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Monitoring Innovation Districts Through the Lens of Urban Sustainability

Urban Sustainability Indicators for Sustainable Innovation Districts - The Case of Oslo

Master's thesis in Urban Ecological Planning
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Abstract

In 2018, Oslo proposed the establishment of three "Innovation Districts" - Oslo Science City, Hovinbyen Sirkulare Oslo, and Punkt Oslo - to diversify its local economy through knowledge-based urban planning strategies. This coincided with the mainstreaming of UN Sustainable Development Goals (SDGs) and Agenda 2030, making sustainable development a cornerstone of Norwegian developmental policies. These policies recommend using SDGs as the foundation for all regional planning efforts.

While innovation districts are not a new concept globally, they have faced substantial criticism for their neoliberal approach, which has worsened social concerns such as gentrification, economic polarization, and inequality. In a world where sustainable development is crucial, urban monitoring can be used to evaluate innovation districts and assess whether they achieve their intended goals, thus giving control over possible negative externalities. In this context, sustainability indicators play a fundamental role in defining specific attributes related to sustainability that should be monitored and prioritized in the planning strategy of Oslo's innovation districts.

Therefore, this thesis proposes an "Urban Sustainability Indicator Set" to monitor Oslo's three innovation districts using a single embedded case study approach. The case of Oslo is treated as a system with the innovation districts acting as its embedded sub-units. The study is project-based, and has been conducted in collaboration with Svale AS, a private-sector start-up, specializing in innovation district programming and sustainable urban development. The topic draws inspiration from an existing activity of the organization to develop a dashboard that aids local authorities in monitoring the state of the innovation economy in Norwegian cities, following the recommendations from The Bass Initiative (2018).

The study identifies elements that influence the innovation districts of Oslo at three levels: the district level, regional level, and national/supranational level, and proposes indicators based on triangulation of the data collected from these three levels. The data collection process primarily involves qualitative methods and utilizes a combination of primary and secondary data sources. Primary data is collected through interviews with stakeholders, users, and domain experts, as well as field notes from site observations. Secondary data sources include relevant strategies and policies pertaining to the city's innovation districts.

The analytical process draws inspiration from two indicator sets that encompass the key elements of the context: the UN-Sustainable Development Goal (SDG) 11 on urban sustainability, which focuses on sustainable cities and communities, and an international perspective on innovation districts by The Bass Initiative (2018). The Urban Sustainability Indicator set is created by adapting existing indicators used internationally to the local context, based on strategies and perspectives rooted specifically in Oslo's innovation districts.

A total of 40 indicators have been identified, which can further be incorporated into a monitoring frame through the processes of weighing, aggregating, and setting targets. the indicators have been adapted to incorporate economic growth while simultaneously bringing forth an inclusive society, that is ready for the green shift, through efficient governance systems. While the proposal of an Urban Sustainability Indicator (USI) set achieves the main objective of this project, the methodology employed for obtaining the results could also be considered a novelty, and is adaptable to other urban planning endeavors, that also intend to integrate urban monitoring into its processes.

Finally, the thesis highlights that the three innovation districts of Oslo function as individual components within a unified framework, each individually, working towards its own set of goals. Moreover, the different objectives of the three districts introduce ambiguity in the notion of what an innovation district really entails. In order to contribute holistically to Oslo's regional sustainability, coordinated efforts are essential. This raises the question of whether Urban Monitoring holds the key to achieving this objective.

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- And my friends in Norway who have been my comrades during this Scandinavian adventure.

From the bottom of my heart, thank you.

CONTENTS

List of Figures

List of Tables

List of Abbreviations

HSO   - Hovinbyen Sirkulære Oslo

OSC   - Oslo Science City

SDG(s) - United Nations Sustainability Goal

UMF   - Global Urban Monitoring Framework

UN   - United Nations

RSI   - Reference Sheet Indicator

SO-xx   - Social Domain Indicator

EC-xx   - Economy Domain Indicator

EN-xx   - Environmental Domain Indicator

GO-xx   - Governance Domain Indicator

CU-xx   - Cultural Domain Indicator

Cities appear more and more to be the sum of many isolated individuals.
Each of them is involved in maximization of his/her particular interests, but
the sum of these choices is not the "common good".

Girard, 2006

1 Introduction to the Study

The quest for knowledge, development, and growth has been a driving force behind a special category of organizational activities and occupations in the 21st century, called "knowledge work", that emphasizes the use of creativity, theoretical knowledge, and a combination of analytical and social skills to contribute to innovation (Newell et al., 2009). This, in turn, has resulted in a new geography of urban development, popularly called "Knowledge-based urban development", characterized by knowledge as the central structuring element of the planning strategy (Chang et al., 2018).

One such knowledge-based urban development typology much discussed in recent discourse, rooted in the idea of economic growth through place-based strategies, is the concept of "Innovation Districts". Innovation Districts can be defined as dense, economically viable urban regions, with high potential for urban regeneration, that are close to an anchor knowledge institution (Katz & Wagner, 2014; Morisson, 2020). Here, leading research and development institutes are co-located with start-ups, businesses, incubators, and other private actors to accelerate innovation. Cities implement such districts in their urban fabric to improve their economic competence on a global scale (Yigitcanlar et al., 2020).

In this regard, Norway is in its own quest for innovation. Known worldwide for its beautiful fjords and the midnight sun, the country has been economically resource-based ever since oil became a viable source of revenue. In fact, in 2022, crude oil and natural gas alone accounted for 73% of the total value of the country's exports (Norwegian Petroleum, 2023). However, the growing urgency to tackle and adapt to climate change has resulted in changing mindsets. The country, while on the one hand aims to contribute to this "green shift", it also no longer sees oil and gas as a stable source of revenue in the long run. With inflation hitting the country's currency in the recent financial crises (Benedictow & Hammersland, 2022), the focus has shifted from relying on oil as a viable long-term safety net to diversifying revenue sources through tech and knowledge-based innovation as a strategy to strengthen the country's future. This, in turn, is believed to safeguard the Norwegian Society's sustainability – in social, climate, and economic terms (Norwegian Ministry of Finance, 2021).

Norway's pursuit to steer away from oil was further influenced by the adoption of the 2030 Agenda and its 17 Sustainable Development Goals (SDGs) by member countries of the United

Nations, including Norway, in 2015. This commitment not only aimed to diversify the economy but also contribute to the fulfilment of the SDGs by 2030. The signing of the Paris Agreement in 2016, which sought to strengthen the global response to climate change, accelerated Norway's efforts (Norwegian Ministry of Local Government and Modernisation & Norwegian Ministry of Foreign Affairs, 2021).

Hence, in 2018, Oslo vocalized its goal to be a "knowledge capital" that is attractive for international and local businesses alike by proposing three innovation districts that would redefine the city's business landscape in the years to come: Oslo Science City (OSC), Punkt Oslo, and Hovinbyen Sirkulære Oslo (HSO) (Oslo Kommune, 2018). In the same year, Oslo established Oslo Science City, Norway's first innovation district, thereby marking the country's entry into this developmental initiative.

In the strategy document that first proposes the concept of Innovation Districts in Oslo, "Campus Oslo - Strategy for the development of the capital of knowledge" (Oslo Kommune, 2018), the city identifies three outcomes that these districts intend to build on - "increase innovation, value creation and number of jobs" (p.51). These are achieved via planning strategies like efficient land-use allocation, public-private partnerships, and innovation testing. Most importantly, the innovation districts provide economic stimulus to the city, by transforming areas around the city's main knowledge institutions (ibid). In short, the innovation districts in Oslo adhere to the definition proposed by Katz and Wagner (2014) while combining economic development with urban regeneration strategies.

1.1 Motivation and Purpose of the Research

Oslo's three innovation districts reflect a metaphor by Girard (2006): They act as three isolated individuals, whose sum is intended to bring out the city's common good. Today, the three innovation districts have developed into individual entities, each with its own strategy to be the medium of positive transformation in the city's business as usual. They are owned by the local authority's Department of Industry and Public Ownership and work through private-public partnerships rooted in spatial and social change (A-Lab, 2021; Hovinbyen Sirkulære Oslo, 2023; PWC & Svale, 2020).

In this sense, Oslo's innovation districts are similar to any other urban planning strategy, that is multidimensional in nature, and characterized by several actors with potentially conflicting values (Bottero et al., 2019). The growing awareness of sustainability as an essential aspect of urban development for a livable, inclusive, and resilient Oslo (City of Oslo, 2017) has led to

2

increasing advocacy for urban planning strategies to be followed up on the basis of sustainability and United Nations Sustainable Development Goals (SDGs) (Norwegian Ministry of Local Government and Modernisation & Norwegian Ministry of Foreign Affairs, 2021). The inclusion of sustainability incorporates an added, much-needed layer to innovation district planning.

Seasons (2003) recommends dealing with such complexity in planning through monitoring processes, that evaluate policies, programs, and processes to understand if they are functioning as intended. Further, the idea of "urban monitoring" was proposed at the Earth Summit of 1992 to promote the action of cities toward urban sustainability (Marsal-Llacuna et al., 2015). "Urban Sustainability Indicators" hence form the foundation of any urban monitoring process and are sustainability determinants that can be measured or investigated.

While some attempts have been made to develop frameworks for monitoring and evaluating innovation districts globally (Burke et al., 2022; Esmaeilpoorarabi et al., 2018; European Commission. Joint Research Centre., 2021; Tan et al., 2023), the studies only look at certain aspects of sustainability and do not view the concept holistically. Moreover, the focus is more on evaluation of innovation districts and less on indicators – the very foundation of these processes.

For example, Rapetti et al. (2022) identifies indicators for a Brazilian innovation district "Porto Digital", through four different developmental aspects: urban, economic, social, and governance; the study primarily focuses on innovation districts as an independent entity and does not study it as part of a larger urban ecosystem. The Bass Initiative (2018) proposes 12 questions to monitor innovation districts that also examine their relationship with the city. However, in addition to being a "one-size-fits-all" document, it focuses heavily on socio-economic processes of innovation districts. Lastly, while the UN Habitat (2022) adapts the SDGs and the New Urban Agenda to city contexts and proposes 79 indicators for urban monitoring, it recommends users to localize the suggested indicators before use.

To the best of our knowledge, there has been no previous study done in the context of indicators for sustainable development that examine innovation district(s) as a component within a larger whole - the city. Moreover, Vreeker & Nijkamp (2006) assert that sustainability indicators are never general and ambiguous, but always context and site specific. This shows that a clear room and need for studying the subject exists.

This thesis therefore aims to identify an "Urban Sustainability Indicator" set, that can further inform monitoring processes of innovation districts in the context of Oslo.

The need for this study is not just theoretically grounded; its necessity in a real-case scenario has been discussed with experts and stakeholders involved in the city's Innovation District planning. While the three innovation districts are currently working towards developing their own sustainability indicators, based on project level and organization-level ambitions, the necessity to develop indicators for coordinating the process on a city-wide level was acknowledged. The study therefore entails a qualitative process of exploring local particularities through the lens of sustainability, concerning the larger regional ecosystem that it is part of.

1.2 Research Questions

Due to the lack of existing research on this subject, the study was conducted in an exploratory manner, guided by, and rooted in existing theoretical frameworks on innovation districts, urban monitoring, and sustainability. The thesis achieves its research purpose by delving into the following research questions:

1. What is the most suitable methodology to identify Urban Sustainability Indicators for Oslo's innovation districts in a way that it integrates the different perspectives that influence it?
2. How could the identified urban indicators be applied?
3. What are the different urban indicator trends for innovation districts and their wider implications for sustainable urban development?

In doing so, the thesis not only proposes an "Urban Sustainability Indicator" set but also suggests a methodology for its identification, and reflects on how sustainability is perceived in the study context. This informs readers about key trends in Oslo's innovation district that can accelerate or hinder its quest for sustainable development. To clarify:

The **research area** of this thesis broadly falls under the theme of "Urban Monitoring," of which indicators are an integral part. In particular, the study focuses on the process of "Urban Monitoring" through the lens of sustainability.

The **object of research** is "Innovation Districts" in the context of Oslo. Even though the subject of innovation districts has been widely contested, discussed, and reviewed on a global scale, it is still relatively new to the urban fabric of Oslo and therefore shrouded in uncertainty. Urban

Monitoring processes can therefore facilitate decision-making processes that can guide policies and political actions.

1.3 Scope of Study

This research is a project-based study, that has been developed by the author, in collaboration with Svale AS, a private-sector urban development consultancy based in Oslo. The organization has a niche in strategy development of Innovation Districts and has worked closely with this planning typology since its very inception. The topic draws inspiration from an existing activity of the organization to develop a dashboard that aids local authorities in monitoring the state of the innovation economy in Norwegian cities, following the recommendations from The Bass Initiative (2018).

While Svale AS views innovation districts primarily in terms of partnership and value-creation, this practice-based thesis is a combination of the organizational goals and the author's personal goals, in sustainable urban development. The thesis is therefore conducted independently, with guidance and support from the team in Svale AS and will act as a foundation to further develop a framework for monitoring evaluation of innovation districts that can be used by municipalities, academia, and other decision-making bodies.

Recalling the title of this thesis, "Monitoring Innovation Districts through the Lens of Urban Sustainability," brings to light three key concepts that are studied in the research to achieve the previously stated research purpose. These three concepts are "Monitoring," "Innovation Districts," and "(Urban) Sustainability." The vast nature of these three concepts, combined with the many ways they have been defined (Alexander, 2006; Estornell et al., 2012; Pesqueux, 2009) necessitates establishing their scope and extents in the context of this project:

Monitoring, also referred to "in-progress evaluation", is a vast process that depends on relevant stakeholder interaction, indicators, database, methods, assumptions, analysis and conclusions (Alexander, 2006). This thesis only lays the foundation for this large process, by proposing indicators, the starting point for monitoring work.

Sustainability is a concept that has taken on a largely political dimension in recent times, which significantly affects its usage and definition (Pesqueux, 2009). In the Norwegian political context, the SDGs have played an influential role in shaping urban planning policies ((Norwegian Ministry of Local Government and Modernisation & Norwegian Ministry of Foreign Affairs, 2021). Thus, the SDGs provide a broader context for sustainability in this

5

thesis. However, one SDG is particularly relevant to the study of sustainability in urban processes: SDG 11, which focuses on sustainable communities and cities (United Nations, n.d.-b). Therefore, the scope of sustainability in this thesis is limited to SDG 11.

Svale AS investigates innovation districts based on the canonical definitions provided by Katz & Wagner (2014). The document was also used to define innovation districts in Oslo while first proposing it. However, Estornell et al., (2012) suggest that due to heterogeneity of strategies, priorities, and contexts within each innovation district, the developments often evolve to take on interpretations that do not comply with the original literature on innovation districts. Therefore, while the thesis theoretically still conforms to the understandings of Katz & Wagner (2014), it is studied in the context of how it has been interpreted by the three innovation districts within Oslo.

Next, the concepts listed above are studied in the context of a live case, the city of Oslo. While Oslo is not the only city with innovation district(s) in a global, Scandinavian, or national context, the thesis focuses on this case for the following reasons:

1. The City of Oslo acknowledges that innovation districts are a nexus between economic growth and urban development and encourages both these aspects to go hand-in-hand (Oslo Kommune, 2018).
2. There exists a formal strategy, Campus Oslo, that studied Innovation Districts and contextualized it to Oslo, based on which further work has been done by the authorities. This strategy was developed through participation from various local stakeholders and calls for active SDG based follow-up.
3. The concept was proposed in 2018 and is still relatively new in Oslo. A monitoring process for the strategy is not yet in place.
4. Convenience of research given Svale AS's location in the heart of one of Oslo's Innovation Districts, and Svale AS's professional association with two innovation districts in Oslo.
5. Limited research on Oslo's Innovation Districts despite the availability of grants (Oslo Kommune, n.d.-b; Regionale forskningsfond, 2023)

This study does not evaluate the city's innovation districts. It merely rather proposes an "Urban Sustainability Indicator set" based on the fieldwork and research conducted during the study. The indicator set can be used as foundation for monitoring works of Oslo's innovation districts. The process identifies patterns and trends in sustainability in the case context that will be

discussed. Lastly, while designing a full framework for monitoring is too large a scope for this master's thesis, the study makes recommendations, that describe how the indicators may be used to develop a full monitoring framework.

1.4 Thesis Outline

In the preceding section, the background of the thesis, the research topic, and its constituent elements: monitoring, innovation district and sustainability were introduced and their respective scope in this research context were defined. The following sections explore these individual elements in depth. In brief, the thesis comprises the following:

In Section 2 - The theoretical foundations relevant to this research are reviewed to better understand its constituent elements: the constituent elements: monitoring, innovation district and sustainability.

In Section 3 - The Case of Oslo is presented in further detail, to understand what constitutes the whole and what constitutes its embedded parts.

In Section 4 - The data collection methods and the analytical framework used for developing the USIs for Oslo are explained.

In Section 5 - The Urban Sustainability Indicators identified for Oslo's Innovation District, through the processes described in Section 3 are presented.

In Section 6 – The results are discussed based on the three research questions, and the limitations of the research are presented. Finally, the chapter concludes this thesis with a question to reflect on.

2 The Theoretical Perspective

Now that Section 1 has introduced what this thesis entails, it is necessary to understand in depth the intricacies surrounding different elements of the study. This understanding helps the reader better comprehend the place and value of the elements in the research objective. Therefore, this section is intended to bind the three elements of this research: Innovation Districts, monitoring, and sustainability, through a discourse of existing theory surrounding them. In doing so, they are interconnected by the virtue of their position in urban planning, which further guides the next steps of this research.

2.1   Innovation Districts as an Urban Planning Strategy

The concept of place-based development in order to boost economic and technological competency of cities is not new. Amirahmadi & Saff (1993) trace such attempts to the 1980s, when policy makers used science parks as an avenue to uplift regional and national economies. This was deeply rooted in theories of agglomeration (Kayanan et al., 2022), that directly linked the localized concentration of specialized industry to innovation and resulted in economic growth (Karlsson, 2008). These developments aim at providing physical infrastructure necessary for networking and accelerating entrepreneurialism, and are typically located in car centric peri-urban areas. (Dinteren & Jansen, 2021; Lindelöf & Löfsten, 2003)

Innovation districts are the modern rendition of traditional science parks. Much like their predecessor, Innovation Districts build on the agglomeration theory (Kayanan et al., 2022) but unlike science parks, are located closer to the city center. They attempt to integrate business-oriented functions with the urban planning concepts like mixed-used development and transit-oriented development well within the urban fabric of the city center (Innovation Quarter, 2021). With new discourses in urban planning focusing on the importance of high urban density, inclusive public spaces, employment opportunities, multi-functionality of space and climate adaptation (Säynäjoki et al., 2014), innovation districts are now seen as a way to integrate the innovation driven economic prosperity while restructuring the traditional notion of a "Central Business District" to a more favorable "City Lifestyle Districts" (Cherry, 2022).

In this sense, innovation districts can be explained by Esmaeilpoorarabi et al., (2020) as a new land-use typology in city centres, that comes from the need to deliver sustainable economic

growth, while also catering to the challenges of urban sprawl, car-centered development, transport justice, etc. in global cities. To promote economic growth, the districts act as hosts to clusters of knowledge-intensive services, connecting leading institutions and firms with supporting infrastructure and amenities. This is complementary to the original formulation of innovation districts by Katz & Wagner (2014), who define the concept as relatively small multifunctional areas, where business functions such as clusters, start-ups, business incubators, and institutional anchors coexist with residential, commercial and social infrastructure. Morawska (2021) adds on to the interpretation that the resultant changes in urban morphology, as a result of innovation districts, create "textured landscapes" that are highly valued by the creative class and professionals. This further attracts more businesses to these areas to set up their establishments which in turn, boosts the city's economic competitiveness on a global scale. In other words, innovation districts stem when the need for economic development meets sustainable urban revitalization through socio-spatial transformation.

In doing so, innovation districts give way to implementing of concepts such as walkable neighbourhoods, where housing, jobs and amenities intermix (Katz & Wagner, 2014). This idea that innovation districts accelerate urban transformation is further supported by Del Cerro Santamarías (2021) who professes that innovation districts have a unique trait that can modify existing societal and city structures. By envisioning areas adept for talent retention, the districts cater to the increasing demands for more and better choices to live, work and play. The mix further results in spaces that function all day long (Morawska et al., 2021).

However, this 21st century planning strategy isn't free from critiques. While innovation districts focus on place-based economic development policies and claim to offer an alternative to neoliberalist urbanism through its socio-economic approach (del Cerro Santamaría, 2021; Katz & Wagner, 2014), they unsurprisingly also have many commonalities with the latter. For instance, like many neoliberal developments, innovation districts focus on large-scale urban interventions that aim to attract global capital, enhance competitiveness and stimulate economic growth through public-private partnerships and market deregulation (Drucker et al., 2019). Chayka (2014) supports the argument against such innovation led urban development by referring to "innovation districts" as self-perpetuating buzz-words, that benefit "corporates-in-training" who already have the means to innovation capital- education, real estate and connections. The biggest and most common critique however is that such knowledge-based developments cause privatization and gentrification (Kayanan, 2022), ultimately resulting

widening of socioeconomic gaps between knowledge "haves" and "have-nots" (Gaziano, 1997).

Even though Chamchong & Boossabong (2021) assert that embedding 'innovation' within urban development frameworks results in sustainable, inclusive and resilient cities, the claim is contested on the pretext that the responsibility of urban development should not be on the shoulders of entrepreneurs, like in the case of innovation districts (Kayanan, 2022). Furthermore, the deregulated, independent nature of such developments, and its impacts on a regional scale makes coordinating policy across multiple levels of governance and physical scales an added challenge (Han & Hawken, 2018).

To truly be the elixir of growth, as first described by Katz & Wagner (2014), innovation district actors must actively work towards the benefit of all socio-economic groups. An example of this is the case of Chattanooga, as narrated by (Morisson & Bevilacqua, 2019). Chattanooga believes that when innovation districts are planned with inequality mitigation policies in place, it results in knowledge spill overs, which reduces the development's negative externalities. Such action-based policies must ensure that the benefits of innovation districts are distributed widely amongst the masses so as to limit displacement and socioeconomic polarization. Lastly, collaborative efforts that enhance co-learning between scientists and stakeholders, such as local communities, cities, and businesses, must be put in place to tailor the innovation districts to the unique conditions of their context and, in doing so, contribute to a sustainability (Moallemi et al., 2020).

2.2   Sustainable Development and Urban Planning Strategies

Sustainability has emerged as a paramount concept in the discourse surrounding urban development in the 21st century. The term "sustainable development" was first announced in 1987, in the report titled "Our Common Future", published by the World Commission on Environment and Development (WCED) (Holden et al., 2017). The report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report, 1987). Additionally, the report further stresses the importance of viewing sustainable development through the intersection of three key aspects: social, environmental and economic (ibid).

The need and urgency for sustainable development was accelerated in 21st century via international treaties such as the Paris Agreement in 2015, that covered climate change, and

the 2030 Agenda in 2015, which proposed 17 interlinked sustainability goals for applicable globally (United Nations, n.d.-b; United Nations Climate Change, n.d.). These 17 goals, popularly referred to as the United Nations Sustainable Development Goals (SDGs) were adopted by all United Nations member states. It comprises action-oriented goals that aim to end global issues with "strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests"(United Nations, n.d.-b) Further, to monitor progress, guide policy and ensure stakeholder accountability toward sustainable development, the 2030 Agenda released a global indicator framework for the 17 SDGs, with 231 unique indicators in March 2017 . (United Nations, n.d.-a)

With over 50% of the global population living in urban areas (The World Bank, 2023) cities today are spatial platforms that present opportunities for addressing the SDGs across multiple sectors- transportation, energy, water, education, and healthcare (Vaidya & Chatterji, 2020). This intersection between urbanism and sustainability is hence termed "Urban Sustainability", and is defined as "the vitality of a city as a complex system, the quality of life of its citizens, or the capacity of nature to support its activities" (Basiago, 1998, p.148). Of the 17 goals, the essence of urban sustainability is captured and incorporated specifically in SDG11- Sustainable Cities and Communities, which aims to make "cities and human settlements inclusive, safe, resilient and sustainable" (The Global Goals, 2023). The goal covers various socioeconomic and environmental aspects of urban planning and comprises targets including but not limited to adequate urban infrastructure, protection of public spaces, climate adaption, resilience planning, and strengthening links between urban, peri-urban and rural areas (Vaidya & Chatterji, 2020).

