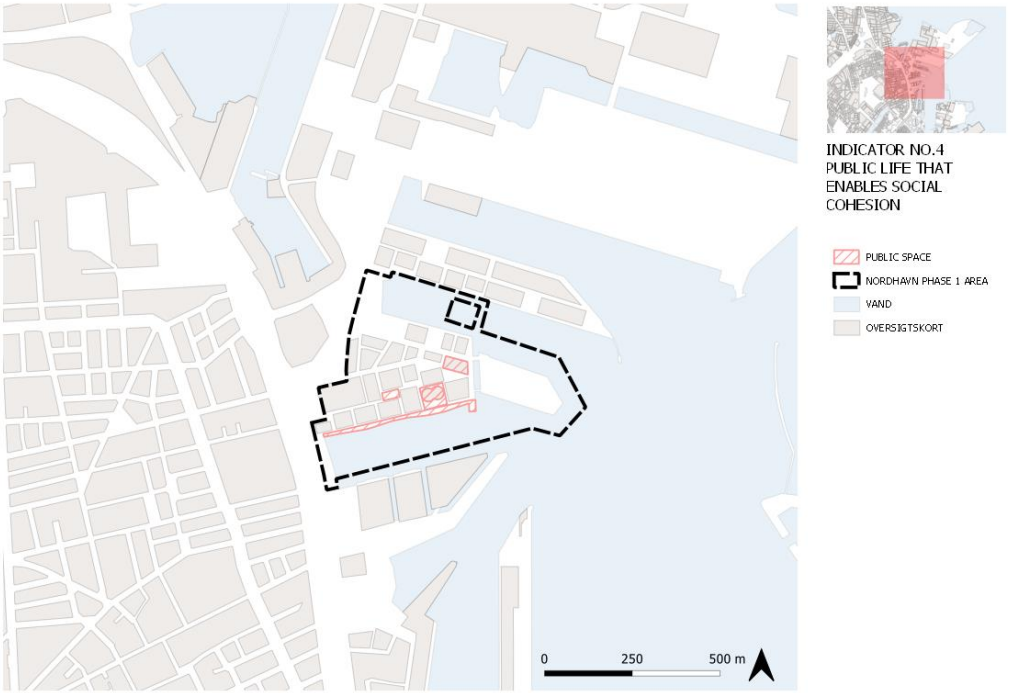
A. Creation of inclusive public life through social interaction.
The relation of the availability of spaces for gathering and neighbourhood land area.

Public Space characteristics must be by the following:
Variety in type: Open private spaces, open public spaces, playgrounds, promenades, squares, a landscape park
Uses: Recreation, sports, gastronomic use, room for various unplanned and unexpected uses
Equipment: Seating areas, bicycle parking areas, public transport stops, lighting
Users: all age groups.

Calculation					Points
Project data					
27.0	ha	Area of study surface			
1.1	ha	Area - Places for gathering			
4		Existing Units - Area for public life, places for gathering			
5.40		Total required units (1 u / 5 ha)	1	5	3.7
0.74		Available units / 5 ha	0.74	3.7	
3.37		Total required units (1 u / 8 ha)	1	3	
1.19		Available units / 8 ha	0.74	2.2	

Area of Analysis

Project Area: Phase 1



4 . Public life that enables social cohesion		
User Experience	Survey or interviews	3.89

C. User Experience

Q1. How frequently do you visit the project public space, namely _, _ and _?

