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Management of green infrastructure in public organizations

Considering cross-sectoral demands and long-term perspectives

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Management of green infrastructure in public organisations
considering cross-sectoral demands and long-term perspectives

Abstract

Urban green infrastructure (GI) plays a critical role in addressing global sustainability challenges such as climate change, biodiversity loss, and public health decline. In the Nordic context, local governments own public space, making them key actors for managing public GI. This dissertation explores how Nordic local governments manage GI across organizational levels in the context of cross-sectoral demands and long-term perspectives. Cross-sectoral demands are seen through the lens of GI as a resource to promote human health and well-being (HH&W). The link between polices and implementation are studied through qualitative methods; document studies, interviews and workshops. The findings show policy addressing the relation between GI and HH&W to be general and undifferentiated, both in how it is described and in related goals and visions. On tactical level, HH&W is considered one of many arguments for the importance of GI. While horizontal collaboration between sectors is ongoing between GI and public health departments, limited resources for collaboration and mismatched priorities between levels undermine long-term outcomes. At the operational level, intra-organizational misalignments leaves maintenance practices focusing on static technical management. This hampers both long term perspectives and a more dynamic view of GI, limiting the strategic response to urban challenges. This thesis concludes that the current linear approaches of managing GI in public organizations do not sufficiently address the inherent adaptive complexity of GI. For GI to contribute to HH&W in a long term perspective, there is a need to understand alignment of visions, planning, design and implementation as an adaptive and ongoing process, operating at several organizational levels, across and within several sectors. This means that to fully harness the potential of GI in addressing current global challenges, a strategic approach to operational practice is required.

Keywords: Green infrastructure, Management, Planning, Maintenance, Public health, Nordic municipalities, Strategic management, Cross-sectoral collaboration, Sustainability

Förvaltning av grön infrastruktur i offentliga organisationer
med hänsyn till tvärsektoriella krav och långsiktiga perspektiv

Abstract

Urban grön infrastruktur (GI) spelar en avgörande roll i att hantera globala utmaningar så som klimatförändringar, förlust av biologisk mångfald och försämring av folkhälsan. I nordiska länder är kommunerna ägare av och ansvariga för att planera och förvalta offentlig GI, vilket gör dem till en central aktör. I denna avhandling undersöks hur nordiska kommuner hanterar GI över organisationsnivåer med avseende på tvärsektoriella krav och långsiktiga perspektiv. Tvärsektoriella krav utforskas genom exemplet GI som en resurs för att främja människors hälsa och välbefinnande. Kopplingen från policy till implementering studeras genom kvalitativa metoder; dokumentstudier, intervjuer och workshops. Resultaten visar att policybeskrivningar av GI som en resurs för folkhälsa är generella och odifferentierade, både i hur relationen beskrivs och i de relaterade målen och visionerna. På taktisk nivå blir folkhälsa främst ett av många argument för vikten av GI, snarare än ett explicit fokus. Medan tvärsektoriellt samarbete pågår mellan avdelningar ansvariga för GI och folkhälsa, undergrävs detta av begränsade resurser och kortsiktiga prioriteringar. På den operativa nivån leder dessa kortsiktiga prioriteringar till resursbrist, vilket gör att fokus hamnar på en teknisk hantering av GI. Detta hämmar möjligheten att fokusera på långsiktiga perspektiv och att hantera GI på ett mer dynamiskt sätt som en strategisk respons på urbana utmaningar. Den nuvarande linjära hanteringen av GI i offentliga organisationer utnyttjar därför inte den adaptiva komplexiteten hos GI till fullo. För att offentlig GI ska kunna bidra till t.ex. folkhälsa i ett långsiktigt perspektiv krävs det att visioner, planering, design och implementering ses som en adaptiv och pågående process som verkar på flera organisatoriska nivåer, över och inom flera sektorer. För att till fullo utnyttja den inneboende potentialen hos GI för att möta dagens globala utmaningar, krävs därför ett strategiskt förhållningssätt till operativ praxis.

Nyckelord: Grön infrastruktur, Förvaltning, Planering, Skötsel, Folkhälsa, Nordiska kommuner, Strategisk förvaltning, Tvärsektoriellt samarbete, Hållbarhet

"As to a park, when the outlay has been made, the results may, and under good management must, for many years afterwards, be increasing in value at a constantly advancing rate of increase, and never cease to increase as long as the city endures."