Urban planning strategies today incorporate a highly interdisciplinary approach that aims to create sustainable cities by focusing on compact urban structures, resource efficiency, nature-based solutions, and equitable distribution of environmental benefits and burdens (Kremer et al., 2019). Examples of such strategies include smart-growth frameworks, zero-impact approaches, biophilic ideas, green infrastructure, and environmentally-just cities that consider the well-being of all groups in decision making (ibid). Furthermore, the interdisciplinarity of such strategies address problems of infrastructure, social equity, and environmental urbanization creatively and contextually (Basiago, 1998).

11

Urban planning strategies are intrinsically social in nature. The high uncertainty that entails such social endeavors needs regular assessments to provide a better understanding of the outcomes of planning interventions, so as to truly result in sustainable. These assessments can be provided through consistent 'Monitoring and Evaluation' at all stages of the project- ex-ante, continuous or ex-post evaluation (Edwards, 2006; Seasons, 2003).

2.3 Urban Monitoring for Urban Sustainability

Urban monitoring can be defined as continuous assessments of urban strategies and urban data related to specific indicators (OECD, 2011) that characterize relevant aspects of urban development. The process aims to inform decision making, policy and provide management and key stakeholders of an ongoing development project with insights into the degree of progress and accomplishment of objectives, as well as the utilization of allocated funds (OECD, 2011; Sala et al., 2015; Shen et al., 2013). In the context of urban sustainability, urban monitoring helps stakeholders pursue sustainable development not just in environmental economic and social domains, but also through cultural and value-based elements ((Sala et al., 2015; Shen et al., 2013). To sum up, sustainability of strategies can be achieved if they are monitored continuously, to ensure that the ongoing development is in line with desired sustainability objectives. This process can therefore be called "Urban Sustainability Monitoring".

While SDGs provide a framework for monitoring sustainable development, Valencia et al. (2019) explains that it's applicability in any urban planning strategy depends on the relevancy, practicality and adaptability of international targets to the local levels. Furthermore, the SDG goals and indicators should be contextualized to the local development agenda to make them effective and to bring about real changes in the lives of people ((Vaidya & Chatterji, 2020). Establishing indicator frameworks can therefore act as an important milestone towards defining goals, standardizing, and reporting and also to integrate sustainable development in urban planning strategies through urban monitoring (Fet & Knudson, 2023; Vaidya & Chatterji, 2020)

2.3.1 Indicators for Urban Sustainability Monitoring.

Indicators are the foundation for monitoring the progress of strategies towards the defined strategy objectives (Seasons, 2003). The exact definition of indicators is ambiguous, and can include a wide range of components, such as, ideas, variables, objects, variable values, etc (Allain et al., 2018). In the context of this research, indicators can be defined as qualitative or

12

quantitative tools which describe complex system characteristics, and facilitate learning and judgement about the situation of a system (Allain et al., 2018; Hiete & Merz, 2009). They bridge the gap between theoretical concepts and decision-making and should be based on a conceptual framework with available, reliable data (Hiete & Merz, 2009; Sala et al., 2015).

The usage of indicators in any urban strategy depends on the existence of a heterogenous set of potential indicators (Allain et al., 2018). These indicators can be contextualized to suit the given strategy through structured discussions on which indicators should be monitored and why it should be monitored (Asare-Kyei et al., 2015; OECD, 2011; Seasons, 2003). Furthermore, the contextualized indicators should be able to identify trends, patterns and positions in the given study (OECD, 2011; Sala et al., 2015). In other words, definitions and requirements of indicators are circumstantial in nature. In the context of urban monitoring for sustainability, Urban Sustainability Indicators (USI) can be defined as a set of factors used to measure and assess the conditions and status of sustainability in an urban area.

2.3.2 Types of Urban Sustainability Indicators

Traditionally sustainability has been classified into three categories- social, environmental, and economic sustainability (Brundtland Report, 1987), and these have been used as parameters for measuring the impact and properties of a given project or strategy. Phillips (2014) asserts that USIs too must include impact aspects of economic, environmental, and equity dimensions and these factors must be interlinked. On the other hand, Rey et al. (2022) suggests indicators in urban sustainability monitoring tools need to include factors beyond environmental, economic and social ones to be reliable, localized and accessible to urban contexts. In this regard, (Kaur & Garg (2019) identify five urban sustainability domains that are recognizable across national and global indicator sets. These domains have been elaborated as follows (ibid):

1. Social Dimension that includes indicators associated with: social and health wellbeing, urban layout/pattern and design, transportation and connectivity, amenity, safety/security, comfort in outdoor areas, innovation, governance.
2. Environmental dimension, that includes indicators related to atmosphere/climate, environmental and ecology, land use and green infrastructure, resources and energy, water and wastewater, natural hazards, solid waste management, buildings and resources, material management.
3. Economic dimension, with indicators of financial concepts, economic impact and economic structure;

13

4. Cultural dimension with indicators of local community cultural and heritage, visual aesthetic sensitivity

5. Institutional dimension with indicators related to institutional framework, institutional capacity.

The indicators can also vary based on the nature of the information. This can be quantitative or qualitative. Simply put, quantitative indicators can be measured or counted, and qualitative indicators are more descriptive in nature (Stevens, 2023). In addition, the numeric nature of quantitative indicators allows comparisons between different entities, while qualitative indictors are more subjective and less precise (Basu et al., 2018). To allow measurement and comparison, urban monitoring tools used in planning have primarily been quantitative in nature (Seasons, 2003). As a result, qualitative particularities, that incorporate human relationships for wellbeing, inclusion and cohesion take a back seat. Components that describes the perceptions, feelings, and values of planning goals, policies, and projects are also left out (Scerri & James, 2010; Seasons, 2003). Therefore, Seasons (2003) recommends use of indicator sets where quantitative and qualitative information complement each other for monitoring urban sustainability.

Lastly, Asare-Kyei et al. (2015) categorizes indicators based on its source of origin. In the process of localization of Urban Monitoring processes and the indicator set associated with, indicators are extracted, either through a pre-existing super-set of indicators, or through fieldwork involving experts, locals and decision makers. Asare-Kyei et al. (2015) refers to the former as "**Reference Sheet Indicators"** (RSI), and the latter as "**Elicited Indicators**". A combination of both is recommended for selecting urban sustainability indicators for any given context.

2.3.3 Selection Frameworks for Urban Sustainability Indicators

The multi-faceted nature of indicators as described in the previous section makes it necessary to define the selection process to effectively serve the purpose for which it is defined. The growing research on the subject has resulted in a plethora of best practices for defining the nature of the indicators. Tengan et al. (2021) assert that indicator sets must be reliable, feasible and provide utility in the decision-making process. Furthermore, the authors summarize many best practices in indicator criteria adopted in the industry.

These include the SMART criteria, which acknowledge that indicators should be Specific, Measurable, Attainable, Results-oriented and Time-bound. Other standards or criteria for

determining a good indicator are the SPICED criteria (Subjective, Participatory, Interpreted and Communicable, Cross-checked and compared, Empowering and Diverse and disaggregated) and the CREAM criteria (Clear, Relevant, Economic, Adequate and Monitorable). Gage and Dunn as cited in (Tengan et al., 2021) define six characteristics of a good indicator: Valid, Reliable, Measurable, Precise, Timely and Programmatically relevant (ibid).

Once the desired properties of the Urban sustainability indicators have been defined, the selection criteria need to be chosen. Indicators can be selected through two approaches –the **top-down approach** and the **bottom-up approach** (Allain et al., 2018; Fet, 2023). Fet (2023) describes the top-down approach as a process that employs indicators relevant to national and international levels, which highlight trends and policies important at that scale. Moreover, the approach can also guide frameworks for data collection and analysis reporting. Similarly, (Fet, 2023) describes the bottom-up approach for indicator collection as a process where data on activities, products and services are gathered and aggregated on a micro level- for example, a company level. This approach is employed to study the impacts of a given strategy locally. Figure 1 illustrates the top-down and bottom-up approach in sustainable urban monitoring (Hamedani & F. Huber, 2012).

Figure 1 Top-Down and Bottom-up approaches in sustainable urban monitoring
(Source: Hamedani & F. Huber, 2012)

Both approaches can involve experts and stakeholders, and can result in indicator set developments through a deliberative approach or a prescriptive approach (Allain et al., 2018). Here, a deliberative approach can be defined as a way of indicator identification, where policy and decision makers learn about the opinions of stakeholders through research consultation processes (Marsden & King, 2009). On the other hand, prescriptive methods prescribe or suggest solutions without consultation, by utilizing available data (Lepenioti et al., 2020).

Once the indicator property and data approach for the heterogeneous indicator database have been defined, relevant indicators that can be used to monitor the context need to be constructed. To achieve this in an urban context, Giaoutzi & Stratigea (2006) recommend identifying project specific or actor specific properties that can influence the course of the project and link these properties to relevant impacts desired or achieved from the project. Indicator selection tools such as DSPIR can be very effective to identify eligible indicators from the superset of indicators.

The Driver-Pressure-State-Impact-Response (DPSIR) framework was created as a tool for the reporting and analysis of environmental issues in the 1990s (Carr et al., 2007). It is now being used by international organizations to assess sustainable development initiatives and to better understand and overcome obstacles to sustainability (Carr et al., 2007). The five indicator categories under the DPSIR framework have been described as by Fet (2023) are as follows:

- Driving Force Indicators are needs that drive a sector or a stakeholder group.
- Pressure Indicators are direct measures of policy effectiveness such as emissions and waste.
- State Indicators correspond to the condition of the environment.
- Impact Indicators refer to changes in the state that may have environmental or economic impacts on the functioning ecosystem.
- Response Indicators express the societal response which often leads to new regulations being developed.

Tanguay et al. (2010) elaborates that once the indicators are identified, they are aggregated, and weighed and assigned targets. Aggregation refers to the process of combining similar indicators into one single indicator. This process can be based on spatial, temporal, and thematical properties of the indicators (Tanguay et al., 2010). Such methods of aggregation can prevent a long list of repetitive indicators and simplify communication of results (Rey et al.,

2022). The process of weighing involves attributing a higher importance to one indicator compared to another (Tanguay et al., 2010). The indicators can either be weighed equally, or statistically, or based on public/expert opinions (Gan et al., 2017). The concept of assigning targets allows for the setting of objectives while measuring the efforts and associated costs (economic, social and political) involved in achieving them. These can be in the form of scientific threshold values, critical values derived from existing standards, and target values based on predefined outcomes of the process being monitored (ibid).

Weighing, indexing and aggregation should be done with care to ensure verifiability, comparability and consistency (Fet, 2023). While these topics have been introduced to give readers a holistic understanding of indicators, this research focuses on identifying and rationalizing indicators rather than on questions pertaining to weighing, target setting and aggregation. Now that the subject of Urban Sustainability Indicators has been described in a broader sense, pertaining to urban planning strategies, the next part of this chapter discusses the concept in the context of innovation districts.

2.4 Urban Sustainability Indicators for Sustainable Innovation Districts

Innovation districts are urban planning strategies with high-cost and high-risk investments (Adu McVie et al., 2023), that are promoted on account of its virtue to enhance the economic, social and environmental sustainability of an urban fabric (Katz & Wagner, 2014). However, its focus on entrepreneurial growth has resulted in economic sustainability being emphasized as the parameter for the success of these urban areas (Read & Sanderford, 2017). Moreover, when social and environmental elements are considered in this context, their roles are also considered from an economic perspective (ibid).

While economic development and social well-being seem to be correlated, the meaning of development is lost when growth is seen as an end in itself (Fioramonti, 2017), as in the case of innovation districts. This results in side effects such as privatization, gentrification, and socioeconomic polarization as previously discussed (Kayanan, 2022). Fioramont (2017) therefore proposes the use "well-being economy model", that involves measuring growth not monetarily, but rather in terms of well-being, both human and natural. This field of thought aligns with Girard's (2006) argument that planning should result in "the common good" : a sense of community and citizenship. This way, innovation districts too, despite its economy centered approach, can be steered in the direction of sustainable development.

In this regard, a sustainable innovation district is defined as:

An innovation district that is "planned and executed to account for the capacity, fitness, resilience, diversity and balance of its urban ecosystem. We take the view of sustainability as an organic process including environment, economy and community: form and efficiency (environmental factors in design, architecture, engineering and construction) as well as policy (urban plans and practices that explicitly aim at maintaining and improving the social and economic well-being of citizens)." (del Cerro Santamaría, 2021, p. 15)

To successfully steer innovation districts towards sustainability, the role of urban planning in innovation districts must therefore form the nexus of strategies and policies (Read & Sanderford, 2017). The interdisciplinarity of urban planning allows collaboration and the integration of multiple perspectives and can thereby address inequalities fueled by the innovation system (Trillo, 2021). In addition to this, monitoring and evaluation of the innovation district operates in the same manner as any other urban planning strategy, and can advise stakeholders on the necessary interventions, policies and investment decisions required to steer it towards sustainability (Adu McVie et al., 2023).

Trillo (2021) therefore suggests that Sustainable Development Goals could act as a cornerstone for deploying and nudging sustainability in innovation districts. In particular, integrating urban planning and innovation driven economic activities into Sustainable Development Goal 11: Sustainable Cities and Communities, makes it possible for the "innovation" component of this urban planning strategy to be addressed in a context broader than just economic sustainability (ibid). Vaidya & Chatterji (2020) however note that SDG 11 is interlinked with several other SDGs. For example, in the context of innovation districts, SDG 9: industry, innovation and infrastructure is of high relevance. This goal seeks to "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" (United Nations, n.d.-b), aligning perfectly with the aspirations and intentions of innovation districts. Localization of indicators to the context of innovation districts in each city is therefore recommended to guide monitoring processes.

The United Nations defines localization as "the process of taking into account subnational contexts in the achievement of the 2030 Agenda, from the setting of goals and targets, to determining the means of implementation and using indicators to measure and monitor progress" (Global Taskforce of Local and Regional Governments et al., 2016). The process is intended to tailor the goals to fit a particular context, thereby enabling local actions towards

SDG achievement. While localizing (Rey et al., 2022), indicators derived from the UN SDGs can be treated as the reference indicator set (Asare-Kyei et al., 2015) that further undergoes deliberation (Allain et al., 2018), elicitation (Asare-Kyei et al., 2015), and validation, to create a comprehensive set of USIs to guide the holistic development of the innovation district in question.

To summarize, this chapter explains the positioning of innovation districts within the broader category of urban planning strategies. It then explains the evolution and relevance of sustainability in urban development. The process of urban monitoring is proposed as a tool to propel sustainable urban development. Indicators that form the starting point of any monitoring process are introduced, categorized, and elaborated in the context of sustainability. Lastly, "Urban Sustainability Indicators" for sustainable innovation districts is discussed. In doing so, the chapter successfully binds together the three elements of this research: Innovation Districts, monitoring, and sustainability.

The theoretical perspective discussed so far informs the methodological processes and analytical framework used to accomplish the objectives of this research. The theory also helps interpret the results in a way that can benefit further work on innovation districts in a real context. The next section introduces the case of Oslo in more detail, for which this thesis proposes a USI set.

3 Object of Study

The case of the city of Oslo, and its short history with innovation districts has been briefly introduced in Chapter 1. This section looks at the case of Oslo's innovation districts as the object of study in greater detail. It also introduces the aims and objectives of the three innovation districts embedded within Oslo. The context of sustainability within Oslo is briefly discussed, followed by which the different aspects of the context are tied together based on how different elements influence the innovation districts.

3.1 Oslo's Innovation Districts – an Urban Planning Strategy

Oslo, the capital city of Norway, serves as the nation's epicenter for innovation. With a strong commitment to addressing poverty, inequality, and climate change, the city has fostered a thriving innovation ecosystem and is committed to achieving the SDGs (Oslo Business Region, 2022). Furthermore, the city has been working towards its commitments by positioning itself as a testbed for innovation that can achieve the city's sustainability goals. In doing so, it aligns its actions with its vision of becoming a resilient society and contributing to a sustainable economy (ibid).

In 2018, The Department of Industry and Ownership, City of Oslo formally proposed a place-based development, to accelerate knowledge growth and innovation in three business centers within Oslo city. This planning strategy gathered inspiration from other Scandinavian cities, such as Copenhagen and Stockholm, that also strengthened economic offerings within the city center, through urban planning strategies. Innovation districts were thus first introduced as a strategy to develop place-based infrastructure to accelerate knowledge-based growth, in a strategy document titled "Campus Oslo - Strategy for the development of the capital of knowledge" (Oslo Kommune, 2018). The planning strategy proposes three innovation districts and was a result of a series of workshops and participatory collaborative activities conducted with actors from the public sector, private sector, and academia (ibid).

The Innovation districts proposed in the city, have been defined as compact geographical districts where large and small enterprises can be co-located, along with entrepreneurial ecosystems and investor milieus, collaborating closely with universities, hospitals, and strong research institutes. These districts will serve as Oslo's new land-use typology and will be

spatially characterized by short travel distances, meeting places, and easy access to knowledge and funding needs (A-Lab, 2021), much in line with the canonical definition of innovation districts, proposed by Katz & Wagner (2014).

The Campus Oslo strategy (Oslo Kommune, 2018) acknowledges that despite Oslo's leading position in terms of higher education, research capabilities, and business location, it still lags behind other Scandinavian capitals, in terms of innovation potential. To address this, the innovation districts aim to foster collaboration among academia, businesses, and public services (Oslo Kommune, 2018). The strategy intends to facilitate more jobs, more innovation, and more value creation (ibid) in the long run, which further is believed to contribute to societal wellbeing. In short, innovation districts of Oslo were proposed as an urban development strategy where the need for economic development meets spatial transformation, in the anticipation of better social benefits.

The Campus Oslo Strategy identifies three specific innovation districts: Oslo Science City, Punkt Oslo (originally called Innovasjonsdistrikt sentrum), and Hovinbyen Sirkulære, as shown in Figure 2, each with distinct objectives and agendas (A-Lab, 2021). While other areas in the city, such as Lysaker, Fornebu, and Skøyen, have been explored for their potential as innovation districts (Grünfeld et al., 2022), this research focuses solely on the innovation districts as identified and proposed in the Campus Strategy.
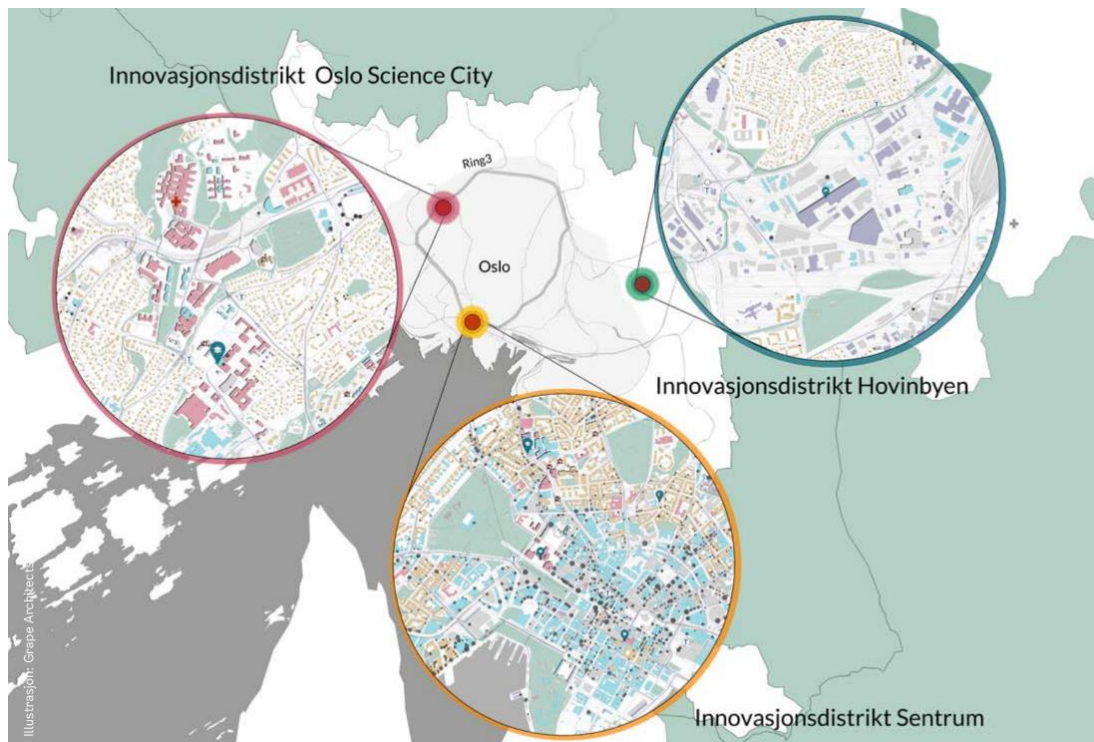
Figure 2 Map of Oslo's three innovation districts (Source: Oslo Kommune, 2018)

3.2 Oslo's three Innovation Districts

3.1.1 Oslo Science City

In recent years, there has been a growing recognition of the importance of fostering innovation, research, and collaboration to drive scientific advancements and societal progress in Oslo ((A-Lab, 2021). In this context, Oslo Science City (OSC) has emerged as a pioneering initiative in Norway. Established in 2019, Oslo Science City is the country's first Innovation District, strategically located in Majorstuen, Marienlyst, Blindern, Gaustad, Ullevål, and Campus Radiumhospitalet (Oslo Science City, n.d.).

The area houses three prominent anchor knowledge institutions, namely the University of Oslo, Oslo University Hospital, and SINTEF, which have earned international acclaim for their contributions to research, education, and innovation (Oslo Kommune, 2018). The objective of implementing innovation district in the area, is to augment existing knowledge assets of these institutions- data, research expertise, policies, knowledge, patents, etc, (Freeze & Kulkarni, 2007) and utilize this resource to build capital. Furthermore, changing the spatial and governance structures in the area is envisioned to foster cooperation and mutual reinforcement among stakeholders (Oslo Science City, n.d.)., The potential for job creation and innovations through these systemic changes in fields such as technology, health, life science, digitalization, energy, mobility, climate, environment, and sustainable solutions has been identified as significant (Oslo Science City, n.d.).

OSC is established as a membership-based association, that coordinates and collaborates developmental strategies, to facilitate close and formalized partnerships between key players in the area: knowledge actors, real estate developers, municipality and start-up ecosystems (A-Lab, 2021). This collaborative platform enables the different stakeholders and members to align their efforts and coordinate initiatives that are believed to be important for improving the characteristics of the area. Additionally, the district aims to transition into a greener space that combines work, study, live, and play, thereby making it an attractive hub for business development, that further leads to job creation (Oslo Science City, n.d.). The ongoing construction and development projects within Oslo Science City lay a solid foundation for its future growth and development, integrating them into a holistic plan for the district (A-Lab, 2021).

Efforts to shape the development of Oslo Science City have involved active participation from students, researchers, business representatives, the municipality, interest groups, and the voluntary sector through workshops and conferences. The engagement of approximately 500 participants has allowed for fruitful discussions on the future needs, solutions, and opportunities within the district (ibid). The participative activities resulted in a "feasibility study", based on which further actions have been taken.