(5= Once a week or more, 3= Once every two weeks, 1= Once a month 0 = Never

Q2. How would you rate the public space in terms of availability and design

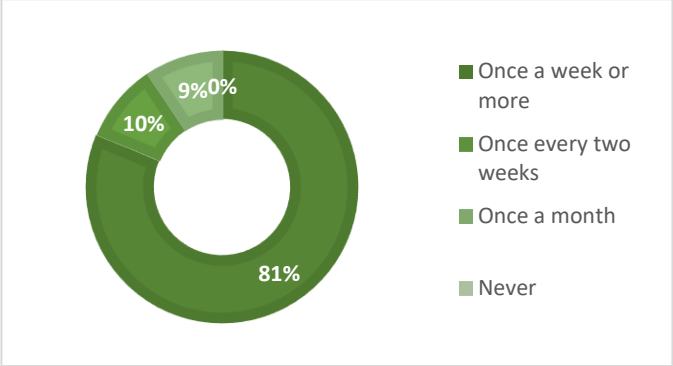
(5= excellent, 3= Good, but could be a better design, 1=Fair, but there should be more public space, 0= Poor

Results			Points
Q1	4.4	Points	3.890625
Q2	3.3	Points	

Aditional evidence

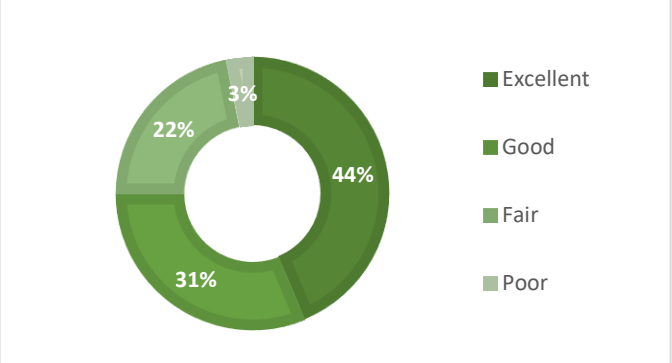
Q1. How frequently do you visit any of the project public spaces, namely Göteborg Plads, Sandkaj Vej, legeplads, Konditaget Lüders?

Once a week or more	26
Once every two weeks	3
Once a month	3
Never	0



Q2. How would you rate the public space in terms of availability and design?

Excellent	14
Good	10
Fair	7
Poor	1



9.2.7 INDICATOR 5

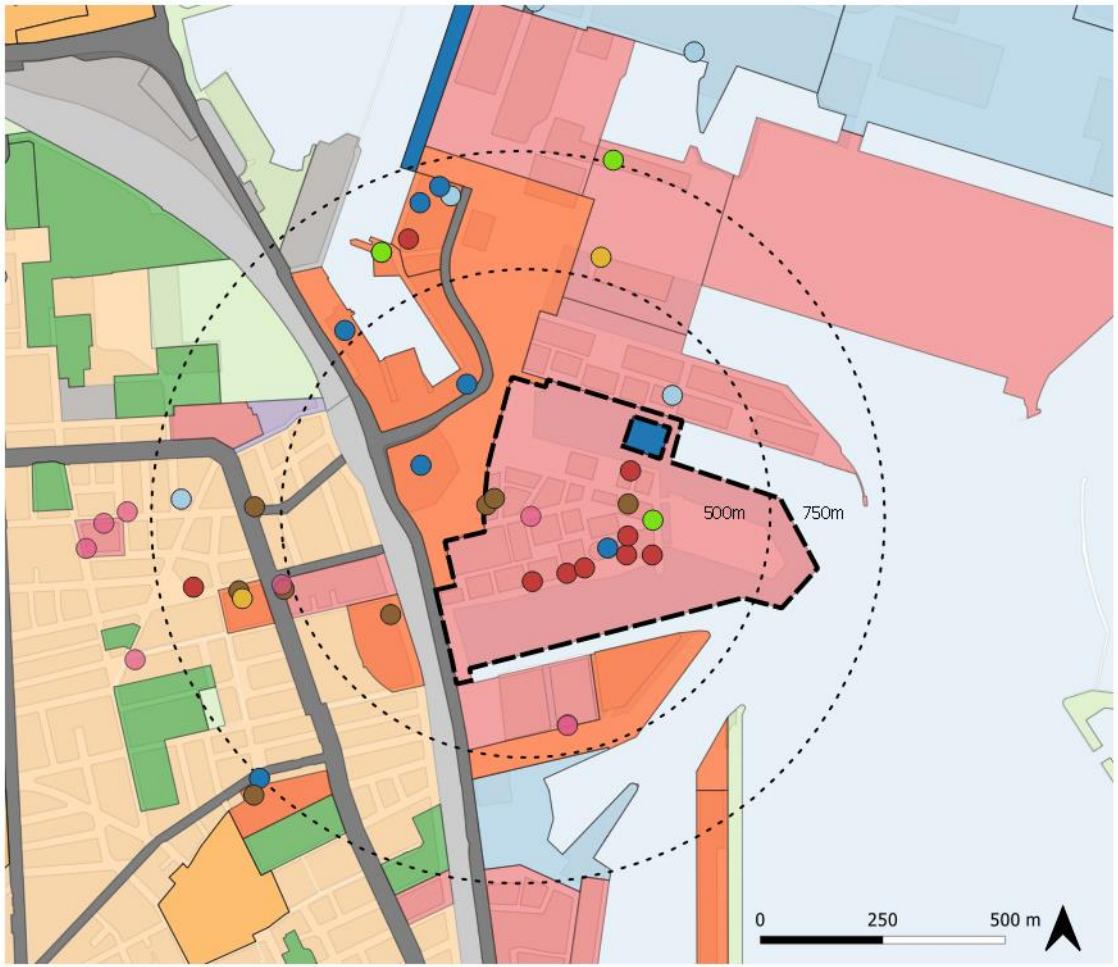
5. Variety and connectivity to social and commercial infrastructure		
System performance	GIS Mapping	4.71