Fredrick Law Olmsted (1880, in Sutton, 1972)

To Björn, Niki, Saxa and Aglaia, for every day

Contents

List of publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I. Sunding, A., Randrup, T. B., Nordh, H., Sang, Å. O., & Nilsson, K. (2024). Descriptions of the relationship between human health and green infrastructure in six Nordic comprehensive plans. Cities, 146. https://doi.org/10.1016/j.cities.2023.104746

II. Sunding, A., Ode Sang, Å., Nilsson, K. & Randrup, T.B. Planning and managing urban green infrastructure for human health: Perspectives on collaboration and implementation from four Nordic cities [in review in Socio-Ecological Practice Research]

III. Sunding A. & Dempsey, N. The nature of a park, managing unpredictability across intra-organizational boundaries [in review in Urban Forestry and Urban Greening]

The contribution of Anna Sunding to the papers included in this thesis was as follows:

I. Conceptualization (80%); Data curation (95%); Validation with support from co-authors; Formal analysis (90%); Methodology (80%); Visualization, Writing – original draft (90%); Writing – review & editing (90%).

II. Conceptualization (80%); Data curation (100%); Formal analysis (100%); Methodology (80%); Writing - original draft (80%); Writing - review & editing (90%).

III. Conceptualization (90%); Data curation (100%); Formal analysis (100%); Methodology (100%); Writing - original draft (100%)

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1. Introduction

The complexity of challenges in the urban environment is increasing in both magnitude and criticality, with issues such as urbanization, climate change and biodiversity loss in the spotlight of global policy and research attention. This complexity becomes particularly visible when increasing pressure to use existing urban space for development (i.e. building and construction) (Maas et al., 2009; WHO Regional Office for Europe, 2016; Lindholm, 2017) is paired with ambitions to handle rising temperatures, storm water and increase biodiversity, while also addressing challenges such as public health.

Urban green infrastructure (GI), broadly seen as a 'network of natural areas' (Benedict and McMahon, 2012, p.1) has been described as offering a 'gateway for sustainability' (Pauleit et al., 2019, p.4), and has been shown to be an important resource in tackling several of the mentioned challenges. This includes its impact in mitigating the urban heat island effect (Balany et al., 2020), and handling storm water through appropriate management (Fletcher et al., 2014). Another current research focus which has gained increasing attention in recent decades is how GI can support human health and well-being (HH&W) (Tzoulas et al., 2007; Suppakittpaisarn, et al., 2017). This type of challenges are generally understood as "wicked problems" – problems that have "*no solutions in the sense of definitive and objective answers*" (Rittel & Webber, 1973, p.155).

As the complexity of demands on GI grows, this increases the need to address questions of stakeholders, resources and multi-disciplinary knowledge (Knapik et al., 2024). As a response to these multiple demands on GI, there is a growing consensus across academia, policy and practice that a transition is needed in how these issues are understood and approached (Hagemann et al., 2020; Guterres, 2021). This runs in parallel with calls for utilizing approaches based on and inspired by nature (Randrup et al., 2020a). These ideas acknowledge how nature does not adhere to a simple linearity (Randrup et al. 2020a; Mosaavi et al., 2021) and does not provide short-term solutions, but instead takes time to develop its full potential or functionality (Sarabi et al., 2020). This non-linearity demands adaptive approaches to learning in processes of planning, designing and managing (Kabisch et al., 2016, Nielsen et al., 2023, Randrup et al., 2023), and even creates a need to organize in a way that is inspired by natural processes, working across

administrative responsibilities and boundaries (Randrup et al., 2020a; Mercado et al., 2023). The inherent dynamics of the biotic foundation for GI, therefore demand ongoing management and maintenance to ensure quality and functionality (Young and McPherson, 2013; Dempsey and Smith, 2014; Fongar et al., 2019). This creates a need not only to construct and maintain, but also to constantly develop GI in order to enhance its value.