3.1.2 Punkt Oslo

Punk Oslo is the newest innovation district in Oslo, that envisions to maximize capital in Oslo's city center through interactions between its actors. It aims to act as a platform to enhance innovation and entrepreneurship in the heart of Oslo (Punkt Oslo, n.d.). The anchor institution of this planning strategy is Oslo's newest and third largest university, OsloMet. Other research and innovation institutions, such as Simula Research Lab, Kristiana University College will also act as key academic actors in the district. Furthermore, many technological companies are located in Oslo's city center, which act as the area's knowledge assets (Oslo Kommune, 2018).

The objectives, needs and aims of this development were selected based on the findings from three workshops between February and March 2022, that were held with participants from academia, the public sector, business, entrepreneurs, and real estate (PWC & Svale, 2020). The workshop concluded that the district should facilitate projects that are rooted in social benefits. Such projects can increase value creation and regional partnerships, which will in turn leads to more jobs (PWC & Svale, 2020).

Punk Oslo hence combines the advantage of technological companies being located in the area, and it's need to facilitate social innovation by being a test area where new and innovative solutions can be showcased. It acts as a 'meeting place' where actors can connect and get to know each other. This makes it possible to test the projects in practice, prototype it, and learn from the process, before implementing it on a larger scale (Punkt Oslo, n.d.). The project already has pioneer solutions that have been tested here, such as, floating solar panels in the harbor basin, a system for stormwater management on the city's roof and autonomous goods delivery at Aker Brygge (Punkt Oslo, n.d.).

From an urban development perspective, 'human-friendly design' strategies, that are multifunctional in nature, with access to green spaces and car-free streets were highlighted to be suitable for the area. The organization's role involves influencing the municipal plans in this

23

direction (PWC & Svale, 2020). In short, by combining interactive and piloting activities with urban development objectives, Punkt Oslo aims to accelerate growth in Oslo's city centre.

3.1.3 Hovinbyen Sirkulære Oslo

The Hovinbyen area, a strategic link between Oslo's inner city and Groruddalen, is on an urban transformation journey. Recognized as one of the city's vital land acquisitions and investment areas, Hovinbyen's significance was further reinforced in June 2018 when the Oslo City Council adopted the "Strategic Plan for Hovinbyen" (Oslo Plan- og bygningsetaten, 2018). This comprehensive plan ensures that the area becomes an attractive place to live, work, and visit, with a focus on sustainable urban extension and connectivity.

Sustainability and the circular economy are central themes in the strategic plan for Hovinbyen, thereby committing the area's development towards environmentally conscious practices and the efficient use of resources. Building upon existing history and established businesses, the strategic plan outlines the importance of strong collaboration between the Oslo municipality and the business sector to realize a sustainable area aligned with circular principles (ibid).

Hovinbyen Sirkulære Oslo was thus established through public-private partnership (Hovinbyen Sirkulære Oslo, 2023) to drive the realization of the area's goals, through innovation, fostering knowledge exchange, and creating new employment opportunities within the circular economy, particularly in the building, construction, and manufacturing industries (Hovinbyen Sirkulære Oslo, n.d.). This innovation district recently announced a public tender for the study of the district's feasibility. The objectives, strategies, and ambitions of Hovinbyen Sirkulære Oslo, as described in the program for this feasibility study (Hovinbyen Sirkulære Oslo, 2023) has been summarized by the author as follows:

> Hovinbyen Sirkulære Oslo, rooted in public private collaboration, was founded to bring value to the Hovinbyen area in the city, which has the ambition to attract between 60,000 and 80,000 new residents and generate up to 100,000 new jobs by 2040. The overarching goal of HSO is to position Hovinbyen as a world-leading innovation district for the circular economy, focusing on construction, building, and manufacturing industries.
>
> The purpose of HSO is to facilitate active interaction among business actors, knowledge communities, the public sector, and civil society, ultimately fostering the comprehensive development of a vibrant urban area where future circular solutions and

employment opportunities are created. Notably, Hovinbyen exhibits an overrepresentation of industries such as energy supply, renovation activities, and business-related services, and therefore sets the stage for innovative advancements in these sectors.

In conclusion, Hovinbyen Sirkulære Oslo is rooted in the concepts of circular economy initiatives and sustainable urban development to guide the areas urban transformation efforts. The organization believes that with its clear vision, strong partnerships, and strategic planning, Hovinbyen will become a model innovation district, attracting residents, businesses, and visitors alike, while paving the way for a greener and more prosperous future.

3.3 Oslo and Sustainability

As of 2022, nearly 23.7% of Norway's population lived in Oslo (Statistics Norway, 2022b). The use of SDGs as a main political framework for urban development has been enforced on a local level and regional level by the national government to address challenges such as poverty, climate change and inequality (Bardal et al., 2021). Furthermore, the local and regional authorities have been entrusted with the responsibility to address local challenges by using SDGs as the foundational component of planning strategies (ibid). While the SDGs themselves have actively encouraged the inclusion of sustainability in public policies and development strategies, these goals and targets are universal in nature to allow flexibility of use and context. The success of its use therefore depends on contextualization, to suit local planning frameworks and situations (Vaidya & Chatterji, 2020). However, a study by Bardal et al. (2021) showed that many respondents from local authorities in Norway had difficulties relating to SDG tools and indicators on a local level.

Despite this, in 2022, Norway was ranked fourth in the world on its progress towards achieving the 17 SDGs. (Sachs et al., 2022). In the context of SDG 11, "Voluntary National Review 2021 Norway"(Norwegian Ministry of Local Government and Modernisation & Norwegian Ministry of Foreign Affairs, 2021) states that the SDG has been localized in Oslo through cycle paths, public transport circular economy strategies. Switching to electric cars and public transportation has been encouraged, which has in turn lowered air pollution levels. However, the exploration of connections between different SDGs to make the implementation holistic is missing. There also exists many social and economic inequalities in urban areas. The housing market is inaccessible, unregulated, and expensive. Lastly, awareness on how actions at the

municipality level cause global socioeconomic implications is lacking. (Norwegian Ministry of Local Government and Modernisation & Norwegian Ministry of Foreign Affairs, 2021).

3.4 Knitting together the context

In the Norwegian Planning context, the local municipalities have the main authority in decision making associated with land-use. However, this can be influenced by regional and local governments, where the regional level coordinates plans across the local bodies in the county (Bardal et al., 2021). This is relevant to the context of Oslo as well. In the context of the three innovation districts, the districts are headed by their respective organizations, who hold responsibility for strategy development, on a district level. However, coordinating the activities on a regional level (throughout Oslo), is in the hands of the Oslo Municipality. Infact, the Oslo Municipality, locally referred to as "Oslo Kommune" oversaw the Campus Oslo Strategy, (Oslo Kommune, 2018). Oslo has the special status of being both a city and a region in Norway. Therefore, its local authorities are also in charge of regional functions (Store Norske Lexikon, n.d.).

The decisions on the district and regional scale are in turn influenced by national priorities and agendas. On a national level, the public document "National expectations for regional and municipal planning 2019–2023" by the Ministry of Local Government and Modernization prescribes that the SDGS will provide direction to Norway's development policies, and must therefore be the foundation for social and land use planning strategies (Fløttum et al., 2022). The Campus Oslo Strategy also recommends the follow-up work associated with Innovation Districts be made based on the UN SDGs. Moreover, the purpose of innovation districts in the Campus Oslo Strategy is highly influenced by the functions and definitions of innovation districts by Katz & Wagner (2014).

Therefore, from the analysis of the urban planning system in Oslo, three distinct spheres of influence on the city's innovation districts clearly emerge, as shown in Figure 3:

1- The district level, which includes the three innovation districts, the organizations enforcing developmental trends within their respective spatial extents, and its users.
2- The regional level, which comprises Oslo Kommune-the municipality, coordinates the activities of the innovation districts and other business-related activities in Oslo.
3- The national level whose agendas are influenced by Supranational strategies.

The National/Supranational levels define the overarching themes of this thesis- innovation districts and sustainability development, through its strategies and policies.

The regional level represents the case of this thesis – Oslo's 3 innovation districts as combined components of the city, while the district level denotes the innovation districts as independent entities, embedded within the case of Oslo. The study incorporates perspectives from each of these levels, to give a holistic understanding of indicators necessary to steer sustainable development in Oslo's innovation districts.

This is achieved through a combination of primary data mainly collected through interviews, and secondary data collected during desk study, as the key sources of information. The research design for collecting data and analyzing it to achieve the objectives of this research has been elaborated in the next chapter.
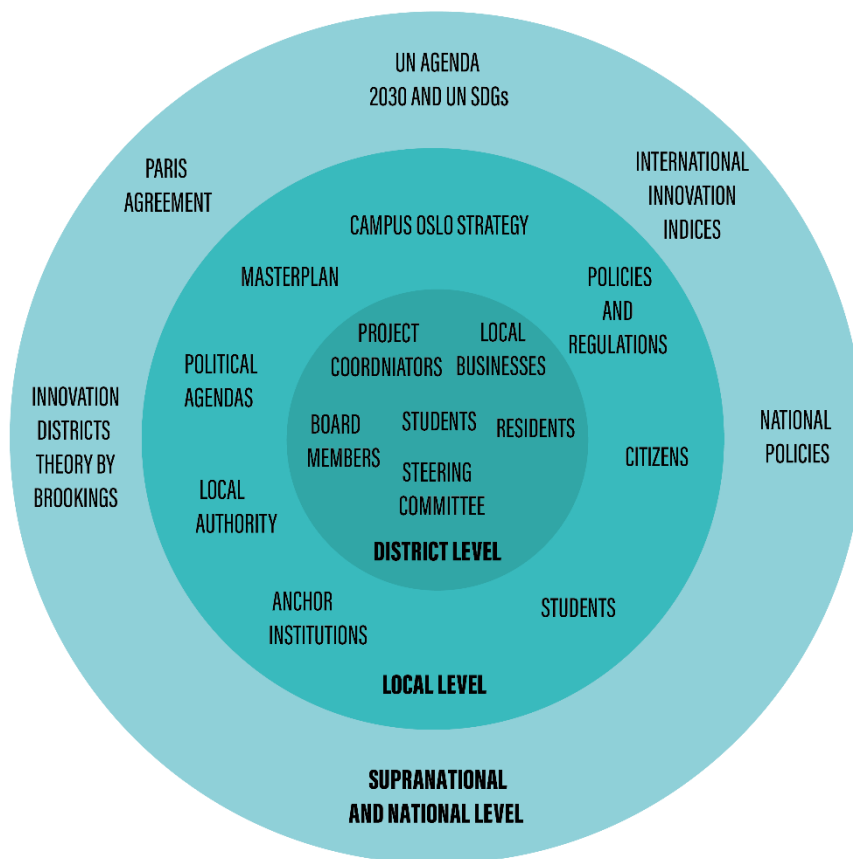
Figure 3 Different Elements in the Three Spheres of Influence in Oslo's Innovation District (Source: Author)

4 Methodology: Urban Sustainability Indicators Identification Framework

Urban Sustainability Indicator identification employs a primarily qualitative approach in this research, and is achieved through a single embedded case study method (Yin, 2018). This chapter introduces the concept of single embedded case study method, and how it translates to the case of Innovation Districts in Oslo. The different stages of research design in this case study, and the specific tools and techniques employed to execute it have been introduced and elaborated. The research design employed in this thesis, and data collection methods associated with it have been verified and approved by the Norwegian Centre for Research Data (NSD).

4.1 Single Embedded Case Study Approach

The case study approach is defined as an in-depth empirical exploration of the selected contexts, from a diverse range of perspectives, to understand the complexity and strengths of the system, project, its stakeholders, or a policy in a real-life (Simons, 2020). The framework for this approach, as implemented in this research, is adapted from Yin (2018), who suggests this method for investigating contemporary scenarios, when subject behaviors cannot be manipulated, such as the investigation undertaken for this study. The method was chosen based on a contextual interpretation of Innovation Districts in Oslo, on a regional scale: A city that is the sum of its three isolated, individual, innovation districts. In the context of this project, the case of Innovation Districts in Oslo is studied contemporarily, wherein the author does not influence the course of events but only observes and studies it. Therefore, the approach was chosen as the best course of action to reach the defined project objectives.

Yin (2018) elaborates that case studies can primarily be distinguished into single case study and multiple case study designs. Evidently, while a single case study design digs deep into the thematical context of one single subject, a multiple case study is designed to consider perspectives from multiple subject categories on a single theme. However, the single case studies may be designed to have one single-case study unit, with multiple sub study units. For example, in the case of this project, (as demonstrated in Figure 4), the theme of urban sustainability and innovation districts are investigated from the larger perspective of Oslo. At the same time, it also involves a deeper study into the three sub-units of Oslo's Innovation
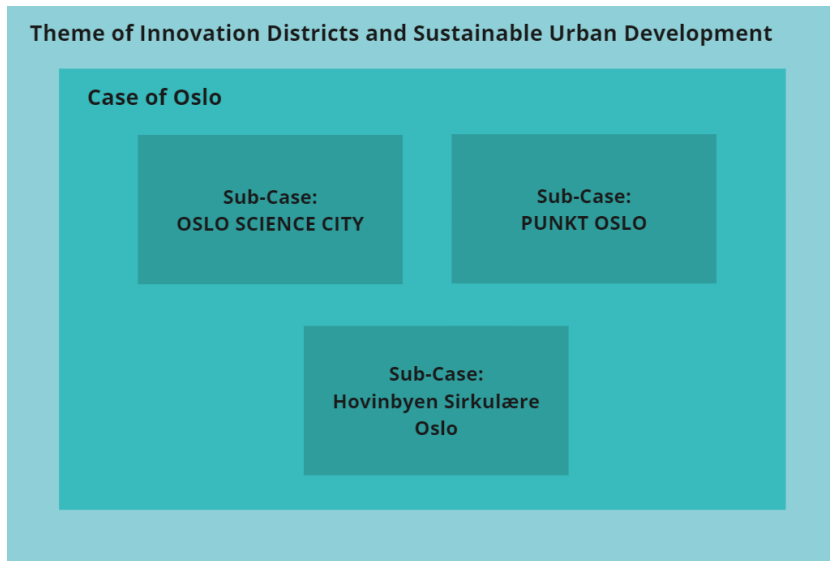
Figure 4 Illustration of Oslo's Innovation Districts as a single embedded case (Source: Author)

District ecosystem, namely, Oslo Science City, Hovinbyen Sirkulære Oslo, and Punkt Oslo. A case study of this nature is called a "Single Embedded Case Study". Yin (2018) further advices that when selecting this approach in research design, the information needs to be analyzed, interpreted, and discussed at both levels- the three innovation districts, and also the overall city Innovation District Ecosystem.

The methodological process of this thesis incorporated is heavily adapted from the methodological flow suggested by Yin (2018). It accomplishes the project objective in five stages (illustrated in Figure 5) as described below:

Stage 1: *Research Planning*, where it was identified that the Case Study approach would be best suited to study the intersection of Sustainable Development and Innovation Districts, using the case of Oslo.

Stage 2: *Research Design*, where the research objective was defined, best practices were studied, and relevant theories were identified. This further informed the chosen data collection tools, and analytical framework.

Stage 3: *Data collection*, where case study evidence was collected through qualitative sources, such as documents, interviews, field notes from direct observation and participative discussions at Svale AS.

Stage 4: *Data Analysis,* where the data is coded and examined based on the chosen theories and research objectives.
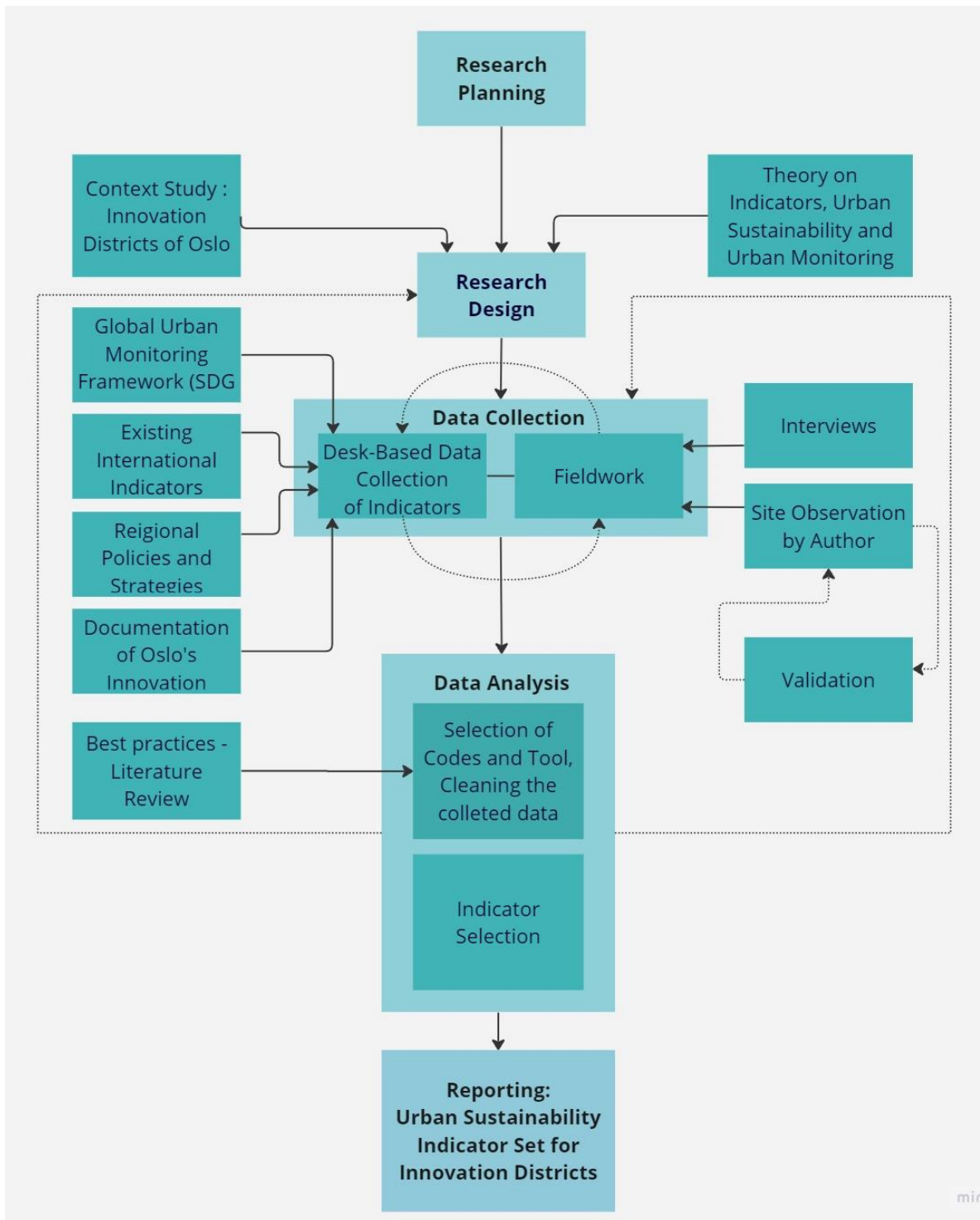
Figure 5 Methodological Process of the research project (Source: Author)

Stage 5: ***Reporting***, where the results are documented and an "Urban Sustainability Indicator set" for Oslo's Innovation Districts is proposed.

The research design underwent multiple changes and fine-tuning throughout the process, informed by the new understanding of concepts obtained during data collection. This iterative process was guided by the resources available at Svale AS, which had previously worked on

projects such as Punkt Oslo and HSO. The topic was extensively discussed with colleagues on multiple occasions, and feedback on the process was provided. Being immersed within the system also enabled the author to gain a deeper understanding of projects and their priorities. Svale AS had an extensive collection of internal documentation, which the author was granted access to, further enhancing the comprehension of the context and strengthening the understanding of innovation district processes.

Stages 1 and 2 of the methodological process have already been addressed in the previous chapters, Chapter 1- Introduction to the Study, and Chapter 2- Theoretical Perspective. The design of the data collection process, and the analytical framework employed for Urban Sustainability Indicator Identification will be discussed in the next pages of the current chapter.

4.2 Data-collection Methodology

4.2.1 Primary Data Collection Through Fieldwork:

Semi-structured Interview :

The primary method employed for data collection was semi-structured interviews, following the recommendations by Adams (2015) to ensure a structured approach. The interviews were conversational, with one interviewee at a time, and conducted anonymously for approximately 1 hour long. The semi-structured approach allowed for flexibility in the discussions, as the focus topics were pre-defined but not strictly adhered to. Before the interviews, an interview guide containing probable questions and discussion topics was prepared and shared with the respondents to assist them in their preparation. The guide was developed based on preliminary studies on the topics and was modified from interview to interview, depending on the participant being addressed. A trial run of the interview process was conducted with a colleague at Svale AS, prior to its project implementation, to assess its effectiveness.

To ensure a comprehensive understanding, the interviewees were selected to represent multiple perspectives within the narrative. This included field experts and local actors directly involved with innovation districts, and users who would be impacted by future development. By including these diverse perspectives, a more well-rounded understanding was sought, enriching the overall analysis. The existing network of Svale AS provided a valuable foundation for recruiting samples associated with innovation districts. In addition to this, snowball sampling (Naderifar et al., 2017) played an equally important role in sample recruitment. Several study subjects recommended relevant actors to be included, and these individuals were approached

to participate in the data collection process. A brief detail of the interviews conducted has been listed in the Table 1.

Table 1: Semi-structured interviews conducted during this study.

Sl. No	Respondent	Interview Objectives
Supranational And National Level		
1	Field Expert on UN SDG 11 and UMF from United Nations (Participant 1)	Understanding perspectives of The Global Monitoring Framework, SDG 11 and indicator identification processes in a professional context
2	Field Expert from United Nations on Innovation based Urban Development	Data on innovation district and monitoring perspectives from an international lens
Regional Level		
3	Politician in Oslo	Data on political relevance of innovation districts, and why it is important to the city
4	Expert Opinion- Innovation Districts in Oslo	Data on the relevance of innovation districts to Oslo and understanding the context of Oslo as a system of innovation districts with 3 sub-units.
District Level		
5	Informant- Oslo Science City	Data on Driver-Pressure-State-Impact-Response in the context of Oslo Science City, it's alignment to Campus Oslo Strategy, and the role of SDGs in follow-up and monitoring
6	Informant - Punkt Oslo	Data on Driver-Pressure-State-Impact-Response in the context of Oslo Science City, it's alignment to Campus Oslo Strategy, and the role of SDGs in follow-up and monitoring
7	Informant - Hovinbyen Sirkulære Oslo	Data on Driver-Pressure-State-Impact-Response in the context of Hovinbyen Sirkulære Oslo, it's alignment to Campus Oslo Strategy, and the role of SDGs in follow-up and monitoring
8	Informant 2 – Oslo Science City	Additional perspective on Oslo Science City, as Svale AS has not directly worked on this innovation district project.
USER PERSPECTIVE		
9	Resident user at Hovinbyen Sirkulære Oslo and Student user at Oslo Science City	Data on user perspective of the innovation district
10	Employee in the Oslo Science City area - Urban Planning Researcher	Data on user perspective of the innovation district, and academic perspective of the development as a sustainable planning strategy.

Site Visits, Observations and Field Notes

The criticism around the reliance on interviews and questionnaires in social research (Webb et al. as cited in McCall, 1984) calls for the inclusion of more field-based methods to complement research work. The three innovation districts in Oslo have demarcated spatial bounds, even though their future impacts are predicted to ripple across the rest of the city. Furthermore, these districts also have their own distinctive physical traits. Site visits were therefore used as a tool after every interview, to understand how the strategies discussed by the informants of the innovation districts can be embedded in space. These site visits were performed individually by the author. Observations (McCall, 1984) made during the visit were then transcribed into field notes, which were further used as inputs for indicator identification.