Convenient access to social and commercial infrastructure
Transport distance (m) or transport time(minutes) on foot, by bike or by public transport.

Soc 1.2.1 Children care and education institutions
preschool, primary and high school, vocational, university
Soc 1.2.2 Facility's for special users
playground, youth club, senior club, cultural house, citizen service, library
Soc 1.2.3 Purchasing opportunities
food store, Kiosk, supermarket, store shopping center, butikker
Soc 1.2.4 Health facilities
Practitioner, Emergency room, Apotek, General hospital, other health facilities
Soc 1.2.5 Service offerings
Bank, postal service, hairdresser, Recycling centers, other services
Soc 1.2.6 Culture Facilities
Cultural house, international house, religious gatherings, restaurant, bar, café, recreational facilities i.e. club
Soc 1.2.7 Sports facilities
sports hall, outdoor sports trails for racing bike, running routes, etc; Swimming pool(indoor or outdoor), fitness center, climbing wall or skating area.

ØKO2.1.3 Mangfoldighed,
5 points = DGNB standard, 3 points = max25% higher than standard, 1 point = max 40% higher than standard

Calculation							Points
Use type	Max Transport time with Bus, bicycle or on foot (Minutes)			Max crow flies distance. Straight line distance between two points on a map (Meters)			
	5	3	1	5	3	1	4.7
Children's institutions and educational offerings	8	10	12	500	625	750	3
Facilities for special user groups	5	6	8	500	625	750	5
Purchasing opportunities	15	19	23	1500	1875	2250	5
Health facilities	10	13	15	700	875	1050	5
Services	10	13	15	700	875	1050	5
Cultural facilities	10	13	15	700	875	1050	5
Sports facilities	10	13	15	1500	1875	2250	5



INDICATOR NO.5
SOCIAL&COMMERCIAL
INFRASTRUCUTRE

NORHAVN
NORHAVN CULTURAL
NORHAVN EDUCATION
NORHAVN HEALTH FACILITIES
NORHAVN KLUB
NORHAVN PURCHASING
NORHAVN SERVICES
NORHAVN SPORTS
NORDHAVN PHASE 1 AREA
BOLIG OG SERVICEERHVERV C
SERVICEERHVERV S
BLANDET ERHVERV E
INDUSTRY J
HAVNEFORMÅL H
TEKNISKE ANLÆG T VEJE
TEKNISKE ANLÆG
INSTITUTIONER O
FRITIDSOMRÅADE O
HUSBÅDE V
BOLIGER B LAV TÆTHED
BOLIGER B HØJ TÆTHED
VAND

5. Variety and connectivity to social and commercial infrastructure		
Space Layout	Project Plans audit	4.30

B. Share and diversity of land use

Existing different forms of use in the neighbourhood. Calculation and breakdown of areas (gross floor areas) in percentage

Berry-indeks = 1 - (type(1)²+type(2)²+type(3)² …. +type(x)²)

The resulting value will be among 0 and 1, the closer it approaches 1, the more diverse the urban area is.