While there is little disagreement that GI provides multiple ecosystem services, and that 'green is good', local governments, as the main bodies responsible for developing and maintaining public GI, are not legally obliged to develop GI (de Magalhães and Carmona, 2009). Furthermore, there is a long and increasingly complex path between policymaking and the actual operational implementation 'on the ground'. Consequently, a range of challenges have been identified in the governance of urban GI (Gulsrud et al., 2017), such as a lack of cross-sectoral approaches (Hagemann et al., 2020), unclear leadership (Qiao et al., 2019), and unclear actor-relations in implementation responsibilities (Haase et al., 2014), leading to this potential 'good' not being fully realized. As such, there is a gap between the benefits of GI described in research, and how this is carried out in practice (Whitten, 2022), with a major barrier for transformation being how GI is planned, managed and governed (Dempsey and Smith, 2014; Randrup and Jansson, 2022).

In this thesis, public urban GI is understood to be comprised of publicly accessible areas that are planned and managed primarily within a local government domain (Carmona et al., 2004; Randrup and Persson, 2009; Dempsey and Smith, 2014; Slätmo et al., 2019). Here, GI planners and managers have the main responsibility of preparing and substantiating policies for political approval, and subsequently strategizing, concretizing and coordinating plans, programs and actions to implement them. However, these responsibilities are often split between separate departments and over several roles and organizational levels (Hagemann et al., 2020; Coquand et al., 2017). The effects of hierarchic separation between intention setting and implementation are not singular to GI but affect public governance in general (e.g. Hudson et al., 2019). Who is involved in decision-making and how information flows from different organizational levels, both 'upwards' and 'downwards', are key issues in this regard (Dempsey and Smith, 2014). In other words, the importance of coordination has been deemed greater than the formal distribution of responsibilities (Carmona et al., 2004).

Research on the health promoting characteristics of GI (Beute et al., 2023) and on health promoting interventions in GI (WHO Regional Office for Europe, 2016) is increasing. However, less attention has been given to the HH&W benefits of urban nature in relation to the local decisions and investments that support urban nature (Dobson et al., 2021), and the practice context in which these decisions are taken needs to be better understood (Dobson and Dempsey, 2021). As sustainable GI depends on long-term perspectives, there is a need to tackle challenges in a way that addresses what happens after the initial planning and design stages. As such, there is a knowledge gap concerning the organizational alignment from policy making to planning, design and operational maintenance.

1.1 GI as a resource to promote HH&W

Of the many contemporary challenges mentioned above, a major concern from a societal perspective is the substantial costs that are associated with a range of physical and mental disorders and diseases (Giles-Corti et al., 2016). Global support for integrating environmental and human health matters is growing, with calls to address human health and well-being (HH&W) in a strategic cross-sectoral approach. This includes the holistic integration of determinants of health in all sectors and with strategic urban planning identified as key for creating HH&W supportive GI (WHO, 2020).

There is a well-documented connection between 'natural environments' and HH&W (For reviews see: Hartig et al., 2014; WHO Regional Office for Europe, 2016; Markevych et al., 2017; van den Bosch and Ode Sang, 2017; Bratman et al., 2019). Efforts to explain how nature affects humans started in the mid-1970s in conjunction with attempts to understand people's preferences in relation to different types of landscapes. Early theories include Prospect-Refuge theory (Appleton 1975) and Biophilia (Wilson 1984). They had a common focus on prehistoric perceptions of danger and how these affect modern human's perceptions of positive environments. Psycho-evolutionary Theory (Ulrich et al., 1991) and the Attention-Restoration Theory (Kaplan and Kaplan, 1989) address the mental rehabilitation effects of access to and contact with nature. Contemporary approaches include pathway frameworks (Hartig et al., 2014; Markevych et al., 2017) and ecosystem services (Shanahan et al., 2015; Bratman et al., 2019). As such, GI can be seen as an integrated, connective and cohesive network of green

environments, understood in a socio-ecological perspective (Mell, 2009; EC, 2013), which provides opportunities to integrate HH&W into GI planning and management (Tzoulas et al., 2007).

After initial establishment, GI management determines the ability to support HH&W based on the functions and uses it enables (Dobson et al., 2021). Consequently, ambitions to develop GI as a health promoting resource must be understood in conjunction with the need to sustain these developments over time (Jansson et al., 2020).