Despite the site visits being guided by context-specific and thematic questions pertinent to the research objective, it could still be influenced by the author's personal biases. The findings from site observations were therefore discussed and validated with the team at Svale AS.

Svale AS as a Focus Group

A focus group is defined by Lederman as "a technique involving the use of in-depth group interviews in which participants are selected because they are a purposive, although not necessarily representative, sampling of a specific population, this group being 'focused' on a given topic" (Rabiee, 2004). The academic nature of this study, and the limited availability of stakeholders involved in innovation district implementation made it challenging to recruit them for Focus Group discussions and workshops. Instead, the team at Svale AS were sampled for in-depth group discussions on innovation districts.

Given the organization's experience with innovation districts, the activity was considered a focus group of experts in the context of this thesis. 10-minute seminars were conducted every fortnight with the team, to discuss the progress on the thesis, and get their suggestions for it. A longer two-hour workshop was convened for time-consuming activities, such as Site observation field notes validation. In addition to this many informal group discussions and debates also organically evolved between the author and the team, during her time at the company.

Figure 8 Focus Group Discussion with Team Svale AS (Source : Author)

Figure 7 Site Visit: Punkt Oslo (Source: Author)

Figure 6 Site Visit: Oslo Science City (Source : Author)

Figure 9 Site Visit: Hovinbyen Sirkulære Oslo (Source : Author)

4.2.2 Secondary Data Collection Through Desk Study

An in-depth study of the subject was only possible if the landscape of innovation districts and SDGs was studied in the Norwegian and international contexts. Therefore, a huge part of the study comprised reading through policies, reports, national statistics, and international perspectives of relevance for this topic. It is important to note that due to Svale's close association with innovation districts in the city, many of the internal reports, that many not be available publicly were also used to better understand the context.

Furthermore, instead of solely depending on primary data as inputs for indicator creation, this thesis uses many secondary sources, that were discovered during desk study. These resources include indicators of relevance to the themes on an international level, strategies for innovation districts on a regional level, and feasibility studies and reports on a regional level. A complete list of secondary data material that were chosen for indicator identification has been listed in the next section on analytical methodology.

4.3 Analytical Methodology

Once the data incorporating different perspectives in the different levels of influence of innovation districts was collected, the data was further analysed to identify and extract indicators. The methodology for identifying Urban Sustainability Indicators for innovation districts in the context of this thesis is achieved by creating a nexus of Top-Down Bottom-Up Approaches, that were defined in Chapter 2. In other words, the indicator set does not solely rely on strategies and policies from just an international/national or just a regional/district perspective. Data from different levels of planning have been combined to create a localized indicator set, that is relevant to the context of Oslo, and also is aligned with the broader agendas that influence its developments from national/supranational levels.

Furthermore, for the purpose of indicator identification, the input data is divided into two categories, as also defined in Chapter 2:

- Reference Indicator Set, where the input already provides defined indicators.
- Elicited Indicators, where indicators will be extracted from heterogenous input materials such as reports, interviews, and field notes.

4.3.1 Framework for Urban Sustainability Indicator Identification for Oslo's Innovation Districts

To develop an Urban Sustainability Indicator framework, the data collected through interviews, desk studies, site observations were first compiled and collected, as tabulated in Table 2. These files were then separated into Reference Sheet Indicators, and Elicited Indicators, based on the source of information, and what kind of information was contained in the data file.

Three files from the desk study were selected for the Reference Sheet Indicator dataset. They were:

- Global Urban Monitoring Framework – to inform reference sheet indicators related to SDG 11
- Assessing your innovation district: A how-to guide – To inform reference sheet indicators related to Innovation Districts
- Oslo Business Region: Oslo State of The City 2022 – To inform reference sheet indicators related to Oslo.

The remaining information was used for indicator elicitation, and the process employed has been described in the sections that follow.

Table 2 Indicator Data source, type, and data collection method

Sl. No	Indicator Source	Indicator Set Type	Data Collection Method
	Supranational And National Level		
1	Global Urban Monitoring Framework (UN Habitat, 2022)	Reference Sheet Indicators	Desk Study
2	Assessing your innovation district: A how-to guide (The Bass Initiative, 2018)	Reference Sheet Indicators	Desk Study
3	International Field Expert, United Nations- SDG 11 and UMF (Interview 1, personal communication, April 2023)	Elicited Indicators	Interview
4	International Field Expert United Nations - Innovation Based Urban Development (Interview 2, personal communication, April 2023)	Elicited Indicators	Interview
	Regional Level		
5	Political Perspective of Oslo's Innovation Districts (Interview 3, personal communication, March 2023, p. 3)	Elicited Indicators	Interview
6	Campus Oslo Strategy- (Oslo Kommune, 2018, pp. 51–63)	Elicited Indicators	Desk Study

7	Planning Strategy for Oslo 2020-2023 (Oslo Kommune, 2020)	Elicited Indicators	Desk Study
8	Oslo Business Region: Oslo State of The City 2022 (The Business of Cities, 2022)	Reference Sheet Indicators	Desk Study
9	Municipality's Perspective of Oslo's Innovation District (Department of Industry Ownership) (Interview 4, personal communication, April 2023)	Elicited Indicators	Interview
10	Innovation District Expert Opinion (Interview 5, personal communication, February 2023)	Elicited Indicators	Interview
District Level			
Hovinbyen Sirkulaere Oslo			
11	Program for Feasibility Study (Hovinbyen Sirkulære Oslo, 2023)	Elicited Indicators	Desk Study
12	Informant- Hovinbyen Sirkulaere Oslo (Interview 6, personal communication, March 2023)	Elicited Indicators	Interview
13	Site Observations - Hovinbyen Sirkulaere Oslo	Elicited Indicators	Field Notes
Oslo Science City			
14	Feasibility Study (A-Lab, 2021)	Elicited Indicators	Desk Study
15	Informant 1 - Oslo Science City (Interview 7, personal communication, March 2023)	Elicited Indicators	Interview
16	Informant 2 - Oslo Science City (Interview 8, personal communication, March 2023)	Elicited Indicators	Interview
17	Site Observations - Oslo Science City	Elicited Indicators	Field Notes
Punkt Oslo			
18	Needs Assessment (PWC & Svale, 2020)	Elicited Indicators	Desk Study
19	Informant – Punkt Oslo (Interview 9, personal communication, February 2023)	Elicited Indicators	Interview
20	Site Observations - Punkt Oslo	Elicited Indicators	Field Notes
User Perspective (District and Regional Levels)			
21	User 1: Resident and Student (Interview 10, personal communication, May 2023, p. 1)	Elicited Indicators	Interview
22	User 2: Employee and Planner (Interview 11, personal communication, May 2023)	Elicited Indicators	Interview
23	User 3: Member, Hovinbyen Sirkulaere Oslo (Interview 12, personal communication, March 2023)	Elicited Indicators	Interview

4.3.2 Process for Indicator Identification

Once the data was categorized into information for elicitation and for reference sheet indicator set creation respectively, they were analyzed and triangulated for pattern matching. This analysis process was conducted in four concrete steps:

- **Step 1:** Categories of USIs for Innovation Districts were defined.
- **Step 2:** Reference Sheet indicators were created.
- **Step 3:** Elicit indicators were created using information extracted from primary data collection techniques and local strategies. This process helped localize indicators to the context of Oslo.
- **Step 4:** Aggregation of similar indicators

The next sections detail the analytical processes followed in each of these steps.

Step 1 :Adapting Existing Frameworks as Foundation for Indicator Identification

To identify USIs for Innovation Districts in Oslo, existing frameworks related to the context were identified, aggregated, and localized. The Global Urban Monitoring Framework (UMF) (UN Habitat, 2022) was used as the framework to inform the SDG aspects of the framework, particularly, SDG 11 indicators of relevance, that focus on urban sustainability. To incorporate the perspective of innovation districts, the indicators suggested in "Assessing your Innovation Districts: A How to Guide" (The Bass Initiative, 2018) have been used as reference. These guides were chosen because it is important for city level monitoring processes to align with international standards, which would facilitate the translation of results to other levels of established monitoring as well. A brief description of both these frameworks has been provided below for better reader clarity:

Global Urban Monitoring Framework

Urban areas have been identified as key areas for SDG implementation, and SDG 11-Sustainable Cities and Communities acts as the 'lynchpin' of the SDG Framework (Global Taskforce of Local and Regional Governments et al., 2016). In fact, over 230 SDG indicators are linked to SDG 11 (Zhang et al., 2021). To therefore achieve the urban components of Sustainable Development Goals, an assessment tool named 'The Urban Monitoring Framework' was introduced in 2022. It integrates another supranational agenda that is closely tied to SDG 11- New Urban Agenda and offers a 'universal framework' for monitoring and

accelerating the implementation of the SDGs, Paris Agreement for Climate Change, Sendai Framework for Disaster Risk Reduction, etc. (UN Habitat, 2022).

The framework (UN Habitat, 2022) proposes evaluation of urban areas by suggesting indicators
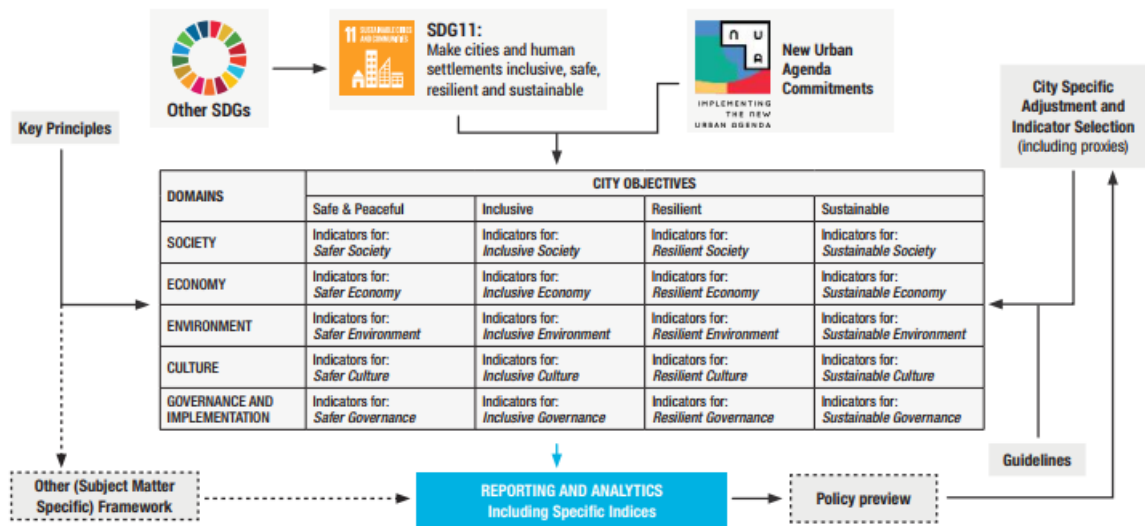
Figure 10 Urban Indicator Matrix suggested by the Global Urban Monitoring Framework (Source: UN Habitat, 2022)

specific to sustainability domains, and city objectives. The indicators are identified and extracted from SDG indicators, The New Urban Agenda Commitments, after consultation and participation with global experts. Despite the framework's focus on urban systems, it does not explicitly focus on SDG11 but rather incorporates the urban dimensions of other SDGs too.

Furthermore, the framework also suggests city specific adjustments to be made to indicators. The indicators are presented as attributes, which indicate the progress in specific sustainability domains and city objectives. There are five sustainability domains suggested in the document: Society, Economy, Environment, Culture and Governance. Similarly, the document suggests four city objectives- Safe &Peaceful, Inclusive, Resilient and Sustainable, and encourages cities to explore topics of their own interests. The final indicator set, as proposed by the framework is presented in a matrix, where Sustainability Domains are conjugated against City Objective.

Assessing your Innovation Districts: A How to Guide

"Assessing your innovation district: A how-to guide," (The Bass Initiative, 2018) is an assessment framework that helps policy makers identify and audit the strengths and challenges in the area, and thereby strategize innovation districts to suit their findings. It aims to steer

resources towards economic development that is both inclusive and innovative, by centering the assessment around five key questions (The Bass Initiative, 2018):

1. **Critical mass:** "Where are your region's highest concentrations of innovation assets?"
2. **Innovation capacity:** "Is the district leveraging and aligning its distinctive advantages to grow and strengthen firms' innovation capacity?"
3. **Diversity and inclusion:** "Does the district have an inclusive, diverse, and opportunity-rich environment?"
4. **Quality of place:** "Does the district have physical and social assets that attract a diversity of firms and people, to increase interactions, and accelerate innovation outcomes?"
5. **Leadership:** "Does the district have the leadership necessary to succeed?"

Once the strengths, challenges and the feasibility of the innovation ecosystem have been assessed, the innovation district may be established. The document suggests establishing 10-12 indicators, based on the city's contexts for audits. These indicators cover social, spatial, and economic attributes of innovation districts, such as employment opportunities, walkability, venture capital volume, diversity, governance structure, etc. The authors further suggest identifying these indicators or modifying them based on local priorities.

Matrix for Urban Sustainability Indicators

Table 3 Urban Sustainability Indicator Matrix for Innovation Districts, adapted from UMF (Source: Author)

	Critical Mass	Innovation Capacity	Diversity and Inclusion	Leadership	Quality of Place
Society	Critical Mass indicators for Social Sustainability	Innovation Capacity indicators for Social Sustainability	D&I indicators for Social Sustainability	Leadership indicators for Social Sustainability	Place based indicators for Social Sustainability
Economy	Critical Mass indicators for Economic Sustainability	Innovation Capacity indicators for Economic Sustainability	D&I indicators for Social Sustainability	Leadership indicators for Social Sustainability	Place based indicators for Social Sustainability
Environment	Critical Mass indicators for Environmental Sustainability	Innovation Capacity indicators for Environmental Sustainability	D&I indicators for Environmental Sustainability	Leadership indicators for Environmental Sustainability	Place based indicators for Environmental Sustainability
Culture	Critical Mass indicators for Cultural Sustainability	Innovation Capacity indicators for Cultural Sustainability	D&I indicators for Cultural Sustainability	Leadership indicators for Cultural Sustainability	Place based indicators for Social Sustainability
Governance	Critical Mass indicators for Governance Sustainability	Innovation Capacity indicators for Governance Sustainability	D&I indicators for Governance Sustainability	Leadership indicators for Governance Sustainability	Place based indicators for Governance Sustainability

As recommended in the UMF (UN Habitat, 2022)., an indicator matrix was developed to combine the five domains pertinent to SGD 11, and the five objectives important to innovation

districts, suggested by The Bass Initiative (2018). The matrix used for categorizing innovation district indicators has been shown in Table 3.

Step 2: Creating Reference Sheet Indicators.

As listed in Table 2, the indicators defined in the following documents have been used for creating reference sheet indicators:

- The Global Urban Monitoring Framework (UN Habitat, 2022)
- Assessing Your Innovation Districts: A How-to Guide (The Bass Initiative, 2018)
- Oslo Business Region: Oslo State of The City 2022 (The Business of Cities, 2022)

The selection of reference sheet indicators from different levels and backgrounds helped ensure different perspectives, which have already been established, are used for the process.

First, the indicators relevant to innovation districts in Oslo were extracted from the UMF (UN Habitat, 2022) and placed in the Reference Indicator Set. The extraction was guided by the definition of innovation districts and its components as explained in the theoretical overview.

Next, the same process was followed to extract indicators pertaining to Innovation Districts from as defined by The Bass Initiative (2018). However, if a similar indicator was already captured by the UMF (UN Habitat, 2022), the indicator from The Bass Initiative (2018) was aggregated with the indicator from UMF (UN Habitat, 2022).

Finally, the process was repeated for the final reference sheet indicator document, denoting city level priorities : Oslo Business Region: Oslo State of The City 2022 (The Business of Cities, 2022). Here, if a similar indicator was already captured in one of the previous documents, the newly identified indicator was aggregated with the existing indicator. A flowchart of this process has been illustrated in Figure 11.

Step 3 : Creating Elicited Indicators

In the next step, the transcripts from the interviews, the field notes from the site observations, and relevant policy documents from a regional and district scale were read through to identify patterns and priorities, that were translated into indicators. Every sentence was investigated to see if it could be defined as a Driver, Pressure, State, Impact or Response, as suggested by Fet (2023). If it did, it was categorized as a possible Indicator. The 5 principles are not incorporated into the results, but have acted as a decision-making tool, that helped the author pick out indicators from raw data.

Next, the elicited indicator was analyzed against the USI matrix for Innovation District proposed in Table 3. If the classification under one of the categories is possible, the indicator is deemed to be relevant for sustainable innovation districts, added to the indicator list for aggregation, under their respective sustainability domains.

Next, the reference sheet indicators are investigated again. If they have been captured in the elicited indicator list already, the indicators are aggregated. If they haven't been captured yet, they are either added to the indicator list for aggregation as a separate indicator or dropped based on their lack of relevance to the Oslo Context.

This process has been illustrated in Figure 12, and was adapted from the analytical framework suggested by (Asare-Kyei et al., 2015). Asare-Kyei et al. (2015), in their research also modify existing indicators, to suit local contexts, based on information obtained through fieldwork based primary sources. This was in line with the overall methodology of this thesis and was thus chosen as the best approach.

Step 4: Aggregation of Indicators to create Urban Sustainability Indicator Framework for Oslo's Innovation Districts

A long list of indicators can be overwhelming for local authorities to measure (Bardal et al., 2021). Furthermore, several indicators can be highly co-related or measure the same phenomena (Gan et al., 2017). Therefore, indicators with high similarities were aggregated based on similarities in definition on type of information needed for judgement.
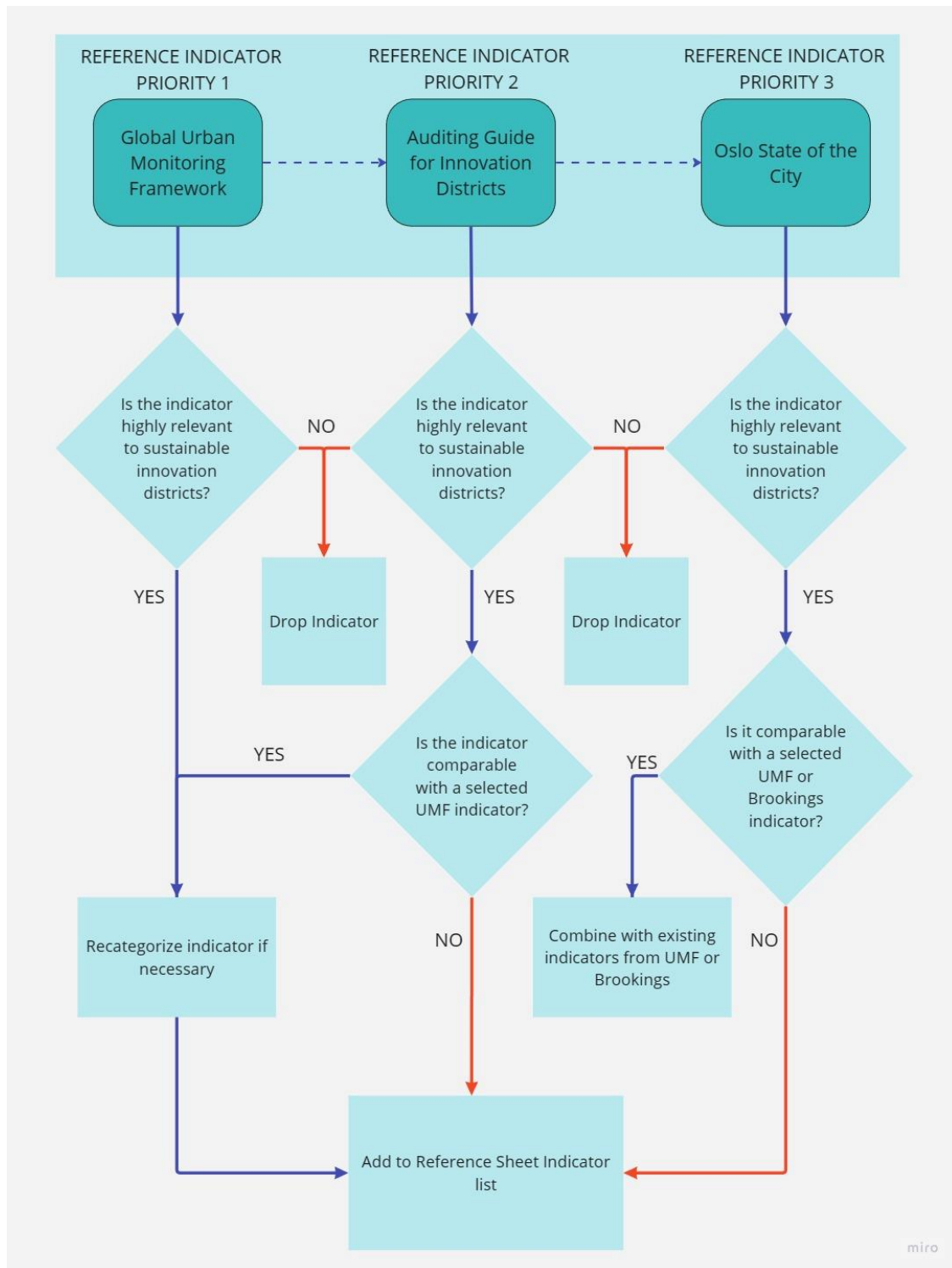
Figure 11 Flowchart of Methodology for creating reference sheet indicators (Source: Author)

43
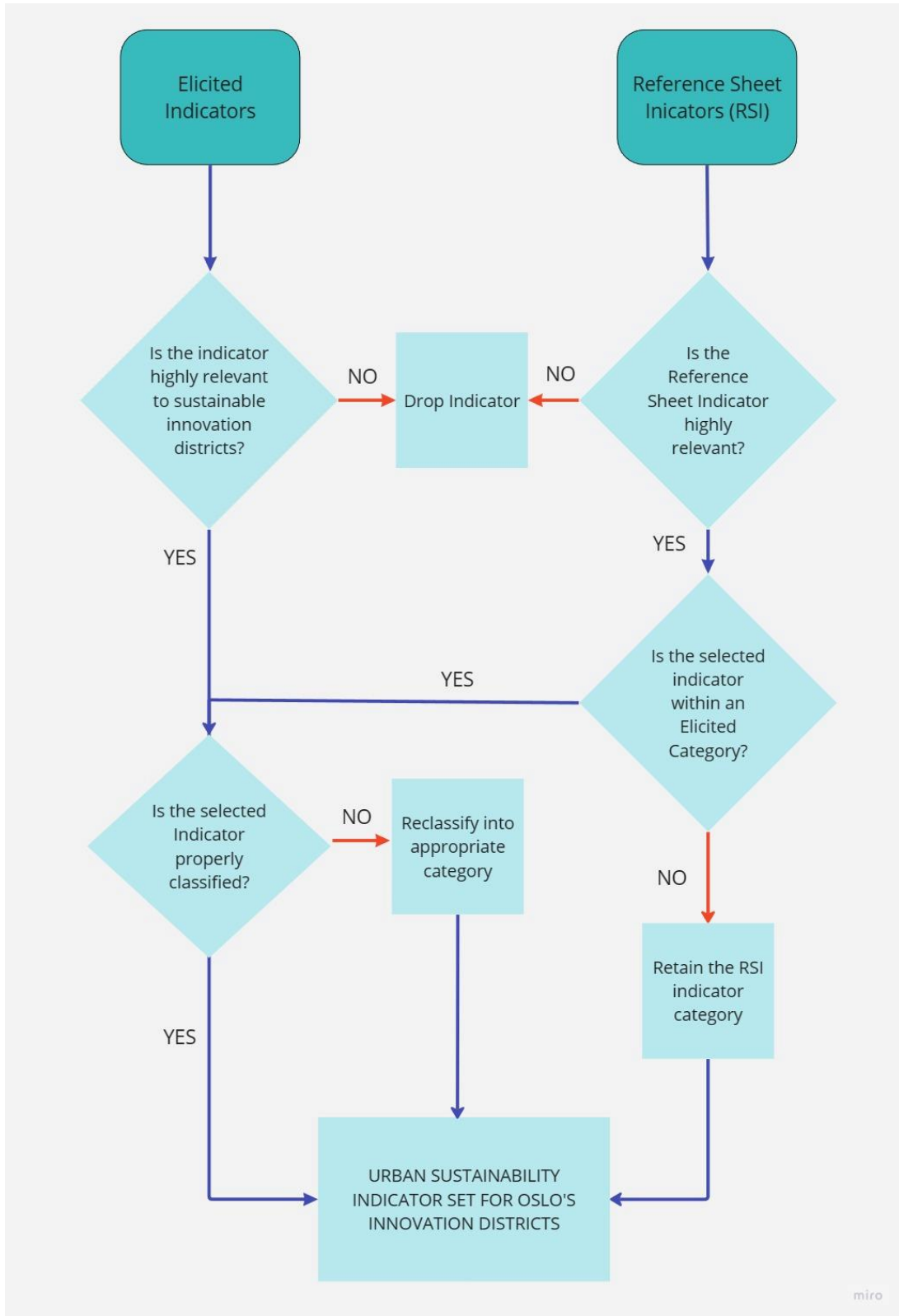
Figure 12 Flowchart of decision-making process to create a USI set for Oslo's Innovation Districts adapted from Asare Kyei et al..(2015) (Source: Author)

4.3.3 NVIVO as a Tool for Indicator Identification.

Given the volume of data, manual analysis and indicator extraction from raw data would have proven cumbersome and challenging. Therefore, a software called "NVivo" was utilized to assist in data processing. The software was used in accordance with the recommendations by Swygart-Hobaugh (2019).