Calculation — Points

Type	Sqm	area (%)	Berry indeks	4.30
Existing building	20000		0.60	4.30
Subareas total	290,000			
Housing	158100	55%	Points	
Business	29000	10%	0.7	5
Open space	87000	30%	0.4	3
Joint facilities	2900	1.0%	0.2	1
retail zone	10000	3.4%		
Groseries	2000	0.7%		
merchandise stores	1000	0.3%		

Subareas as stated in local plan:

SA II	78,000
SA III	60000
SA IV	59000
SA V	68000
SAVI	25000

Additional Evidence

The project area is developed under the cateogy for mixed-use Housing and Services (C) (Boliger og serviceerhverv (C)KK). Area designation C3

The areas are used for housing and service industries, such as administration, liberal professions, shops, restaurants, hotels, vocational and leisure education, primary and lower secondary education and crafts and other businesses that can be accommodated in the area. Stores are allowed in accordance with retail regulations in the general regulations.

The Local plan subareas are I. Område syd for Sundkrogsgade ('Det grønne loop'), II. Århusgade, III. Sandkaj,IV. Redmolen V. Fortkaj og Stubkaj, VI. 'Kronløbsøen'

Diversity of uses

From left to right:
Administration / grosery store
Realestate
Restaurant
Apotec
Supermakert
Coffee place
Restaurant







5. Variety and connectivity to social and commercial infrastructure	
User Experience	2.86

C. User experience

Q1. Which of the following activities do you perform in the area within a 10 minutes' walk? (select all applicable ones)
-Use Educational facilities (daycare, schools)
-Use of clubs(elderly, youth, art), library
-Shop in the area (kiosk, supermarket, butikk and shopping centre)
-Use of health facilities (practitioner, apotek, hospital)
-Use of services like a bank, post service, other services
-Use for leisure and cultural activities: cultural house, religious gatherings, social gathers in a restaurant, bar, cafe; Use of public space and recreational activities: green spaces, water, nature areas, squares
-Use of sports facilities (outdoor and indoor)

(5= 5 out of 7, 3= 3 out of 7, 1=2 out of 7)

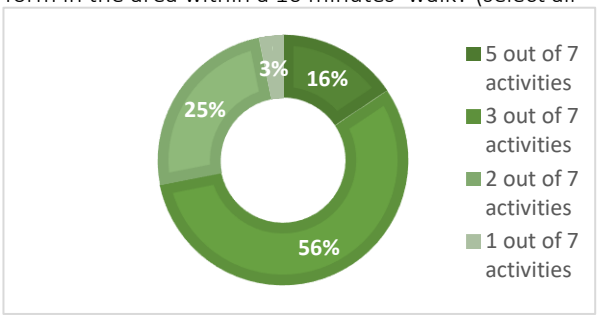
Q2. Are you satisfied with the availability of social and commercial infrastructure within walking distance?
Very satisfied, Satisfied, Average, Not satisfied

Results	
Q1	2.7 Points
Q2	3 Points

Additional evidence

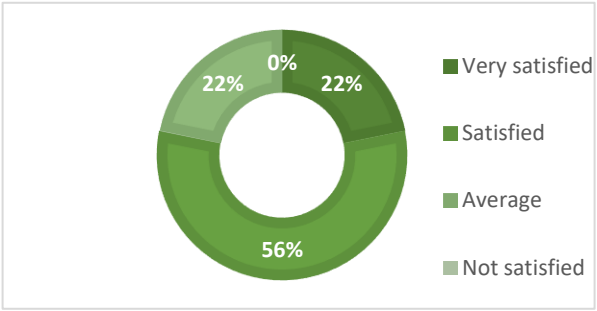
Q1. Which of the following activities do you perform in the area within a 10 minutes' walk? (select all applicable ones)

5 out of 7 activities	5
3 out of 7 activities	18
2 out of 7 activities	8
1 out of 7 activities	1



Q2. Are you satisfied with the availability of social and commercial infrastructure within a walking distance?