Accordingly, NVivo nodes were used to "denote and connote (or code)"(Swygart-Hobaugh, 2019) the collected data. The software's "code" feature was employed to identify indicators. Two levels of urban indicator codes were created. The first level consisted of the five sustainability domains: Society, Environment, Economy, Culture, and Governance. Each domain had five innovation district objectives as defined previously: Critical Mass, Innovation Capacity, Diversity and Inclusion, Quality of Place, and Leadership.

The data sources were then individually examined. When a statement that could potentially represent a code was identified, a new indicator was created based on the suggested implications of the statement. This indicator was placed under the appropriate sustainability domain and corresponding innovation district objective. The highlighted statement was then assigned to the indicator code. If the statement had implications for an existing indicator, it was highlighted and assigned accordingly.

In other words, the analytical framework described previously in Figure 11 and Figure 12 were adapted to fit the features of the software. Figure 13 provides a snippet of the NVivo software screen displaying some of the identified indicators.

Figure 13 Snippet of NVivo software, used for analyzing data (Source: Author)

4.3.4 Reliability and Validity of Research

The study has been contextualized to the case of Oslo, defines indicators pertinent to the city's three innovation districts, and acts as the starting step to monitoring the city's innovation districts. Johnson (1997) however, warns that the qualitative nature of the study, that employs open-ended and explorative methodologies can result in inaccurate and biased results. To provide evidence of research quality, and ensure trustworthiness several authors therefore recommend ens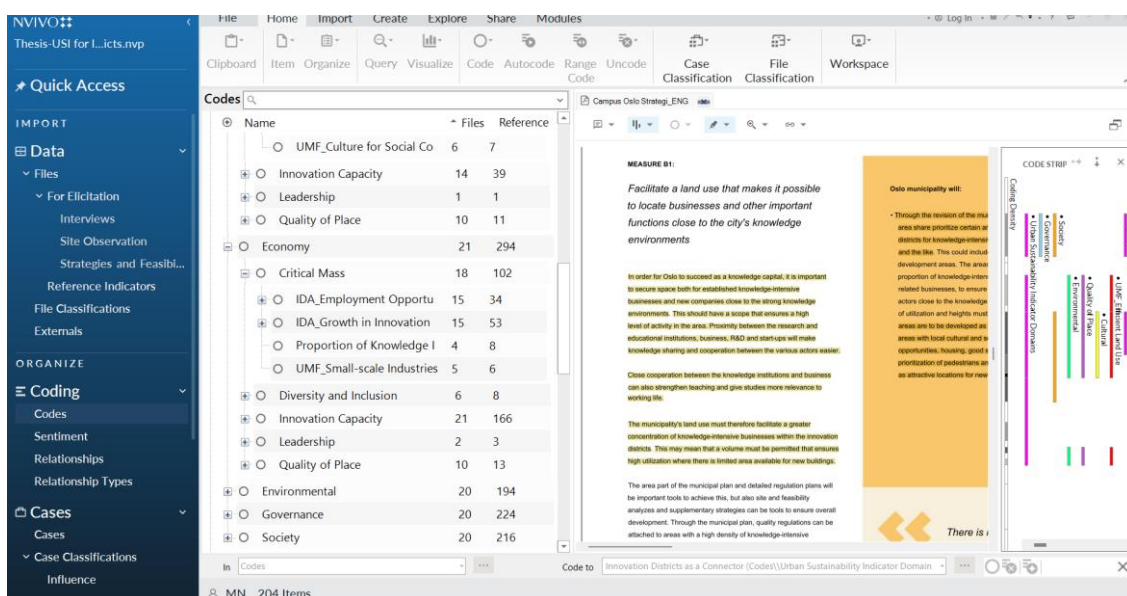uring research reliability and validity of research (Hayashi et al., 2019; Johnson, 1997; Long & Johnson, 2000). Johnson (1997) therefore recommends a list of validity strategies to promote the quality of qualitative research. Of these strategies, the following have been employed throughout the research process to ensure reliability of results:

- *Triangulation:* The research converges data from different sources, categories and perspectives and levels of influence over innovation districts. This allowed cross-checking of information and conclusions, which further led to the identification of trends and differences within the chosen context. The triangulation process included multiple data sources (data triangulation) and multiple research methods (method triangulation) to paint an accurate picture of the case.

- *Extended fieldwork:* The fieldwork extended for a period of five months, while gaining firsthand experiential learning from at a consultancy that has worked with innovation districts from its very inception.

- *Reflexivity:* The author continuously reflected on the information gathered at every step, and possible biases that were formed as a result, that could hamper the quality of future work.

- *Negative case sampling:* To work on the biases identified through reflexivity, the interviewees were chosen to include actors who are directly involved in Oslo's innovation district implementation, and actors who are not directly associated, but know about it or will likely be influenced by it. This helped gather multiple perspectives and thus reduce bias.

- *Pattern matching:* Manually matching a large quantum of data over the extended fieldwork could reduce the quality of results. The software NVivo therefore supported the pattern matching process, that further informed the indicator set.

- *Peer review:* The interpretation of the fieldwork was reviewed with the colleagues from Svale who act as "interested peers", and with two "disinterested peers" from outside the organization throughout the fieldwork, to challenge the interpretations and findings.

46

To recap, Chapter 1 introduced the main objective of this thesis :

> ***This thesis therefore aims to identify an "Urban Sustainability Indicator" set, that can further inform monitoring processes of innovation districts in the context of Oslo.***

The subsequent chapters that followed described the theoretical frameworks and context study, that intend to give the reader a deeper understanding of the background associated with this research paper. A deeper understanding of the theory and the context further informed the selection of an ideal research design to guide this project.

A qualitative single embedded case study method was thus chosen as to be the ideal method for this study, given the context of Oslo's Innovation Districts: A city as the sum of its three isolated, individual, innovation districts. The analytical process defined to extract indicators the data collected during the research employed the use of NVivo, for better data triangulation and pattern matching. The process resulted in the proposal of an ***"Urban Sustainability Indicator" set*** contextualized to Oslo and its three innovation districts.

5 Result: USI set for Innovation Districts in Oslo

The Urban Sustainability Indicator set for Oslo's 3 innovation districts is a collection of quantitative and qualitative system characteristics, that facilitate investigating innovation districts from the perspective of urban sustainability, as defined UN SDG 11. (Allain et al., 2018; Hiete & Merz, 2009).

The fieldwork confirmed that the **three innovation districts** are defined differently, and therefore have their **own individual strategies**, primarily guided by the local context, and the priorities stated by members, and project level goals. While Oslo Science City focuses on building its existing research and development strengths through colocation and marketing strategies (Interview 8, personal communication, March 2023), Hovinbyen Sirkulære Oslo aims to be the pioneer for circular economy (Interview 6, personal communication, March 2023). Punkt Oslo on the other hand is still finding its grounding (Interview 4, personal communication, April 2023), but uses themes such as "social innovation" and "data-driven innovation" to steer forward (Interview 9, personal communication, February 2023; PWC & Svale, 2020).
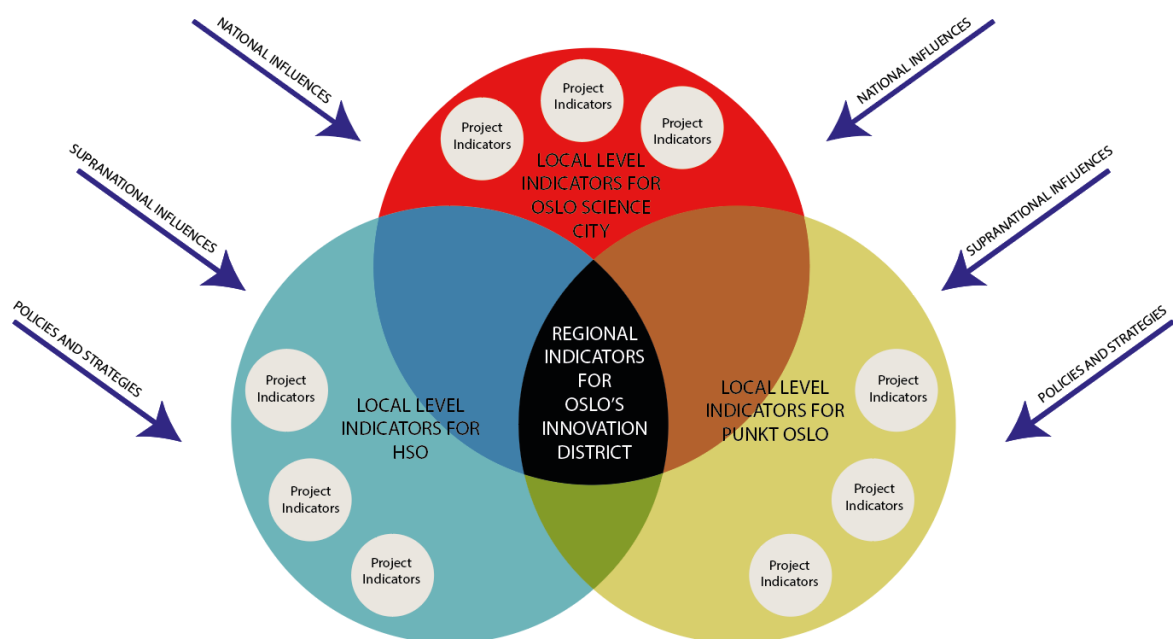
Figure 14 USIs for Oslo's Innovation District: The Nexus

The three innovation districts are further influenced by regional and national strategies, that are strongly based on supranational agendas. In addition to this, the interviews **highlighted that the members of the innovation districts have their own goals, that the innovation districts aim to mediate and collaborate. The combined effect** of all these goals forms a nexus, that intends to benefit **the entire city of Oslo in a positive manner**. Even though the districts had a difference in end objectives due to organizational differences, many commonalities were discovered between them. **These commonalities therefore form the *"Urban Sustainability Indicator" set.***

The analytical process resulted in a total of 40 indicators, which have been displayed using the Urban Sustainability matrix in Table 4. The matrix tabulates sustainability domains of the indicators against its innovation district characteristic. The result showed that the economic-innovation capacity domain had the highest number of indicators. This reiterates theory- the main objectives of implementing innovation districts are rooted in accelerating economic growth through advancements in innovations. The rest of the indicators have been distributed across the matrix, in a heterogenous manner. However, due to the inclusion of perspectives beyond innovation districts, the indicators have been defined to incorporate economic growth while simultaneously bringing forth an inclusive society, that is ready for the green shift, through efficient governance systems.

Table 4 Urban Sustainability Indicator Set for Oslo's Innovation Districts

	Critical Mass	Innovation Capacity	Diversity and Inclusion	Leadership	Quality of Place
Society	Distribution of Employees and Residents	Educational Attainment of Local Residents	Access to resources for Low-Income Groups Diveristy of workers and Residents	Mediation for Social Cohesion	Equity in Access to Public Transport Neighborhood Safety
Economy	Employment Opportunity Growth Distribution of Small, mid-size businesses and startups in the city Proportion of Knowledge Intensive Businesses	Digitization of the Innovation Districts Connections between Industry and Anchors Research and Development Activities	Unemployment Rate Wealth Distribution and Mean Household Income Suitability for Start-Ups and small-scale businesses		Affordability of Real Estate Innovation District as a test arena

49

		Annual Growth Rate of GDP per Capita			
Environmental	Greenhouse gas emissions Renewable Energy Share	Research and Innovation that Contribute to Green Shift Waste Reduction, Reuse and Recycle	Education for Sustainable Development	Budget for Actions related Climate Change Mitigation	Quality of Infrastructure of Sustainable Mobility Efficient and Multi-functional Land-Use Access to Open Public Spaces
Cultural	Retentiton of Local Values and Culture	Integration of Innovation District Culture	Culture for Social Cohesion		
Governance	Contribution and Ownership of Members	Short term wins Flexibility of Policy Utilization of E-Governance and Digital Governance Tools	Direct Participation Structure of Civil Society and Public in Planning Legal Framework for Equality	Efficiency in Urban Governance Clear Goal Setting	Coordination with Urban Development Strategies

The indicators for each of the 5 domains of the Global Urban Monitoring Framework will be discussed individually in the sections that follow. The elaboration shall include a definition of the indicator, the data sources it has been adapted from, and the rationale behind its incorporation into the indicator set, based on the discourses within the data sources.

For the sake of clarity, the primary/secondary data from which the indicators have been adapted have been coded as follows:

Primary Data Sources:

Table 5 Codes for Primary Data Sources Used in the project.

Indicator Source	Data Source Code
Supranational And National Level	
International Field Expert, United Nations- SDG 11 and UMF (Interview 1, personal communication, April 2023)	Interview 1
International Field Expert United Nations - Innovation Based Urban Development (Interview 2, personal communication, April 2023)	Interview 2
Regional Level	
Political Perspective of Oslo's Innovation Districts (Interview 3, personal communication, March 2023, p. 3)	Interview 3

Municipality's Perspective of Oslo's Innovation District (Department of Industry Ownership) (Interview 4, personal communication, April 2023)	Interview 4
Innovation District Expert Opinion (Interview 5, personal communication, February 2023)	Interview 5
District Level	
Informant- Hovinbyen Sirkulaere Oslo (Interview 6, personal communication, March 2023)	Interview 6
Site Observations - Hovinbyen Sirkulaere Oslo	Field Notes HSO
Informant 1 - Oslo Science City (Interview 7, personal communication, March 2023)	Interview 7
Informant 2 - Oslo Science City (Interview 8, personal communication, March 2023)	Interview 8
Site Observations - Oslo Science City	Field Notes OSC
Informant – Punkt Oslo (Interview 9, personal communication, February 2023)	Interview 9
Site Observations - Punkt Oslo	Field Notes PO
User Perspective (District and Regional Levels)	
User 1: Resident and Student (Interview 10, personal communication, May 2023, p. 1)	Interview 10
User 2: Employee and Planner (Interview 11, personal communication, May 2023)	Interview 11
User 3: Member, Hovinbyen Sirkulaere Oslo (Interview 12, personal communication, March 2023)	Interview 12

Secondary Sources:

Table 6 Codes for Secondary Data Sources Used in the project

Secondary Data Source	Document Code
Supranational And National Level	
Global Urban Monitoring Framework (UN Habitat, 2022)	Document 1
Assessing your innovation district: A how-to guide (The Bass Initiative, 2018)	Document 2
Regional Level	
Campus Oslo Strategy- (Oslo Kommune, 2018, pp. 51–63)	Document 3
Planning Strategy for Oslo 2020-2023 (Oslo Kommune, 2020)	Document 4
Oslo Business Region: Oslo State of The City 2022 (The Business of Cities, 2022)	Document 5
District Level	
HSO- Program for Feasibility Study (Hovinbyen Sirkulære Oslo, 2023)	Document 6
OSC-Feasibility Study (A-Lab, 2021)	Document 7
Punkt Oslo- Needs Assessment (PWC & Svale, 2020)	Document 8

5.1   Domain 1: Society

The society domain for innovation district includes indicators that ensure the interests of the citizens are upheld, through the incorporation of a diverse range of social phenomena such as equality, migrant welfare, education, diversity, resource accessibility, and transport equity. While the planning strategy strives for economic development, the society domain ensures the benefits of the innovation districts are distributed across the city's diverse demographic groups. Seven indicators were identified in total for this domain.

5.1.1 Critical Mass Indicator(s)

SO-01. Distribution of Employees and Residents

Definition	This indicator denotes the ratio of people employed in the area to the ratio of people living in the area.
Sources	Document 2, Interview 1, Interview 2, Interview 3, Interview 4, Interview 5, Document 6, Interview 6, Document 7, Interview 9, Interview 10
Rationale for incorporation	Innovation districts have been envisioned as areas where citizens can live, work, and play (Oslo Kommune, 2018). The innovation districts, OSC and HSO in particular want a balance of residential and job opportunities in the area, which further cuts down travel time (Interview 4, personal communication, April 2023), and helps in implementing ideas such as 10-minute city, mixed use and transit-oriented development (Interview 11, personal communication, May 2023). Therefore, the indicator monitors the balance between live and work functions, so as to foster development which incorporates housing in close proximity to work offerings.

5.1.2 Innovation and Capacity Indicator(s)

SO-02. Educational Attainment of Local Residents

Definition	This indicator can be defined as the level of education attained by people over the age of 16 years (Statistics Norway, 2022a).
Sources	Document 1, Document 2, Interview 3, Document 6, Document 8
Rationale for incorporation	The Bass Initiative (2018) identify educational attainment as an indicator that can elucidate the socio-economic conditions of residents within an

	innovation district. In Oslo, Interview 3 (personal communication, March 2023) asserts that the city intends to invest in skills, education, and training, to empower its citizens to drive economic development. With the possible outcomes of innovation districts being deeply intertwined with the local knowledge environments, education undoubtedly plays a crucial role in enhancing residents' employability and concurrently improving the pool of skilled individuals within the city. This indicator assesses the change in the level of education of citizens, due to strengthening of knowledge environments by innovation districts. It must be investigated on a city level, but also for individual demographic groups, based on gender, age and background (UN Habitat, 2022).

5.1.3 Diversity and Inclusion Indicators

SO-03. Access to resources for Low-Income Groups

Definition	This is a qualitative indicator that identifies the accessibility to the benefits of innovations, as perceived by low-income groups.
Sources	Document 2, Interview 2, Document 6, Document 8
Rationale for incorporation	The concept of innovation districts has a reputation for neoliberalist values, that ultimately favor the elite (Interview 2, personal communication, April 2023). The local authority representative (Interview 4, personal communication, April 2023) argues that this will not be the case in Oslo. To be truly inclusive in its approach, active steps must be taken by innovation districts, to include marginalized groups in its strategies. The measure, therefore, monitors if the benefits of innovation districts are distributed amongst low-income groups of the city. Anne T and Bass (2018) suggest that one way this can be done is by investigating if low-income residents in areas surrounding the districts are connected to the planning strategy via jobs, education and/or business opportunities.

SO-04. Diversity of Workers and Residents

Definition	This indicator investigates the distribution of economic, ethnicity and gender diversity of workers in the area.
Sources	Document 2, Interview 2, Interview 3, Document 6, Interview 6, Document 8, Interview 11
Rationale for incorporation	The Needs Assessment of Punkt Oslo (PWC & Svale, 2020) stresses the need for innovation districts to benefit the common man. Being the country's intercultural capital, Oslo has diverse demographic groups, who must be included in the housing and financial offerings of the area (Interview 2, personal communication, April 2023). The indicator therefore aims for a more equitable distribution of users in the area, which can be achieved with a mix of various industries, companies, jobs, and housing typologies (Interview 11, personal communication, May 2023).

5.1.4 Leadership

SO-05. Mediation for Social Cohesion

Definition	The indicator refers to action-based measures that improve the other indicators in the Social Domain, either directly via the innovation districts or through mediation with civic bodies and member organizations.
Sources	Interview 3, Interview 4, Interview 5, Interview 6, Interview 7, Interview 8
Rationale for incorporation	The innovation districts function as member organizations (Interview 6, personal communication, March 2023; Interview 9, personal communication, February 2023) in which the members pursue their self-interests, encompassing both social and economic aspects (Interview 6, personal communication, March 2023). Consequently, innovation districts assume the role of an impartial mediator in the Oslo context (Interview 7, personal communication, March 2023). Due to the involvement of many different actors, the efforts of the district may amount to mere diplomacy, without any much action as a result (Interview 9, personal communication, February 2023). Therefore, for

	innovation districts to be more than mediation efforts, and to actively prioritize social sustainability in its efforts, action-based measures that promote social well-being must be set in place.

5.1.5 Quality of Space Indicators

SO-06. *Equity in Access to Public Transport*

Definition	The amount of time taken by groups to reach the innovation districts by public transport as opposed to by car, from different parts of the city, mapped against the socio-economic condition of the group (Lunke, 2022).
Sources	Document 1, Document 2, Document 3, Document 4, Document 5, Interview 5, Interview 3, Interview 2
Rationale for incorporation	The innovation districts already have good public transport infrastructure (Interview 5, personal communication, February 2023). However, going forward, the mobility solutions proposed in the area must not only link the different neighborhoods within the innovation district, but also to the rest of the city and region (Interview 11, personal communication, May 2023), thereby making it accessible even to the common man (PWC & Svale, 2020). The same has also been indicated as a priority action in the feasibility study of Oslo Science City. Therefore, equity in access to public transport should be one of the factors to monitor.

SO-07. *Neighborhood Safety*

Definition	This indicator has been defined based on the interpretation provided by UMF. "Proportion of population that feel safe walking alone around the area they live after dark" (UN Habitat, 2022, p. 54)
Sources	Document 1, Interview 1, Document 4, Interview 11, Interview 12
Rationale for incorporation	The city of Oslo envisions to create a "safe" society for all through its developmental plans (Oslo Kommune, 2020). However, an urban planner who works in the OSC area, (Interview 11, personal communication, May 2023) addressed his fear that the innovation district development could

	result in spaces that are bustling with people during the day, but empty and even dangerous to walk at night, such as an innovation district in Canada. Furthermore, the site observations, especially of the Hovinbyen district, show that the area lacks streetlights in many parts, is automobile centric, and due to the industrial nature of its land-use, it could be perceived as unsafe. In conjunction to this, Interview 1 (personal communication, April 2023) also highlighted safety of the area is an important indicator in planning strategies.

5.2   Domain 2: Economy

The main intent for the proposal of innovation districts in Oslo is to accelerate economic growth by creating a bridge that fosters public-private-academic partnerships (Oslo Kommune, 2018). Furthermore, the strategy was proposed by the municipality's department for industry and ownership, which deals with the economic and business functions of city development. Unsurprisingly, the domain contains the highest number of indicators. The 12 indicators monitor the DPSIR factors associated with the city's economic resources, such as human capital, skills, opportunities, and support.