Very satisfied	7
Satisfied	18
Average	7
Not satisfied	0



9.2.8 INDICATOR 6

6. Convenience for active mobility		
Systems performance	Statistics or Demographic data	5.00

Traffic safety - Active mobility Reported accidents for bicycle and on foot.

5 points - Local area accidents are lower than the city average
3 points - Local area accidents are in accordance with the city average
1 point - Local area accidents are no more than 10% higher than the city average

Calculation — Points

Area of analysis: Project first phase

	Total accidents 2018	Inhabitants %	Land area %	Factor (%land+%inhab)	Density (hab /hectare)	Inhabitants	Land area (hectare)	5
Copenhagen					71	633021	8978	
Bicycle	150	0.02%	1.7%	0.02				
On foot	74	0.01%	0.8%	0.01				
Nordhavn / accidents estimation (density factor)					218	2500	11.5	
Bicycle	4	0.1%	32.1%					
On foot	2	0.1%	15.8%					

	yearly total	per day
City average	224	0.61
Local Average	6	0.02

Source

Færdselsuheld statistiks, (DST-3, 2019)

*An estimation of the local accidents is made to understand how the number of accidents behave on the project area. This estimation takes into consideration the density, the total number of inhabitants and the land area. These numbers are correlated to the city ones and the obtained statistics about accidents for the city of Copenhagen. This estimation is only to reflect the usability of the measurement, but not the reality in Nordhavn.

6. Convenience for active mobility		
Space Layout	On-site observations	3.5

B. Layout conditions for active mobility

Respond to each of the questions. (Yes = 5 points, Partially = 3 points and No=0 Points

M1. Weather Shelter. Can you observe any elements that serve as weather protection for the sidewalks and bicycle lanes? (For example trees, shelter structures, etc.?

M2. Safe crossroads. Are there sufficient road signs that enable safety in crossroads?

M3. Active mobility first. Are there physical elements that do not limit but enhance and prioritize mobility in the forms of walking, using a wheelchair, or pushing a stroller? (For example, bumps in crossroads, wide walking paths, separated bicycle lanes?)

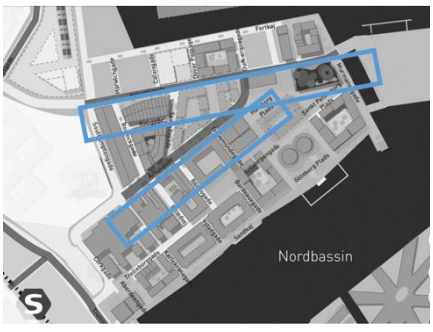
M4. Openness and visibility. Is it evident how to move through the space without having to take an illogical detour? If people are at the edges of the space, can we still relate to them as people or are they lost in their surroundings?

Strategy	Description	Points
		3.5
M1.	Weather Shelter Partially. The sidewalks in Århusgade have trees all along the way, these serve as shelter for both, people walking and people on bicycles. However, trees are found only on one side of the road and not on the two of them. On the other hand, there are very few trees in Helsinkigade.	3
M2.	Safe crossroads Partially. There are bumps on the crossroads in Århusgade that make cars reduce speed before reaching the crossing area; however, there is limited signage on the roads. Speed in the main street is reduced to 30 km/hr	3
M3.	Active mobility first Partially. The Sidewalks are 3.3 and 2.5 m wide (North and south sidewalk) on Århusgade, which allow from 2 to three people walking side to side on it. There is only a bicycle lane on one fo the sides of this street. There are bumps on the crossroads. On Helsinkigade, there are bicycle lanes on both sides of the street; however, sidewalks are smaller 2.85 and 1.8 wide (North and south sidewalk).	3
M4.	Openness and visibility Yes. The roads are very straight forward, and it is easy to see all the movement happening in the streets.	5

Area of Analysis

B. Helsinkigade

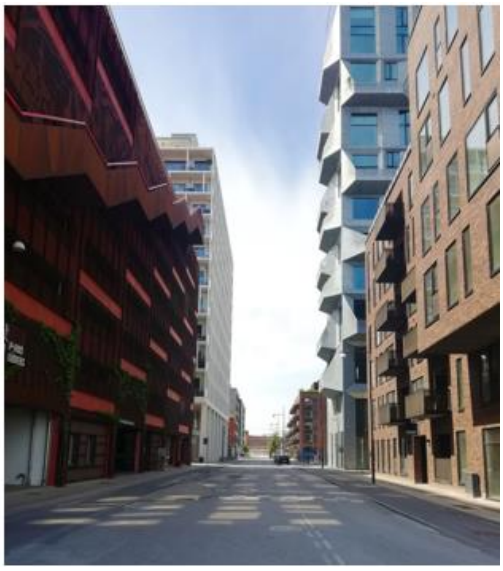
A. Århusgade



Additional evidence

A. Århusgade

B. Helsinkigade



Shelter, openness and visibility

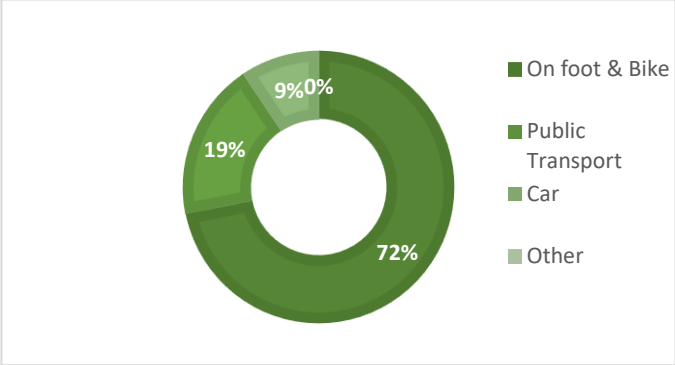
Crossroad

Active mobility

6. Convenience for active mobility			
User Experience		Survey or interviews	3.44
C. User experience Q1. Which of the following better describes your main mean of transport? (Car, Public Transport, Bike, On foot) (5=on foot and bike, 3. public transport, 1 car) Q2. How long is your commuting time to work, studies or any other daily activities? (10 min, 20, 30 min) (5=10 min, 3=20min, 1=30min)			
Results			
Q1	4.25	Points	
Q2	2.625	Points	
Additional evidence			

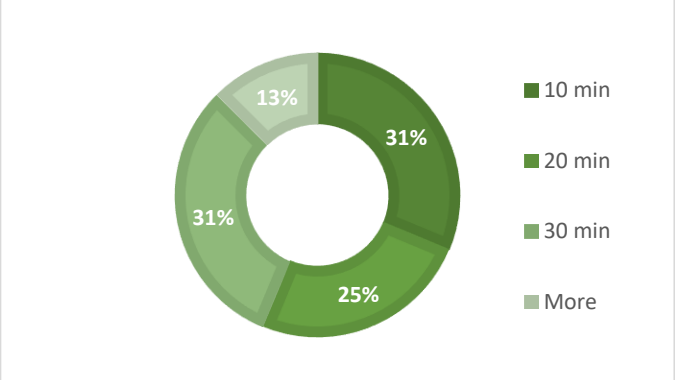
Q1. Which of the following better describes your main mean of transport?

On foot & Bike	23
Public Transport	6
Car	3
Other	0



Q2. How long is your commuting time to work, studies or any other daily activities?