5.2.1 Critical Mass Indicators

EC-01. Employment Opportunity Growth

Definition	This can be defined as the increase in the number of jobs per industry in a given time period. (Interview 5, personal communication, February 2023; The Bass Initiative, 2018)
Sources	Document 2, Interview 1, Interview 2, Interview 3, Document 3, Interview 4, Interview 5, Document 6, Interview 6, Document 7, Interview 7, Interview 8, Document 8, Interview 9
Rationale for incorporation	The sources from district and regional levels concur that the main goal of proposing an innovation district in Oslo was to foster a greater abundance of job opportunities across various business sectors. Moreover, all three innovation districts emphasize the potential of their respective areas to attract and retain a higher number of jobs in the future (Interview 6,

	personal communication, March 2023; Interview 7, personal communication, March 2023; Interview 9, personal communication, February 2023). The innovation districts therefore strive to expand job prospects not only within existing industries but also by introducing new employment opportunities that align with the values of existing industries in the area (Interview 6, personal communication, March 2023).

EC-02. *Distribution of Small, mid-size businesses and startups in the city*

Definition	The indicator refers to the clustering, dispersion, spread and co-location of small, mid-size businesses and startups (The Bass Initiative, 2018)
Sources	Document 2, Interview 2, Interview 3, Document 3, Document 4, Interview 4, Interview 5, Document 6, Interview 6, Field notes OSC, Document 7, Interview 7, Interview 8, Document 8, Interview 9
Rationale for incorporation	The implementers of the innovation district believe that small businesses, startups, and scale-ups would receive significant support if located within the district, through proximity to capital and potential knowledge exchange (Interview 3, personal communication, March 2023; Interview 6, personal communication, March 2023). The districts aim to encourage these actors to accelerate their development through interactions with knowledge institutions in the area (Oslo Kommune, 2018). However, an international expert on innovation-based development (Interview 2, personal communication, April 2023) and an employee in the OSC area (Interview 11, personal communication, May 2023) highlight the concern that developmental trends in the area may lead to unaffordability for small businesses, which often have limited capital, potentially causing them to prefer other locations. Therefore, the innovation district must closely monitor the location patterns of these startups to better understand if they are indeed attractive for smaller organizations too.

EC-03. *Proportion of Knowledge intensive businesses*

Definition	According to Eurostat, a business is classified as "knowledge-intensive" if at least 33 percent of its workforce has higher education qualifications

	(Eurostat as cited in Lars Petter Ber, 2016). The indicator refers to the percentage of businesses that are knowledge intensive in nature. (Anne T & Bass, 2018; Interview 5, personal communication, February 2023; The Business of Cities, 2022)
Sources	Document 3, Document 5, Interview 5, Document 6, Document 7, Interview 8, Document 8
Rationale for incorporation	As per the Campus Oslo Strategy, the innovation districts aim to attract a significant number of knowledge-intensive and R&D-related businesses to the area, with the goal of creating a dense network of actors who can foster innovation through collaboration. An informant of OSC, (Interview 8, personal communication, March 2023) further suggests that these businesses should align with the knowledge priorities identified by the innovation districts, which can further enhance the skills development of the local population through internships, joint research projects, and other initiatives (Interview 11, personal communication, May 2023; The Bass Initiative, 2018). It is therefore important for the districts to establish a target for this indicator and monitor it to ensure the presence of a sufficient proportion of knowledge-intensive businesses in the area.

5.2.2 Innovation Capacity Indicators

EC-04 Digitization of the Innovation Districts

Definition	Digitization of innovation districts involves incorporating digital technologies and infrastructure to existing and new operations, to foster collaboration and improve the overall efficiency of processes (Interview 1, personal communication, April 2023; UN Habitat, 2022).
Sources	Document 1, Interview 1, Document 5, Document 6, Document 7, Document 8
Rationale for incorporation	The interviews and strategies highlight digitization as a key focus of innovation districts. The importance of digitization from the focus of international competitiveness was highlighted by The Business of Cities (2022), who emphasized that digital infrastructure is as important as physical infrastructure in the districts. HSO (Interview 6, personal

	communication, March 2023) exemplifies this with reference to improving the efficiency of manufacturing and construction work in the area through technology and digitization. In this regard, OSC (A-Lab, 2021) also highlights "digitization" as one of its priorities, as the process is increasingly influential in the science and applied research that its anchor institutions engage in. Similar patterns were identified in Punkt Oslo (PWC & Svale, 2020), which recommends an overall digital landscape in the area, including access to Wi-Fi, digital booking systems for office spaces and other digital tools for interaction. While concerns exist regarding the potential inequality and spatial segregation (Interview 2, personal communication, April 2023; Interview 11, personal communication, May 2023) caused by concentrating digitization efforts in innovation districts, an informant of Punkt Oslo (Interview 9, personal communication, February 2023 said that innovation districts can serve as testing grounds for digitization initiatives before implementing them citywide.

EC-05 Connections between Industry and Anchors

Definition	This indicator can be defined by the number and quality of networks and connections created by the innovation district among its industry actors and between industry and knowledge actors.
Sources	Document 2, Interview 2, Interview 3, Document 3, Document 4, Document 5, Interview 4, Document 6, Document 7, Interview 7, Interview 8, Document 8, Interview 10, Interview 11, Interview 12
Rationale for incorporation	The main ambition of innovation districts is to foster collaborations between business/industry groups and local knowledge anchors, driving the city's economic growth. As stated by a local authority representative (Interview 4, personal communication, April 2023): *"I think cooperation is the main point….Using each other's resources is extremely important because resources are scarce."* Several sources envision that this collaboration will empower existing academic communities to develop new knowledge that can be disseminated to benefit society (A-Lab, 2021; Interview 9, personal communication,

February 2023; PWC & Svale, 2020). Furthermore, by bringing together industry and knowledge actors, the innovation districts provide a platform where networks can be built, that can further facilitate knowledge sharing, project partnerships, internships, etc. (Interview 5, personal communication, February 2023). Oslo Science City being the oldest innovation district in the city has already organized many match-making events, that according to an informant (Interview 7, personal communication, March 2023) was successful in bringing together and connecting its participants.

EC-06 Research and Development Activities

Definition	The indicator reflects efforts and progress in commercializing knowledge assets. It includes the number of research and development activities that have received funding, and the number of research that were published, and the number of research commercialized.
Sources	Document 1, Interview 1, Interview 2, Interview 3, Document 3, Document 4, Interview 4, Interview 5, Document 6, Document 7, Interview 7, Interview 8, Document 8, Interview 9
Rationale for incorporation	The data sources highlight that mobilizing research and development activities can further influence the increase in employment opportunities, facilitate technological advancements, and result in an overall stable economy, that is resilient to future shocks. In this regard, a politician (Interview 3, personal communication, March 2023) explains that the existing conglomeration of research institutes in Oslo gives the city a regional advantage in the knowledge sector. The politician further adds that despite this, the sector seldom plays a significant role in contributing to innovation in businesses today. This was further elaborated by an informant (Interview 8, personal communication, March 2023) who explained that despite being rich in wealth, the city has faced troubles connecting capital to research and start-ups, which makes innovation districts an important strategic project for the city. Through innovation

	districts, funds can be directed towards research work, and the further commercialization of results (Oslo Kommune, 2018).

EC-07. Annual Growth Rate of GDP per Capita

Definition	The indicator was derived from the UMF, which defines it as "the sum of the gross value added (wages plus business surplus plus taxes less imports), or the total final demand (consumption plus investment plus exports), relative to the city's total population". (UN Habitat, 2022, p. 93)
Sources	Document 1, Interview 3, Document 4. Interview 6, Interview 8
Rationale for incorporation	Being centered around building economic resilience and sustainability in Oslo, the success of the innovation district relies on its ability to ultimately boost the city's GDP per capita. Although no direct references for "GDP" were found in the district level and regional data sources used for this research, the sources were in consensus that innovation districts should enhance the city's competitiveness on an international scale through increased value creation (Interview 4, personal communication, April 2023; Interview 6, personal communication, March 2023; Oslo Kommune, 2020 This idea was comparable with UMF's indicator on GDP growth rate.

5.2.3 Diversity and Inclusion Indicators

EC-08. Unemployment Rate

Definition	The indicator denotes the percentage of population that is unemployed, investigated against demographic categories, such as age, background, education level, etc (The Bass Initiative, 2018; UN Habitat, 2022).
Sources	Document 1, Document 2, Interview 3, Document 3, Interview 4, Interview 5, Interview 8
Rationale for incorporation	Job growth is a primary success attribute of innovation districts, as described in indicator EC-01. However, a local politician (Interview 3, personal communication, March 2023) stresses the idea that the city's innovation districts will not just provide jobs for the 'knowledge-elite', but for a wide range of people, with different educational backgrounds. It then

	becomes necessary to map out employment, not just from the perspective of success in being employed, but also from the perspective of those who remain unemployed.

EC-09. *Wealth Distribution and Mean Household Income*

Definition	The indicator maps the income distribution in different parts of the city, and the compares mean household income within the innovation district, against city level mean.
Sources	Document 1, Document 2, Interview 2, Interview 3
Rationale for incorporation	Despite the focus of Oslo's local authorities to promote social equality through and within innovation districts (Interview 4, personal communication, April 2023) the improvement of local infrastructure, driven by capital intents of local business groups can result in gentrification (Interview 2, personal communication, April 2023). A resident of HSO (Interview 10, personal communication, May 2023, p. 1) explains that the already ensued urban regeneration around HSO, and the anticipation for further development has resulted in skyrocketing real estate values. In contrast, the local politician (Interview 3, personal communication, March 2023) stresses that the objective is to ensure that the space is affordable and accessible to the "ordinary citizen". The indicator that would monitor this aspect must map the income distribution within the innovation districts, and around the city, to understand what income groups can actually afford to live in the innovation district. The UMF also recommends monitoring income distribution through the Gini Coefficient, which measures "the extent to which the distribution of income (or consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution" The World Bank as cities in UN Habitat, 2022, p. 81)

EC-10. *Suitability for Start-Ups and small-scale businesses*

Definition	This can be studied qualitatively by the policies and support available for small scale businesses to establish their base in the innovation districts.

	From a more result-oriented perspective, the indicator shows growth in the number of new businesses, start-ups, scaleups, number of unicorns, etc. (Interview 2, personal communication, April 2023; The Bass Initiative, 2018)
Sources	Document 1, Document 2, Interview 2, Interview 3, Document 3, Document 4, Document 5, Interview 4, Document 6, Interview 6, Document 7, Document 8, Interview 9
Rationale for incorporation	Oslo aims to promote entrepreneurship in the city through access to critical expertise, networks and capital (Oslo Kommune, 2018). Moreover, A-lab (2021) elaborates that OSC intends to facilitate arenas and meeting places where investors can access knowledge communities, and thereby support the growth of startups and small businesses. The interview with informants from Punkt Oslo and HSO also clarified their visions to support start-ups in their respective districts, much like OSC (Interview 6, personal communication, March 2023; Interview 9, personal communication, February 2023). This indicator therefore investigates if the innovation districts are truly the small business/start-up friendly urban areas they intend to be.

5.2.4 Leadership Indicators

In the context of Oslo, the fieldwork showed that the innovation districts do not intend to lead economic sustainability but are more the mediators of the growth. This has been explained by an innovation district stakeholder (Interview 8, personal communication, March 2023), who compares innovation districts to a dance floor:

"We could construct the dance floor, but people need to dance themselves".

No indicators pertaining to the leadership aspect of economic sustainability were identified.

5.2.5 Quality of Place Indicators

EC-11. Affordability of Real Estate

Definition	This indicator compares the value of real estate within the innovation district against the city median.

Sources	Document 2, Interview 2, Interview 4, Document 7, Document 8, Interview 11
Rationale for incorporation	The rationale here is also rooted in the potential impact of unaffordability and gentrification as previously discussed. The rise in real estate value can render the district unaffordable for start-ups and small businesses, leading to the displacement of current residents and an influx of higher-income groups. This contradicts the vision of innovation districts as inclusive spaces that cater to the needs of the general population, rather than being driven by the elites.

EC-12. Innovation District as a test arena

Definition	This indicator investigates the extent to which the innovation districts have been used as test arena in the city. It may be measured by the number of innovations or ideas that were tested in the districts in a given time period.
Sources	Interview 3, Document 3, Interview 4, Document 6, Interview 6, Document 7, Interview 7, Document 8, Interview 9
Rationale for incorporation	According to Punkt Oslo's needs assessment (PWC & Svale, 2020), one way that the innovation district supports entrepreneurs, is by serving as test arenas for their innovations. HSO also shares a similar aspiration to act as a demonstration arena for circular solutions (Hovinbyen Sirkulære Oslo, 2023). OSC specifically aims to implement the concept of a test arena by enabling the sharing of test facilities and laboratories in its anchor institutions (A-Lab, 2021). While an informant of Punkt Oslo (Interview 9, personal communication, February 2023) acknowledges that being a test arena is just one of the many functions that the innovation districts aim to facilitate, the informant also highlights its potential to address city challenges by first testing the feasibility of solutions in a smaller geographical context. Hence, it has been proposed as an indicator to urban sustainability.

5.3 Domain 3: Environment

Creating an economy that propels the city's transition to a greener way of life is one of the intended objectives of the innovation district (Oslo Kommune, 2018). The three innovation districts have their individual ways of contributing to this green shift. HSO can be attributed as the most aligned with environmental sustainability, with its main vision being to establish a culture of circular economy within the district. OSC, in its feasibility study, lists emission-free transport and environmental research as its proposed contributions to environmental sustainability. Punkt Oslo aims to contribute to the climate goals by acting as a testbed innovation (Interview 9, personal communication, February 2023). The indicator identification methodology identifies eight urban-environmental indicators listed as follows:

5.3.1 Critical Mass Indicators

EN-01. Greenhouse gas emissions

Definition	UMF defines this indicator as the "Total greenhouse gas emissions per year per capita" (UN Habitat, 2022, p. 148).
Sources	Document 1, Document 4, Document 6, Interview 6, Field notes OSC, Field notes PO, Interview 11
Rationale for incorporation	The local politician who was interviewed (Interview 3, personal communication, March 2023) believes that innovation districts play a crucial role in the city's efforts to achieve the goals of the Paris Agreement. Construction activities contribute to a significant percentage of global emissions responsible for global warming. Considering the numerous new buildings planned for the HSO and OSC, an urban planner (Interview 11, personal communication, May 2023) therefore suggests focusing on reducing emissions from building construction. In this regard, an informant of HSO (Interview 6, personal communication, March 2023) emphasizes the importance of circularity and emission reduction in the construction sector as key objectives of the innovation district. Although OSC's feasibility study (A-Lab, 2021) does not explicitly discuss emissions in relation to its new construction projects, the district aims for zero-emission transportation and conducts research on carbon emissions through its member institutions. Additionally, an OSC informant (Interview 7,

	personal communication, March 2023, p. 1) clarifies that its members regularly assess their emissions, thereby demonstrating a commitment to emission monitoring and reduction. While Punkt Oslo does not directly address emission reduction, its needs assessment (PWC & Svale, 2020) suggests repurposing of old buildings. An informant of Punkt Oslo (Interview 9, personal communication, February 2023) also mentions that the district will facilitate the testing of solutions that have the potential to reduce emissions in the future.

EN-02 Renewable Energy Share

Definition	This indicator has been defined by the UMF, as the "Renewable energy share in the total final energy consumption" (UN Habitat, 2022, p. 138).
Sources	Document 1, Interview 2, Interview 3, Document 3, Document 4, Document 5, Document 6, Interview 6, Document 7, Interview 11, Interview 12
Rationale for incorporation	In Norway, 98% of the electricity produced comes from hydropower, a renewable energy source (Regjeringen, 2016). Despite this, an expert on innovation-based development (Interview 2, personal communication, April 2023) recommends the adoption of other renewable energy technologies, such as solar power. He adds that this should be a key strategy for innovation districts to contribute to reduced emissions from energy use. An informant from one of HSO's member organizations (Interview 12, personal communication, March 2023) also asserts the need for this indicator, stating that renewable energy is beneficial for businesses, the climate, and reduces strain on the electricity grid. The informant further adds that HSO and other districts could potentially increase their share of renewable energy by using district heating for space heating. The city solely relies on electricity for heating during its cold winter months, and this is long overdue for a change. Lastly, an informant of Punkt Oslo (Interview 9, personal communication, February 2023) provides an example of its work on renewable energy: a floating solar panel project tested in the Oslo Fjord through the district. Renewable energy therefore

	forms an interesting part of the discourse around environmental sustainability in Oslo's innovation districts.

5.3.2 Innovation Capacity Indicators

EN-03. Research and Innovation that Contribute to Green Shift

Definition	The indicator can be defined as the of number studies conducted, number of research papers published, patents filed, innovative products tested each year in the field on environmental sustainability.
Sources	Interview 2, Interview 3, Document 4, Interview 5, Document 6, Document 7, Interview 8, Interview 12
Rationale for incorporation	A field expert (Interview 5, personal communication, February 2023) emphasizes that innovation districts are driven by the "green shift," aiming to transition Norwegian society towards a more sustainable economy. However, a local politician (Interview 3, personal communication, March 2023) highlights that such transitions necessitate new skills, technologies, and mindsets. Moreover, the green transition requires investments in sustainable energy solutions, decarbonization, and new industries. These goals can be achieved by enhancing research, developing technologies, and implementing strategies in the field of environmental sustainability.

EN-04 Waste Reduction, Reuse and Recycle

Definition	The indicator refers to the efforts and effectiveness of innovation districts in minimizing waste generation, promoting reuse of materials, and increasing recycling rates as part of their sustainability and circular economy goals.
Sources	Document 1, Document 4, Document 6, Interview 6, Document 7, Interview 12
Rationale for incorporation	The City's Planning Strategy (Oslo Kommune, 2020) emphasizes that waste disposal is a significant challenge in the city and highlights waste incineration as a major source of emissions on a regional level. This aspect holds particular importance for HSO, which already includes goals related

	to circular economy principles such as "reuse," "recycling," and "waste reduction" (Hovinbyen Sirkulære Oslo, 2023), and has several industries in the area that work on waste recycling (Interview 5, personal communication, February 2023). Furthermore, with the construction of new buildings in HSO bound to produce construction waste, an informant (Interview 6, personal communication, March 2023) suggests monitoring the "recycling rate" as a relevant indicator. Oslo Science City, as stated in its Feasibility Study (A-Lab, 2021), also acknowledges the need to minimize resource consumption through recycling and reuse, although specific strategies for achieving this goal are not outlined. Nevertheless, considering the regional focus on waste treatment, the innovation districts can track this indicator by encouraging their members to prioritize reduction, reuse, and recycling practices.

5.3.3 Diversity and Inclusion Indicators

EN-05 Education for Sustainable Development

Definition	This indicator is defined in the UMF as "Extent to which education for sustainable development is mainstreamed in (a) education policies; (b) curricula; (c) teacher education; and (d) student assessment". (UN Habitat, 2022, p. 136)
Sources	Document 1, Interview 3, Document 4, Document 6
Rationale for incorporation	A local politician (Interview 3, personal communication, March 2023) emphasizes the need for new skills, technology, and mindset to accelerate the transition to a zero-emission society. This need is even more highlighted with regards to achieving the indicator: "EN-03 Research and Innovation that Contribute to Green Shift" discussed previously. An expert on Oslo's Innovation Districts (Interview 5, personal communication, February 2023) recommends that educational frameworks must incorporate information on sustainable development, to equip the citizens with awareness and skills pertaining to the field. This could further contribute to research and innovation. Such knowledge dissemination may not just be in the form of formal education, but can also be through means

	like citizen engagement, workshops, etc. to reach the masses. Therefore, monitoring sustainability in education can be a way of advancing towards environmental sustainability.

5.3.4 Leadership Indicators

EN-06. Budget for Actions related Climate Change Mitigation

Definition	Adapted from the UMF (UN Habitat, 2022), the indicator assesses the allocation of budgets specifically for climate change mitigation and adaptation actions within the innovation district. The UMF also clarifies that mitigation actions aim to reduce greenhouse gas emissions. (p.155)
Sources	Document 1, Interview 3, Document 4, Document 6, Document 7
Rationale for incorporation	The local politician (Interview 3, personal communication, March 2023) explains that the process to transition to "green shift" would necessitate investments in new and sustainable energy solutions, decarbonization, and new strategies. The Planing Strategy of Oslo (Oslo Kommune, 2020) adds that the success of climate mitigation projects, such as emission-free waste treatment and CO_2 sequestration, depends on private actors identifying commercial prospects and receiving financial support from the government for CO_2 capture facilities. By establishing and expediting a specific budget for climate change mitigation, and the member organizations of innovation districts will be encouraged to actively integrate this objective into their strategies and processes.

5.3.5 Quality of Place Indicators

EN-07. Quality of Infrastructure of Sustainable Mobility

Definition	This indicator investigates the provision, adoption, and performance of sustainable mobility infrastructure in innovation districts, for better walkability, bicycle connections, and public transport use.

Sources	Document 2, Interview 3, Document 3, Document 4, Document 5, Interview 5, Document 6, Interview 6, Field notes HSO, Document 7, Field notes OSC, Field notes PO, Interview 11
Rationale for incorporation	The Campus Oslo Strategy (Oslo Kommune, 2018, pp. 51–63) prioritizes pedestrians, cyclists, and public transport in the innovation districts, to create an attractive location for businesses, while also reducing transport emissions. A field expert in Oslo's innovation districts (Interview 5, personal communication, February 2023) supports this, highlighting that modern workers prioritize proximity and connectivity to the city center over long car commutes to business parks in the suburbs. Additionally, the three innovation districts prioritize sustainable mobility options, such as attractive walking environments, improved biking connections, and efficient public transport in its future developments. While the site observations showed that OSC and PO already have a well-functioning sustainable mobility network, HSO's mobility network is heavily car centric. This indicator assesses the quality, efficiency, and user satisfaction of sustainable mobility options in and around the innovation district.

EN-08. *Efficient and Multi-functional Land-Use*

Definition	While the UMF defines this indicator as "the ratio of land consumption rate to population growth rate", it is much more broadly defined the context of Oslo's innovation districts. The indicator incorporates several purposes, including increasing building and development density, implementing mixed-use development, repurposing underutilized spaces, expanding residential opportunities, ensuring sufficient green areas per capita, enhancing connectivity to neighboring areas, and considering the aesthetic appeal of the district.
Sources	Document 1, Document 2, Interview 1, Interview 2, Interview 3, Document 3, Document 4, Document 5, Interview 4, Interview 5, Document 6, Interview 6, Field notes HSO, Document 7, Interview 8, Field notes OSC, Document 8, Interview 10, Interview 11, Interview 12

| Rationale for incorporation | Efficient land use is a crucial indicator in innovation districts, for both sustainable development and also to achieve district goals. The Campus Oslo Strategy - (Oslo Kommune, 2018, pp. 51–63) directs the three innovation districts to be developed as attractive and multi-functional urban areas, incorporating cultural, service, recreational, and residential offerings within a walking distance. Users prioritize this approach, particularly in HSO and OSC, where recreational activities are lacking. However, an informant of OSC (Interview 8, personal communication, March 2023) notes the existence of strong interests within the innovation district system that advocate for taller buildings and better utilization of space. An employee and planner based in the OSC area (Interview 11, personal communication, May 2023), on the other hand, expresses concerns that innovation districts could become a platform for interested business actors to renegotiate building heights in lieu of better real estate returns, an idea he strongly opposes. Given Oslo's northern location, he argues against high-rises in the city, as they would cast long shadows and result in less sunshine within the urban fabric during winter months.

While the specific definition of "efficient land use" may be determined by the city's land-use policy, a Punkt Oslo informant (Interview 9, personal communication, February 2023) believes that flexible policies within the context of innovation districts could facilitate experimentation with new solutions. Nevertheless, HSO (Hovinbyen Sirkulære Oslo, 2023) proposes a recommendation that could apply to all innovation districts:

"Prioritization of land use must not compromise the functionality of the urban area." |
|---|---|

EN-09. Access to Open Public Spaces

Definition	UMF defines the indicator as, "Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities" (SG 11.7.1 as cited in UN Habitat, 2022, p. 129). Additionally, the indicator also investigates the porosity of the first floor

	of building plinths in the district, its adjacent street environment as increased porous building plinths improves the district's urban life.
Sources	Document 1, Field notes HSO, Document 7, Field notes OSC, Document 8, Field notes PO.
Rationale for incorporation	All three innovation districts express the need for public spaces in the area, to make it inviting for both potential businesses, and also the city's population (A-Lab, 2021; Hovinbyen Sirkulære Oslo, 2023; PWC & Svale, 2020) Furthermore, good public spaces can act as good meeting spaces. An informant of HSO (Interview 6, personal communication, March 2023) also pointed out that street level interaction with building plinths is an important spatial indicator for the district, as it creates porosity between spaces and contributes to urban life betterment. In this regard, an employee/planner based in OSC (Interview 6, personal communication, March 2023) also supports the need for good public spaces in the innovation district as it can protect the area's "human scale", thereby improving the quality of the spaces.

5.4 Domain 4: Culture

The cultural domain is the least developed of the five sustainability domains. The analysis of this project's collected data sources showed that the concept of "culture" in the sense of heritage is not particularly a priority in Oslo's innovation district. However, culture is seen more in the sense of incorporating the identity of innovation districts into the mindsets of people. While HSO, OSC and Punkt Oslo do mention the provision of "cultural offerings" in their respective areas, a local innovation district expert (Interview 5, personal communication, February 2023) clarifies that these cultural offerings are more leisure oriented, in the form of theatre, music, concerts, etc. This has already been incorporated in indicator EN-08, "Efficient and Multi-functional Land-Use". Therefore, only three relevant indicators have been identified for the culture domain, as listed below:

5.4.1 Critical Mass Indicator

CU-1. Retention of Local Values and Culture

Definition	The indicator refers to the safeguarding and recognizing the importance of the unique characteristics and local identity that are rooted in and around the innovation districts.
Sources	Interview 1, Document 4, Interview 5, Interview 6, Interview 7, Interview 8, Interview 12
Rationale for incorporation	The Planning Strategy of Oslo (Oslo Kommune, 2020) emphasizes that long-term management of cultural and historic value in the city's development is important. In this context, an informant of OSC (Interview 7, personal communication, March 2023) highlights that Blindern, a neighborhood within the OSC area has a high cultural and conservational value. An analysis conducted by OSC however reveals that due to the area's potential for growth, it cannot be treated as a mere "museum". Instead, any future development in the area must be proposed in a way that it respect Blindern's cultural values. However, another informant of OSC (Interview 8, personal communication, March 2023 that the acknowledgement of cultural values has not translated into action in the district. The informant narrated the case of renaming a metro station in the OSC area from "forskingparken" (in Norwegian) to "Oslo Science City", to brand the district internationally. The action faced a lot of criticism regarding lack of sensitivity to local culture from the Language Council of Norway. Sentiments in favour of historic value preservation were also expressed in the HSO case, which intends to preserve the area's original identity: industrial establishments (Interview 6, personal communication, March 2023). A culmination of all these different discourses shows the relevance of including an indicator to investigate how local culture and value have been integrated in the development of innovation districts.

5.4.2 Innovation Capacity Indicator

CU-2. Integration of Innovation District Culture

Definition	The indicator refers to the effectiveness of innovation districts in being embedded in local identity.
Sources	Document 6, Document 8, Interview 7, Interview 9, Interview 10, Interview 11
Rationale for incorporation	An informant of Punkt Oslo (Interview 9, personal communication, February 2023) describes that the district aims to create a local identity, where citizens identify the area as one where the development, testing, and showcasing of cutting-edge innovation takes place. Additionally, the informant also emphasizes that cultivating an innovation culture involves upskilling citizens to further enable their contribution to innovation processes. A representative of the local authority (Interview 4, personal communication, April 2023) adds that reaching out to the masses is important. When people know that a development of this sort is happening, they are more likely to be inspired by it, benefit from it. In this regard, an informant from OSC, (Interview 7, personal communication, March 2023) acknowledges that active efforts have been made by OSC to disseminate information of its works to citizens, particularly students. However, a student at one of OSC's anchor institutes, (Interview 10, personal communication, May 2023, p. 1) admits to never having heard of the concept before the interview. An informant who is an employee at the same institute (Interview 11, personal communication, May 2023, p. 2), stumbled upon the planning strategy "by accident" and firmly believes that the district is not offering anything innovative from what already exists. Decision makers must therefore reflect on how to incorporate innovation districts, and what additional value it creates in existing urban systems.

5.4.3 Diversity and Inclusion Indicator

CU-3. Culture for Social Cohesion

Definition	The indicator has been adapted from UMF. It aggregates "Intercultural tolerance (Percentage of people who do not object to having a neighbour from another culture); Interpersonal trust (Percentage of people reporting that other people can be trusted)." Additionally, based on the primary data sources of the project, intercultural inclusion is also aggregated into this indicator. The UMF also recommends investigating "The perception of gender equality". (UN Habitat, 2022, p. 158)
Sources	Document 1, Interview 2, Document 3, Interview 5, Field notes HSO, Field notes OSC, Field notes PO
Rationale for incorporation	Campus Oslo (Oslo Kommune, 2018) proposes innovation districts to enhance the city's business attractiveness and attract more investment. Furthermore, if successful in generating employment opportunities for a diverse range of individuals from different backgrounds, innovation districts will bring in new demographics to the workforce (Interview 3, personal communication, March 2023). The Hovinbyen area, located in East Oslo, already has significant immigrant population (Wessel et al., 2018). An international expert (Interview 2, personal communication, April 2023) therefore highlights that innovation districts often involve urban regeneration projects that usually target areas with ethnic minorities, leading to gentrification, and subsequent displacement. He also recommends making effective outreach efforts to diverse groups, potentially providing information in multiple languages. Therefore, the impact of the districts on an intercultural, and interpersonal level should be assessed using the indicator.

5.4.4 Leadership Indicator

The indicator identified for "Leadership" is "Marketing and Identity Creation of Innovation Districts". However, this can also be assessed by Indicator "CU-2. Integration of Innovation District Culture". Therefore, a dedicated indicator has not been provided.

5.4.5 Quality of Space Indicator

No indicators specific for the cultural domain under quality of space were identified. While it can include attributes such as the number of leisure and cultural spaces, these elements can also be investigated as part of indicator EN-08, "Efficient and Multi-functional Land-Use.

5.5 Domain 5: Governance

The campus Oslo describes the three innovation districts as areas that can, over time, become multi-functional urban spaces, through "positive interactions between its actors". In other words, much of the functions of the district currently deal with mediation and coordination, which make the governance domain important. A total of 9 indicators were identified under this domain, and they mainly deal with the administrative and policy aspects of innovation districts.

5.5.1 Critical Mass Indicator

GO-1. Contribution and Ownership of Members

Definition	The indicator qualitatively assesses the engagement of member organizations of innovation district in terms of their contribution.
Sources	Interview 3, Document 3, Interview 4, Document 6. Interview 6, Interview 7, Document 8, Interview 11
Rationale for incorporation	The three innovation districts are membership organizations formed through partnerships between the private sector, public sector, and academia (Oslo Kommune, 2018). An informant of HSO (Interview 6, personal communication, March 2023) emphasizes that a member is expected to contribute both in terms of discussions and also through tangible organizational actions towards the district's development goals. However, an informant of Punkt Oslo (Interview 9, personal communication, February 2023) notes that the representatives from member organizations are often high-level executives who have limited time availability, with only one hour allocated every two months for meetings. This hastens the district's progress. The informant therefore suggests involving other employees within member organizations in decision making and actioning processes and encourages members to view innovation districts as integral parts of the entire city, not just their specific

	areas of interest. Therefore, the indicator recommends establishing contribution parameters for members, ensuring their active involvement based on other indicators mentioned in the research.

5.5.2 Innovation Capacity Indicator

GO-2. Short term wins

Definition	The indicator assesses the number and type of success stories achieved within a specific short time frame.
Sources	Interview 5, Document 6, Interview 6, Document 8
Rationale for incorporation	The innovation district is a long-term project that requires a longer time frame to measure its effects (Interview 8, personal communication, March 2023). However, this can lead to a loss of momentum, support, and interest from stakeholders. To address this, an expert on Oslo's innovation district (Interview 5, personal communication, February 2023) recommends short-term wins to keep stakeholders motivated. An HSO informant (Interview 6, personal communication, March 2023) proposes incremental action by breaking down the project's large scope into smaller, tangible projects to maintain momentum. In line with this, the Punk Oslo Needs Assessment (PWC & Svale, 2020) plans on implementing low-budget short-term (three-year) projects to assess their impact and build momentum. In addition to promoting momentum, and engaging stakeholders, the indicator also aims to study the effects of proposals short term, before investing in them for an uncertain long-term impact.

GO-3. Flexibility of Policy

Definition	This indicator refers to the ability of regional frameworks to adapt to and accommodate the requirements of the innovation districts, in a way that it also upholds city level sustainability goals.
Sources	Interview 2, Interview 4, Interview 6, Document 8, Interview 9, Interview 11

Rationale for incorporation	An informant from HSO (Interview 6, personal communication, March 2023) believes that innovation districts are meant to push boundaries and discover new ways to address urban challenges. However, the existing rules and regulations that govern these districts pose significant challenges in this regard. An informant from Punkt Oslo (Interview 9, personal communication, February 2023) addresses the issue too, while elaborating the struggles in spatially defining testing grounds for piloting innovations, due to the time-consuming bureaucratic processes involved. A planner based in the OSC area Interview 11, personal communication, May 2023) however, argues that while flexibility is important, it should not involve completely relinquishing development rights to the developers in these districts, who are often members representing the private sector. This may lead to prioritizing profits over social benefits. Nevertheless, the employee concurs that the city should remain open to innovation by allowing for controlled experiments while maintaining a level of strictness. The indicator therefore doesn't advocate for a complete autonomy of policies, but rather throws light on the importance of finding a balance between the district's goals and the broader objectives pertaining to city level sustainability.

GO-4. Utilization of E-Governance and Digital Governance Tools

Definition	Adapted from the UMF, the indicator refers to the integration of Information and Communication Technologies (ICTs) in governance networks and sharing of public information, to facilitate efficiency, accountability and inclusivity (UN Habitat, 2022, p. 186).
Sources	Document 1, Interview 1, Interview 2, Document 4, Document 5, Document 6, Interview 6, Document 8
Rationale for incorporation	The lack of transparency in governance and decision-making within Oslo Science City has been heavily criticized and has even led to the project's delegitimization (Interview 8, personal communication, March 2023; Interview 11, personal communication, May 2023). An informant of OSC (Interview 8, personal communication, March 2023) further elaborates that

79	the innovation district has failed to effectively showcase its benefits for the city. While most of the criticism is directed towards Oslo Science City, this can be attributed to the fact that it was established much earlier than HSO and Punkt Oslo, which are still developing its strategies. It is therefore crucial for innovation districts, as publicly funded projects, to ensure accessibility of information and the opportunity for feedback (Interview 5, personal communication, February 2023). By implementing digital solutions, the processes can become more efficient (Oslo Kommune, 2020 and effectively disseminate information to citizens, businesses, and other stakeholders (UN Habitat, 2022).

5.5.3 Diversity and Inclusion Indicator

GO-5. Direct Participation Structure of Civil Society and Public in Planning

Definition	The indicator has been adopted from UMF and investigates the involvement of civil society and citizens in planning, management, decision making and the involvement of citizens in innovation district. As described in the UMF a Civil Society encompasses various entities such as non-governmental organizations, local community groups, organizations based within communities, groups that represent specific regions, labor unions, research institutes, think tanks, professional associations, non-profit sports and cultural organizations, as well as any other groups that advocate for the needs and desires of their members and the broader community. The indicator involves both the participation of the civil society, and public engagement in innovation district processes.
Sources	Document 1, Document 2, Interview 2, Interview 3, Document 3, Document 4, Document 5, Interview 4, Interview 5, Document 6, Interview 6, Document 7, Interview 7, Interview 8, Document 8, Interview 9, Interview 11
Rationale for incorporation	The strategy documents of the innovation districts: Campus Oslo, Feasibility Study of OSC, and the Needs assessment of Punkt Oslo were developed with the participation of public, private and academic actors (A-Lab, 2021; Oslo Kommune, 2018; PWC & Svale, 2020). Despite this, an

	informant of OSC (Interview 8, personal communication, March 2023) argues that Oslo Science City has not been successful in involving trade unions, citizens, students, and even the ordinary employees who are all supposed to be the main beneficiaries of the district. The informant further explains that while some engagement with students has taken place during the project's feasibility study, it has been more along the lines of informing rather than truly incorporating their ideas. In contrast, another informant who is directly involved in OSC implementation (Interview 7, personal communication, March 2023) explains that the district's current actions look at how to engage with students and the local population. Moreover, there are only four members who run OSC, and they want its steps to be well-informed, well-defined, and concrete, which takes time.
	In the case of Punkt Oslo, decisions are made based on the opinions of its members, with academia holding a large chunk of representation. Citizen engagement, when involved, is mainly in the form of testing the innovation process. (Interview 9, personal communication, February 2023)
	An expert in Oslo's innovation districts (Interview 5, personal communication, February 2023) explains that the involvement of citizens in urban development activities is mandatory according to national regulations. The UMF (UN Habitat, 2022) explains that civil society and public participation bring forth positive communication between the local authority and the public. This, in turn, helps in solving problems that are important to society, avoiding the allocation of resources to activities that may have a negative impact on society. Therefore, the indicator stresses the participation of residents, students, employees in the innovation district processes to ensure resources are allocated to real issues identified by the masses.

GO-6. Legal Framework for Equality

Definition	This indicator investigates the implementation and monitoring of legal frameworks and programs that enforce equality in terms of gender, race, and socio-economic class.

Sources	Document 1, Document 2, Interview 2, Interview 11, Document 8
Rationale for incorporation	The stakeholders interviewed (Interview 3, personal communication, March 2023; Interview 4, personal communication, April 2023) express the desire for the city's innovation districts to be inclusive and offer opportunities to a large group of people. The three innovation districts also profess values related to inclusion and social wellbeing in their missions (A-Lab, 2021; Hovinbyen Sirkulære Oslo, 2023; PWC & Svale, 2020). However, the business centered nature of the very concept of innovation districts can result in issues like societal seclusion, gentrification, that further exacerbates existing inequality (Interview 2, personal communication, April 2023; Interview 11, personal communication, May 2023, p. 2). In this regard, legal frameworks and programs that promote, enforce and monitor equality are recommended. (The Bass Initiative, 2018; UN Habitat, 2022)

5.5.4 Leadership Indicator

GO-7. Efficiency in Urban Governance

Definition	The indicator investigates the availability of a framework to efficiently coordinate the governance of innovation districts.
Sources	Document 1, Document 2, Interview 2, Interview 3, Document 3, Document 5, Interview 4, Interview 5, Document 6, Interview 6, Document 7, Interview 7, Interview 8, Document 8, Interview 9, Interview 11
Rationale for incorporation	The three innovation districts function as separate entities, governing frameworks within their respective geographical boundaries (Interview 4, personal communication, April 2023). These districts identify themselves as public-private-academic partnerships, where the municipality holds an equal membership position in the steering committee of all three districts. Additionally, an informant of OSC (Interview 8, personal communication, March 2023) notes that while the municipality holds a formal decision-making role within the partnership, they maintain impartiality and exercise caution in terms of the depth of their involvement.

	The expert on Oslo's innovation districts (Interview 5, personal communication, February 2023) elaborates on the governance process, elaborating that the three districts primarily operate in siloes, which makes sense given their specific area-focused challenges. Even then, they also share common goals, ideas, and processes, which would benefit from increased collaboration. Therefore, an informant of Punkt Oslo (Interview 9, personal communication, February 2023) believes that the municipality must play a more active role in leading the collaboration. However, such integration may present challenges and could be seen as imposing limitations on the districts (Interview 6, personal communication, March 2023). Nonetheless, an international expert (Interview 2, personal communication, April 2023) advocates for the need for a shared platform or a mediator, in addition to existing frameworks, where the districts' influence on the city can be viewed holistically.

GO-8. Clear Goal Setting

Definition	The indicator inspects the clear articulation of the goals and intended outcomes of the innovation district.
Sources	Document 2, Interview 2, Document 3, Interview 4, Interview 5, Interview 6, Document 7, Interview 7, Interview 8, Document 8, Interview 9, Interview 11, Interview 12
Rationale for incorporation	An informant representing Punkt Oslo (Interview 9, personal communication, February 2023) believes that the concept of innovation districts is still vague for decision makers and members, which slows down actions. The sentiment is shared by an employee based in the OSC area (Interview 11, personal communication, May 2023), who firmly believes there is nothing "innovative" in the "innovation districts" does not understand the objectives behind its implementation. Furthermore, one of OSCR's informants (Interview 8, personal communication, March 2023) describe much of the work done by the Oslo Science City as a marketing endeavor, aimed at highlighting the resources the area already has, and further building up on it. However, a field expert (Interview 5, personal

	communication, February 2023) points out that HSO's vision of a "circular economy" is clearer and better contextualized compared to the other two districts. This clarity enables them to effectively communicate their ambitions to the public and stakeholders who may not be familiar with the concept of innovation districts. In this context, the indicator of "Clear Goal Setting" becomes crucial to highlight the importance of establishing and communicating specific, well-defined intensions.

5.5.5 Quality of Space Indicator

GO-9. Coordination with Urban Development Strategies

Definition	This indicator investigates the incorporation of innovation districts in regional level plans proposed by local authorities.
Sources	Interview 3, Document 3, Interview 4, Document 6, Interview 6, Interview 7, Document 8, Interview 11
Rationale for incorporation	Campus Oslo (Oslo Kommune, 2018, pp. 51–63) emphasizes the municipality's desire to closely integrate the physical aspects of urban planning with the city's economic goals, to facilitate the co-location of relevant businesses near the identified knowledge environments. A local authority (Interview 4, personal communication, April 2023) observes that multiple departments within the municipality are involved in the planning of innovation districts, but the districts have a stronger connection with the department of industry and ownership, which focuses on Oslo's business environment as a whole (Interview 6, personal communication, March 2023; Interview 9, personal communication, February 2023). The districts try to influence urban development strategies by sharing recommendations for their respective areas with the planning department. Their latest input includes suggestions for the upcoming city masterplan, which is scheduled for public review in 2023. Many informants expressed eagerness to see how the innovation districts have been incorporated into Oslo's urban fabric in the masterplan that is scheduled for release in 2023 (Interview 3, personal communication, March 2023; Interview 5, personal communication, February 2023). The indicator therefore reflects on the urban development

	coordination frameworks, that embed innovation districts into the city's plans.

The analytical process, informed by the theoretical framework, guided the accomplishment of the thesis objective: To propose an Urban Indicator set for the urban monitoring of Oslo's innovation districts. It further identified several patterns and discrepancies, which were used as discourses to strengthen rationale behind selection of each indicator. These trends also pave way for a reflection on what sustainability means for Oslo's innovation districts: holistically, and at different spheres of influence. Moreover, it also begs the question of the role of innovation districts as urban planning strategies, to action the sustainability indicators identified through this thesis. Lastly, as discussed in Chapter 2 on theoretical frameworks, the process of USI identification only marks the beginning of urban monitoring processes.

The following chapter therefore discusses the results through the three research questions that this project was introduced with, and the trends that emerged during the process of developing the results, to further reflect on what it means, and how it can be used.

6 Discussion and Conclusion

This thesis originated with the intent to identify Urban Sustainability Indicators for Oslo's innovation district. It proposed to answer three research questions that would further concretize the mentioned objective:

1. What's the most suitable methodology to identify Urban Sustainability Indicators for Oslo's innovation districts in a way that it is integrates the different perspectives that influence it?
2. How could the identified urban indicators be applied?
3. What are the different urban indicator trends for innovation districts and their wider implications for sustainable urban development?

The proposed Urban Sustainability Indicator set for Oslo's innovation districts consists of 40 comprehensive indicators that are based on Oslo's unique characteristics, challenges, impacts, and objectives related to innovation districts. It is important to note that this indicator set is not the final destination but rather the beginning of a continuous journey toward advancing the sustainability of Oslo's innovation districts through monitoring processes. The research questions outlined earlier played a crucial role in guiding the development process of these indicators, resulting in comprehensive findings. Additionally, the final indicator set prompted further reflection on the research questions, expanding their scope beyond the confines of Oslo's context.

Upon retrospectively examining the entire process, several patterns and trends emerged, which are significant for strengthening the concept of sustainability in innovation districts in Oslo. These patterns also align with the theoretical foundations upon which Oslo's three districts were established.

This section therefore aims to address the three research questions by providing answers and reflecting on the implications of these answers. It seeks to highlight the most notable insights gained throughout the entire process. Additionally, it is important to acknowledge that the process encountered challenges and limitations, which will be briefly discussed. These limitations and discussions will then inform future research work.

6.1 What's the most suitable methodology to identify Urban Sustainability Indicators for Oslo's innovation districts in a way that it integrates the different perspectives that influence it?

The exploratory nature of this study revealed that innovation districts in Oslo operated as autonomous entities owned by the local authority. While inspired by international developmental contexts, these districts functioned in accordance with local policies, political objectives, decisions of its respective board members, and other local planning strategies. Consequently, the chosen methodology aimed to consider the influence of these diverse sources when studying innovation districts at a city level. The methodology was hence developed after extensive examination of the context of Oslo and relevant theoretical frameworks. This research question on 'What' the most suitable methodology is has been answered already in Chapter 4. This section therefore reflects on the suitability of this methodology not only with respect to its application to the context of this study but also to other planning strategies for indicator identification.

6.1.1 Retrospective reflection of the methodology

The USI identification framework design drew inspiration from the work of Bardal et al., (2021), discussed in the previous chapters, where the challenges of implementing sustainability and SDG frameworks at the local level in Norway were highlighted. These challenges included a lack of tools, expertise, and contextual relevance. In response, the proposed USI identification framework offers a flexible and robust approach that allows for the localization of international frameworks to suit local contexts. By doing so, it addresses both the national pressure for SDG incorporation and the local concerns of relevance and expertise.

Upon reflection of the methodology implemented during the thesis, it became evident that the very process of indicator identification fostered dialogue and a reflective engagement with stakeholders regarding the systems in Oslo's innovation districts. For example, in an interview with an informant of Punkt Oslo (Interview 9, personal communication, February 2023), the importance of citizen engagement for social inclusion in innovation districts and urban planning was emphasized, aligning with the considerations for civil participation that has been suggested by UN Habitat (2022) and The Bass Initiative (2018). The informant highlighted the current indirect methods of citizen engagement and reflected on the need to explore more direct ways of engaging with citizens going further. Similar moments of reflection occurred during many other stakeholder interviews too. Furthermore, the process also unveiled the sharing of

some controversial information and challenges that informants would not have expressed in a public setting.

These findings suggest that while monitoring processes provide a formal assessment of progress, the methodological process of indicator identification is equally crucial as it fosters dialogue and reflection. Furthermore, it is worth noting that while stakeholder interviews conducted on a one-on-one basis facilitated dialogues between the interviewee and respondent, focus group discussions held at Svale AS for the validation of site observations revealed the benefits of group discussions, which promoted broader dialogue, reflection, and peer-based learning. Therefore, a combination of both one-on-one interviews and focus group discussions is recommended to capture a comprehensive range of perspectives.

It can be argued that the methodology employed in this project itself could potentially facilitate the achievement of identified USIs, such as governance indicators like GO-07 (Efficiency in Urban Governance) and GO-08 (Clear Goal Setting). The rationale for the inclusion of GO-7 as an indicator is that while the need for a common platform is acknowledged by innovation districts with the municipality being the coordinating entity, the concern regarding loss of autonomy and a feeling of imposition on being governed by the local authority was raised.