10 min	10
20 min	8
30 min	10
More	4



9.2.9 INDICATOR 7

7. Wind comfort		
Systems performance	Statistics or Demographic data	5.00

A. Registered local wind speeds. The number of days per year on which alarm levels are exceeded.

* 5 m/s or above - Mechanical effect is experienced. If not high frequency, there are no problems with wind comfort in parks, waiting for areas, street cafes and playgrounds.

* 10 m / s or above - Pedestrians travel with difficulty. Allowed in areas for short stays

High wind speed above 13 and frequency > 1%.

* 15 m/s or above - Pedestrians are at direct risk of accidents. Frequency > 1%, Unpleasant, troublesome wind protection

Index.
1 point. 80% of the areas register within high wind speed
3 points. 50% of the areas are within high wind speed
5 points 25% of the areas are within high wind speed

Area of analysis	Points
Copenhagen, 2019. Days per month with winds above 10 m / s for up to 10 min, højeste 10 min middel	5

JAN	FEB	MARCH	APRIL	MAY	JUNE
10	8	14	3	7	2
JULY	AUGUST	SEPç	OCT	NOV	DEC
5	3	7	7	9	11

Total days	86	
Percentage	24%	Days a year with winds above 10 m / s for up to 10 min

Reference and notes

(DMI, 2019)
*This calculation was adapted due to lack of available data in the topic of winds in the area. The calculation takes into consideration the city scale winds. The index value was calculated considering the % of days per year, instead of % of area.

7. Wind comfort		
Space Layout	On-site observations	2.33

B. The building, space between buildings and vegetation. Analyze the geometrical structure of buildings, space between buildings & landscape planting.

M1. Buildings height variation measured by floors
5 . Homogeneous building heights
3. 1-2 floors variations
1. 3-5 floors variations
0. Higher variations

M2. Minimization of the distance between buildings ratio - Relation among building height(H) and street width(B)
5. Ratio H to B is >2, high shutter effect
3. Ratio 1/2 <HB < 2 , lip effect
1. Ratio HB < 1/2, turbulence

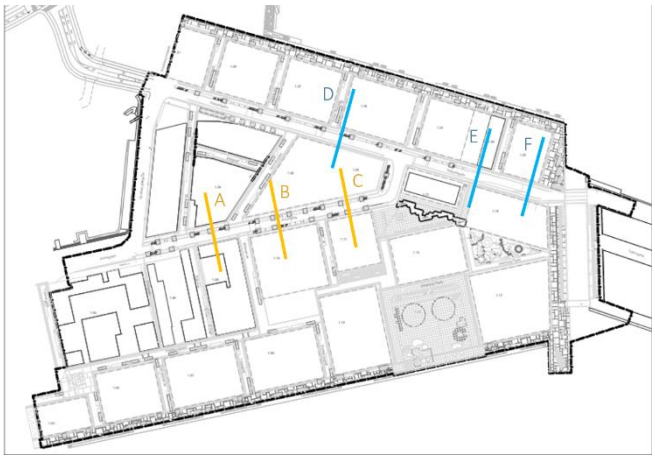
M3. Variation of the street throughout its length. Variation in street condition, direction and orientation in relation to wind courses, and when does it occurs.
5. Every 100 meters
3. Between 100 and 250 meters
1. Over 250 meters.

M4. Vegetation to diffuse wind flow. Greenery coverage along with street courses.
5. Dense vegetation along with street courses
3. Scattered vegetation
1. Lawn areas and open spaces.