Nonetheless, it is interesting to reflect on whether monitoring and indicator identification could be this common platform, that sets a "common framework for action" (Interview 11, personal communication, May 2023, p. 2), while simultaneously allowing autonomy. By employing the suggested method and setting common goals through dialogues, district-level indicators can be incorporated in a manner that aligns with city level objectives and conforms to national-level directives for SDG incorporation. This approach further enables the local authorities to establish a framework that promotes sustainable development through innovation districts, with the conformity being determined by the districts themselves. Consequently, this framework facilitates clearer goal mediation (GO-7).

6.1.2 Adaptability of the methodology

The methodology employed to identify Urban Sustainability Indicators (USIs) in Oslo's innovation districts can be readily replicated to identify USIs for other planning strategies. This can be achieved by substituting the data sources used for Oslo's innovation districts with the narratives and strategies relevant to the planning strategy under consideration. What allows for this flexibility is the fact that the framework was built around more general planning, monitoring and indicator theories, which hold true for many contexts pertaining to

sustainability. This flexibility offered by the process in localizing indicators makes the context of Oslo's innovation districts merely an exemplification of its implementation.

An ideal method for indicator identification is suggested to be qualitatively designed to promote dialogue and deepen understanding of existing and missing attributes in urban planning strategies. The qualitative nature of the methodology allows for simplicity, and makes it easy to be replicated by resources with minimal technical background.

6.2 How could the identified urban indicators be applied?

Now that the research has defined Urban Sustainability Indicators for monitoring innovation districts at the regional context of Oslo, the next steps include defining a data collection/measurement technique, weighing the indicators, and assigning targets as recommended by Tanguay et al. (2010). The recommendations below are an account of key learnings and suggestions by the author based on how the USIs proposed can be further developed and made use of for monitoring processes. The suggestions are informed by an exploration of the theoretical frameworks of section 2.3.3 over the different identified indicators conducted during the project work, with some recommendations by the domain experts who were interviewed, and also the author's professional experiences from her role at Svale AS.

The data collection process for the defined indicators depends on what data best assesses and monitors the indicator in question. For example, to monitor EC-09 (Wealth Distribution and Mean Household Income), two kinds of data can be identified. Firstly, the income average of residents within the innovation district, and the average of the city as a whole. Secondly, the income distribution of residents is mapped based on their work/residential locations. Once the kind of data needed to assess the indicator has been decided, the next question would entail the identification of where this data could be acquired or collected from. In the Norwegian context, an advantage for data collection lies in the fact that much of such urban information is open source and can easily be obtained from sources like Statistics Norway (Statistics Norway, n.d.). Furthermore, quantitatively measured, the indicators are numerical in nature and allow for a comparison of results. Qualitative measurements for this indicator may be performed to surveys, focus group discussions, etc, if needed.

The identification of measurement and data collection techniques should involve local data experts to identify the right source of data for a certain indicator and relevant district-level and regional-level stakeholders who can come to a consensus on the sub-priorities for each

indicator. The selection of such sub-priorities can be done by reflecting on the following questions, as suggested by an expert on Innovation Based Urban Development, (Interview 2, personal communication, April 2023):

"What is happening with respect to the specific indicator? Are they effective? What can make them more effective? What kind of technology might make some of those processes more effective? Is there any innovation needed and what kind?"

Since many of the indicators have been adapted from UN Habitat (2022) or The Bass Initiative(2018), these documents can also be referred to for suggestions on measurement techniques for the corresponding indicators. An expert on SDG11 and Urban Monitoring, (Interview 1, personal communication, April 2023), further explains that if the measurement is qualitative in nature, the result can be displayed as key messaging, where key points are extracted from the discussions and studied.

The next step is weighing and target setting as described in Chapter 2, Section 2.3.3. A diverse range of stakeholders associated with the innovation districts and local experts adept at urban monitoring may be brought together to decide on the best way to weigh the indicators based on their importance for the development of the district. Alternatively, the indicators may also be weighed equally if they are deemed equally important (Gan et al., 2017). The target setting process will involve defining a baseline or target on how the indicator should perform. Once the indicator has been monitored, it can be compared to this target to determine if it has performed poorly, as per the defined target, or better than the defined target.

Lastly, the evaluating body may also decide on the best way to visualize and report the USIs. In this regard, an expert on SDG11 and Urban Monitoring (Interview 1, personal communication, April 2023) , recommends using maps where data is spatially disaggregated to observe spatial inequalities within urban settlements. If the data is disaggregated by other categories, such as gender-based income disaggregation, the interviewee recommends using charts. Furthermore, a dashboard approach, where the data is hosted somewhere, could allow for knowledge sharing and dissemination among stakeholders and citizens. Additionally, using bivariate choropleth maps for measuring indicators that compare different phenomena, such as Indicator SO:01 - Distribution of Employees and Residents, which compares housing density with workplace/employment density (Interview 12, personal communication, March 2023, p. 2) may also be explored. This way, the proposed USIs are recommended to be used further for monitoring Oslo's three innovation districts on a regional scale.

6.3 What are the different urban indicator trends for innovation districts and their wider implications for sustainable urban development?

The Urban Sustainability Indicator process successfully identified 40 indicators that are relevant to assessing urban sustainability in Oslo's innovation districts. When considering the five sustainability domains proposed by UN Habitat(2022), it was found that the highest number of indicators identified was for the economic domain, totaling 12, followed by the governance and environmental domains, each with nine indicators. In contrast, the cultural domain displayed the fewest indicators, with only three identified. Moreover, upon analyzing the indicators in relation to the innovation district domains, it was observed that innovation capacity had the highest number of indicators, amounting to 11, followed by diversity & inclusion with nine indicators, and critical mass with eight indicators. The number of indicators across the different domains have been visually represented in Figure 15.

6.3.1 Implications of indicator distribution across different domains

Through the utilization of the "Urban Sustainability Indicator matrix," it becomes apparent that these indicators are more complex than can be strictly categorized within a single domain. An indicator that primarily impacts the economic domain may also have significant social implications. It was seen that interdependencies among indicators are effectively highlighted by the matrix. For example, consider the indicator EC-08: Unemployment Rate. While this indicator is primarily associated with the economic sustainability domain, as classified in the UMF(UN Habitat, 2022), it also possesses profound social implications, potentially indicating resource disparities, issues with general wellbeing and exacerbating demographic inequalities (ibid). The matrix adeptly identifies and visualizes these interrelationships among indicators.

This comparative analysis validates the theoretical assumptions that innovation districts are deeply intertwined with economic sustainability, as many indicators were identified in both domains. In terms of social sustainability discourses in the districts, a pattern identified from the data sources: that although social well-being is important in Oslo's context, it is of greater significance that efforts are distributed to benefit a larger and more diverse group of people. This was also reflected in the indicator distribution. While the social sustainability domain had only seven indicators, the diversity and inclusion domain included more attributes, which could also be interpreted on the same lines.
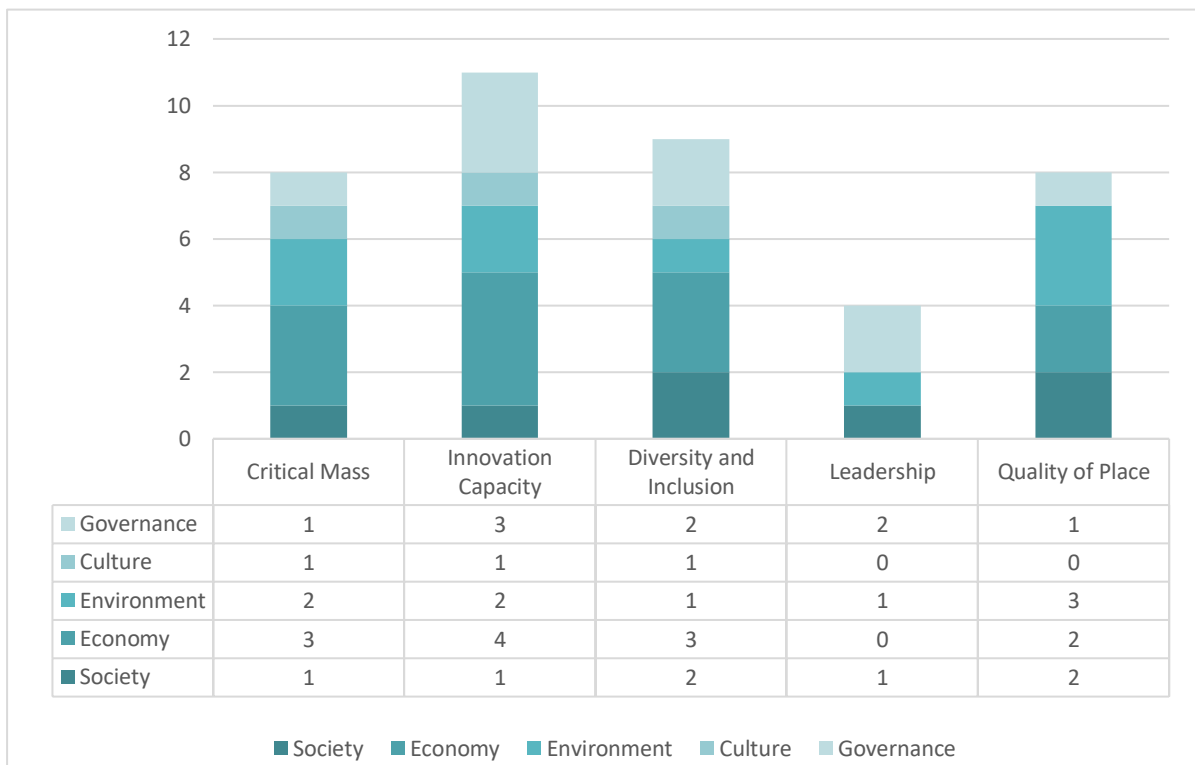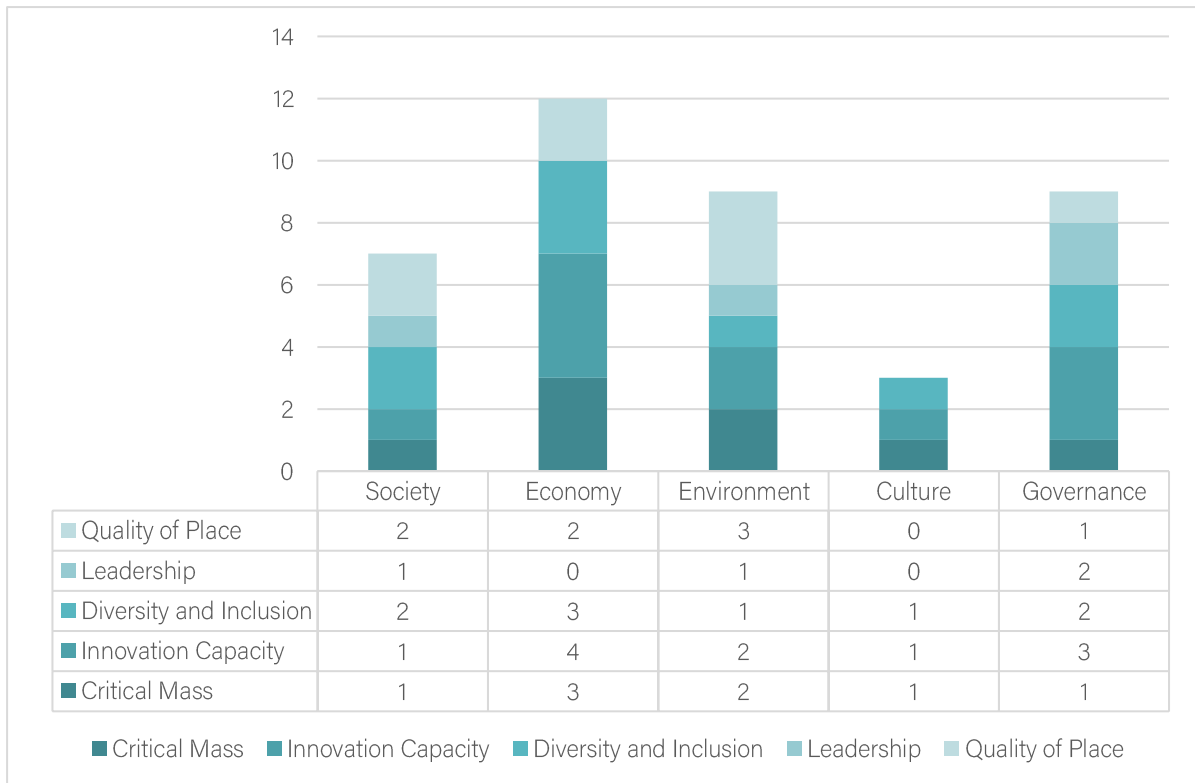
First chart data table:

	Society	Economy	Environment	Culture	Governance
Quality of Place	2	2	3	0	1
Leadership	1	0	1	0	2
Diversity and Inclusion	2	3	1	1	2
Innovation Capacity	1	4	2	1	3
Critical Mass	1	3	2	1	1

Critical Mass Innovation Capacity Diversity and Inclusion Leadership Quality of Place

Second chart data table:

	Critical Mass	Innovation Capacity	Diversity and Inclusion	Leadership	Quality of Place
Governance	1	3	2	2	1
Culture	1	1	1	0	0
Environment	2	2	1	1	3
Economy	3	4	3	0	2
Society	1	1	2	1	2

Society Economy Environment Culture Governance

Figure 15 Distribution of Urban Sustainability Indicators across different domains (Source: Author)

Similarly, while leadership had the least number of indicators in the innovation domain, the governance domain identified nine sustainability indicators. This too was in line with a pattern identified for the context of Oslo's innovation districts, in the data sources that were used for USI identification. The documents and the interviews addressed questions on governance/leadership in case context, in line with establishing a fair and transparent decision-making system (UN Habitat, 2022) as opposed to a strong organizational leadership (The Bass Initiative, 2018) to drive sustainability efforts. In other words, a governance-based approach of managing innovation districts was identified to be more important than organized leadership.

Nevertheless, it is important to note that a higher number of indicators within a specific category does not necessarily indicate a high level of performance within that domain. To recap, the selection of indicators was not solely based on the importance of achieving specific objectives for the innovation districts. Instead, it was informed by a comprehensive amalgamation of drivers, pressures, states, impacts, and responses (Carr et al., 2007) identified throughout the narratives, which were further aggregated within the components of the matrix. An additional analysis of indicators across different scales of influence revealed variations in opinions and trends, highlighting the dynamic nature of sustainability assessment.

For instance, while stakeholders associated with innovation districts in Oslo suggested in their conversations that economic sustainability indicators were the most crucial for the districts and could be achieved through innovation capacity indicators, external actors held different opinions, placing greater emphasis on socio-economic factors implications of innovation districts such as gentrification and high real-estate values. However, this discrepancy aligns with the existing theoretical debates around the sustainability of innovation district. What stood out though, akin to the discussed theory, was the discourse surrounding the importance of Governance Indicators in the development of sustainable innovation districts.

6.3.2 Governance indicators as the corner stone to the implementation of sustainable innovation districts in Oslo : A critical take

During the process of data triangulation and pattern matching, the governance domain revealed numerous contestations and opportunities for reflection. The final set of indicators demonstrated that governance sustainability possessed the second highest number of indicators, which starkly contrasted with the study conducted by Rapetti et al. (2022), where governance sustainability indicators were identified as the least developed in innovation

districts. Moreover, in the context of this project, the number of indicators related to governance was notably higher among interviewees from the regional and district levels.

This discrepancy may stem from the fact that while the indicators in other sustainability domains were influenced by the general theories of innovation districts popularized by Katz & Wagner (2014), the governance indicators were shaped by the day-to-day experiences of stakeholders associated with the planning strategy. Similarly, Rapetti et al. (2022)'s study was primarily based on literature review too, which indicates the reason behind the weak trends of governance indicators in his results. As a membership-based organization, it was noted that their indicators, strategies, and objectives relied heavily on the decisions made by the board, which often favoured the sector with the highest representation. For instance, a greater representation of a certain private sectors on the board of members resulted in decisions being aligned with private interests. Moreover, not keeping these members satisfied meant risking the loss of their interest and financial support. The membership-based nature of the districts raises the question of whether the definitions, ideas of sustainability, and goals are merely reflections of member goals.

Furthermore, the concept of innovation districts has been interpreted differently in the three districts, creating ambiguity of what really an innovation district is in Oslo. This brings to mind a comment made by a UN expert on innovation based development (Interview 2, personal communication, April 2023) that the very idea of innovation districts is vague, in international contexts too.

In Oslo, while innovation districts are treated as urban planning strategies on a policy level, with discussions on juxtaposition of business and land use functions, the nature of work performed by the project coordinators seemed more intermediary in function and entailed bringing together actors from different sectors. Moreover, these districts were implemented with the aim of increasing attractiveness for businesses, according to Campus Oslo (Oslo Kommune, 2018). The chairman of the OSC also presented innovation districts as a part of an international trend, in a presentation in May 2023 (Lindqvist, 2023) .

A combination of these all discussions paves the way for new questions and important to be explored and discussed:

- Who really pulls the strings in innovation districts? Whose "common good"(Girard, 2006) do innovation districts really take care of?
- While innovation districts profess sustainability, what authority do they really have to implement sustainability?
- Most importantly, what truly constitutes an innovation district in the context of Oslo? Is it primarily an urban planning strategy, a marketing strategy, or an intermediary organization that simply relays board decisions to the local authority? Can it be seen as a partnership forum? Or, at the risk of introducing more ambiguity to its definition, is it a combination of all these elements?

These questions do not disprove the concept of innovation districts but rather highlight the need for extensive work in terms of governance and governance indicators in Oslo's innovation districts. The intention of the innovation districts in Oslo is to contribute to the city's sustainability objectives identified through this project. However, it is crucial to recognize that sustainability, like any other urban planning strategy, is a multifaceted development approach that requires coordination for a holistic and positive impact on the city.

The current fragmented and ambiguous way of working, as observed in the context of Oslo, necessitates introspection and opportunities for improvement. The monitoring of the governance domain indicators listed in the USI first, could therefore pave way for effective incorporation of other domains of USIs in the indicator list.

6.4 Limitations of the project work

The project achieves its objective of creating an Urban Sustainability Indicator Set to monitor innovation districts in Oslo. Despite considerable efforts to ensure the comprehensiveness and validity of the results, the project work was influenced by certain boundaries and constraints. This section provides a description of these limitations and outlines the steps taken to address them:

Language: One hurdle to this research was the author's lack of fluency in the local language, Norwegian. Even though all the interviews with local stakeholders were carried out in English, the policy documents in the local, regional, and national levels were in Norwegian. While these were machine translated to English before analysis, it may have resulted in certain local

nuances or strategies of relevance being missed out in the process. However, the interpretations from the document were verified with the colleagues at Svale AS, who were native speakers of Norwegian, whenever unclear.

High reliance on leadership: It was identified that much of the goals, objectives, and processes set in place in the innovation district depended on leadership, and who was in control of administering the program. While the indicators have been identified based on the current situations and existing priorities in the system, this could most likely change when a change in the leadership is seen, and new agendas are chalked out. This brings in an element of uncertainty in the research. However, by building the framework around more concrete and universal strategies from the UN Habitat (2022) and The Bass Initiative(2018), the influence of uncertainty surrounding the local level on the indicator set has been reduced.

Time constraint: Given the limited availability of district and regional level stakeholders to dedicate themselves to this project, it was not possible to involve them in subsequent discussions or in a combined workshop following the semi-structured interview. Such follow-up actions would greatly aid in strengthening and validating the research. However, the stakeholders offered to address any doubts via email after the semi-structured interview, and this option was utilized when necessary.

Early Project Stage: The concept of innovation districts was only introduced in Oslo in 2018, with Oslo Science City being the first to be implemented. During the project, it was observed that the innovation districts were still in their inception stages, with frameworks still being identified and made for the smooth running of the development. The goals and proposals were not set in stone and much of the decisions made on a district level relied on the input of its member organizations. The thesis therefore only reflects the initial state of what is happening locally. Nevertheless, monitoring frameworks are supposed to be flexible frameworks, that are created as early as possible in a project, to track and address issues as early as possible (European Commission, n.d.).

Land-use Plan: The land use aspect of the municipality plan is currently undergoing revision, and the new masterplan has not yet been released during the course of this project. The stakeholders mentioned that the spatial goals of the innovation districts were communicated to the authorities responsible for the land use plan. It would have been interesting to observe how these goals were translated into policy. Regrettably, the land use plan was not released during the course of this project (Oslo Kommune, n.d.-a). However, the Oslo Planning Strategy, which

outlines the city's overall intentions for both land use and social development until 2023, was used as a point of reference.

Bankruptcy: Unfortunately, it is worth noting that Svale AS, the company associated with this thesis, experienced financial difficulties, and filed for bankruptcy in mid-May. Consequently, further follow-up of the indicators proposed in the study could not be conducted. However, it is important to emphasize that the data collection had already been completed prior to this event, mitigating any significant impact on the overall progress of the work.

6.5 Recommended Future Work

The thesis proposes Urban Sustainability Indicators (USIs) for monitoring innovation districts in Oslo that reflect the existing priorities and the identified gaps in the current state of affairs. However, the discussions so far and the limitations encountered during the research process indicate opportunities for further work, which can enhance the strength and applicability of the indicators. The following recommendations are therefore suggested:

Validation of Indicators: The thesis utilized personal interviews to explore the context beyond local strategies and reports. To further validate the indicator list, it is recommended to engage in follow-up validation works with stakeholders such as project coordinators and local authority representatives in the form of focus group discussions, workshops, etc. This process can help verify the relevance and accuracy of the indicators proposed.

Investigation of Indicators in Land-Use Strategy: Since the latest land-use strategy that received recommendations from the innovation districts was not publicly available during the duration of this study, the proposed indicators need to be validated against once the document has been released.

Emphasize Sustainability and Collaboration: The USI's help address the concept of sustainability in Oslo, through the innovation districts. However, the districts are still isolated efforts. To truly gauge and coordinate their impact om sustainable urbanism on a city level, a common platform that integrates the different efforts needs to be established.

Clarification of the Role of Innovation Districts in Oslo: To enhance the understanding of innovation districts in Oslo, it is recommended to clarify their role within the city. Is an innovation district primarily an urban planning strategy, a public-private partnership forum, a marketing strategy, or an intermediary organization? This clarity of definition will provide a stronger foundation for future research work.

6.6   Conclusion

"Cities appear more and more to be the sum of many isolated individuals. Each of them is involved in the maximization of their particular interests, but the sum of these choices is not the common good" (Girard, 2006, p. 87).

Oslo's innovation district system consists of three isolated individual districts, each driven by members aiming to maximize their own interests. While sustainability as the common good is discussed in the context, they lack a coordinated framework for effective implementation.

This thesis began with the proposal of exploring Urban Monitoring as a means to implement sustainability in Oslo's innovation districts. It introduced an Urban Sustainability Indicator Set as the first step in this monitoring process. However, the subsequent analysis of the indicator set revealed that challenges within the governance system could hinder the successful implementation of sustainability in the city. The current siloed approach of the innovation districts may impede their coordinated contributions to the city's sustainability goals. Consequently, the thesis argues that governance indicators serve as the foundation for implementing all other types of sustainability indicators.

In light of these findings, further exploration of sustainability concepts in Oslo's innovation districts should not solely focus on identifying additional indicators, but rather on enhancing the coordination and implementation of the actions within the system. This raises questions about the role of Urban Monitoring in facilitating such coordination.

Can Urban Monitoring serve as the platform that Oslo's innovation districts need to achieve better coordination and ultimately contribute to the city's sustainability objectives?

Further research and examination are required to address these important questions.

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105

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111