Strategy	Description	Points
		2.3
M1	Building heights Along Århusgade, the building heights vary from 1 to 2 floors among each other, while in Helsinkigade, they vary from 3 to 5 floors.	2
M2	Distance between buildings Mean value resulted from measurements in additional evidence	3.3
M3	Street variation In Århusgade, the street is straight without variation fro 220m. In Helsinkigade, the street is straight without variation fro 320. Therefore, the average grade is 2 (3points+1 point)	2
M4	Vegetation to difuse wind There are lawn areas on Helsinkigade and scattered vegetation on Århusgade.	2

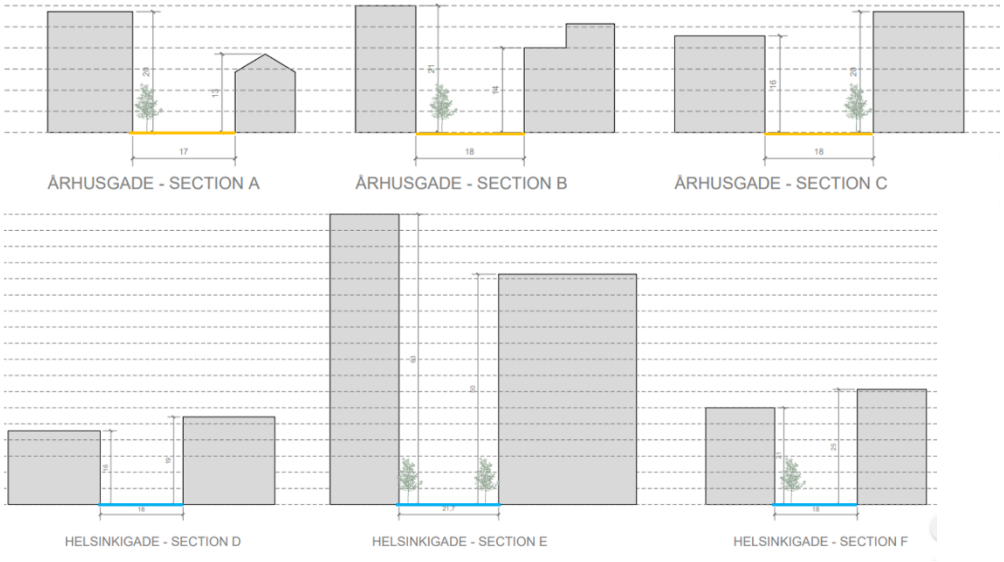
Area of Analysis - Additional Evidence

Helsinkigade &
Århusgade



Buildings height variation and distance between buildings

Distance between buildings



A	Height	20	1.18	1:1 ratio	3		
	Base	17					
B	Height	21	1.17		3		
	Base	18					
C	Height	16	0.89		3		
	Base	18					
D	Height	16	0.89		3		
	Base	18					
E	Height	63	2.74	3:1 ratio	5		
	Base	23					
F	Height	21	1.17		3		
	Base	18					

7. Wind comfort		
User Experience	Survey or interviews	3.06

C. Experience Regarding the walking paths, the squares, the promenade and green and blue areas.

Q1. Have you experienced that the public space or walking traits become very windy and result impossible to stay or walk through there?
0= very often, 3 Often, 1=rarely 5= Never

Q2. Do you spend time in any of the public spaces at different times of the year?
Yes, all 4 seasons (5), Most of the time, 2 -3 seasons(3), One season(1), one season (0)

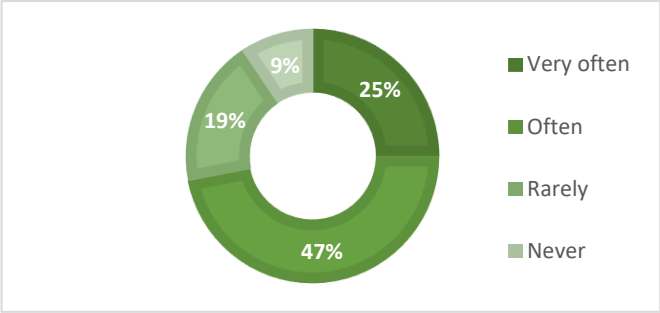
Results

Q1	1.5	Points
Q2	4.625	Points

Additional evidence

Q1. Have you experienced that the public space or walking traits become very windy and result impossible to stay or walk through there?

Very often	8
Often	15
Rarely	6
Never	3



Q2. Do you spend time in any of the public spaces at different times of the year?

4 seasons	26
2 -3 seasons	6
one season	0