1.2 Responsibilities for the planning and provision of GI, and public health promotion in the Nordic countries

This PhD study uses cases based in the four largest Nordic countries: Denmark, Finland, Norway and Sweden. On a global scale, the Nordic countries share a range of similarities, with many common traits stemming from the governance tradition of the welfare state (Pedersen and Kuhnle, 2017). These similarities can be found in health-promoting responsibilities on the local governmental level (Helgesen, 2014), which, for the Nordic countries, is controlled by individual municipalities. There are, however, formal differences in whether cross-sectoral collaboration on public health issues is demanded by national legislation, see table 1.

Nordic counties are often ranked highly in measures of sustainable development (Sachs et al., 2024), quality of life (Helliwell et al., 2022) and health-relevant sociodemographic measures (Knudsen et al., 2019). Similarly, Nordic cities score highly when it comes to air and water quality, (Aguiar Borges et al. 2017). However, segregation and socio-economic differences are key challenges for some Nordic cities, alongside differences in access to urban amenities (Naess et al. 2007; Tunström and Wang, 2019). Furthermore, differences in mortality rates, rates of illness, perceived well-being (Rehn-Mendoza and Weber, 2018), and life expectancy gaps based on socioeconomic status are still larger than expected compared to other European countries that have less generous welfare policies (Mackenbach, 2017).

From a planning perspective, the studied Nordic countries share a ‘comprehensive integrated approach’, focusing on the horizontal and vertical integration of policies (Nadin and Stead, 2008). As such, spatial planning is understood as an important process for achieving set goals at the local

government level (Aguiar Borges et al., 2017; Gustafsson and Andréen, 2018). Planning legislation in all Nordic countries integrates the prevention of harm to humans and the environment, with national differences on the specificity of the expectations on the health promotion of resulting environments at the local government level, see table 1. Beyond this, there is a range of international regulations and declarations which more or less explicitly imply that urban GI needs to be developed and managed, including The European Landscape Convention (CE, 2000), Agenda 2030 (United Nations 2023), and the New Urban Agenda (United Nations, 2017). Despite this, the provision of urban greenery and demands on its ongoing management are not statutory in the Nordic context (Lidmo et al., 2020; Lidmo and Bogsason, 2020; Randrup and Jansson, 2022). However, at the time of writing, the European Nature Restauration (EU 2024/1991) was ratified. This will undoubtedly have an impact on the provision of urban GI, as it is now formally required that local governments prevent the loss of urban green space, and *"inter alia by integrating green infrastructure and nature-based solutions, […] contribute to maintaining and increasing not only the area of urban green space but also, if trees are included, the area of urban tree canopy cover."* (EU 2024/1991, section 48). This thesis will not speculate as to exactly what the impact of the European Nature Restoration Law will be in each of the Nordic countries, but argues that this legislation does not negate the relevance of the arguments made.

Another joint characteristic of the Nordic countries is high levels of local governmental autonomy (Landner et al., 2016), which means that municipalities have a high level of independence in how legislative demands and guidelines are understood and addressed. Beyond this, public health and GI planning and management are addressed by different departments. The challenges of a cross-sectoral approach are highlighted as presenting a need to overcome the *"sectoral/policy field division of functions characterising public organizations"* (EC, 2020, p. 127). However, currently, there is a lack of knowledge on the implications of cross-sectoral policies at the local government level (Candel and Biesbroek, 2016; Karlsen et al., 2022).

Table 1. Nordic countries' responsibilities at the local government level for health promotion and related legislation and formal guidelines

Finland	**Norway**	**Denmark**	**Sweden**
Health Care Act dictates that all parts of the municipal organization are responsible for promoting public health (Finlex 30.12.2010/1326, §12).	Public Health Care Act dictates that the state of health in the municipality guides the municipal planning strategy (LOV 2011-06-24 nr 29, §5-6).	No legal requirements for public health promotion. Cross-sectoral public health strategy recommended by the Association of Danish Municipalities (KL) (Aarestrup et al., 2007).	No legal requirements for public health promotion. National goals for public health (Swedish government, 2002).
The comprehensive plan must make opportunities for a safe and healthy living environment which takes different population groups into equal consideration (Finlex 5.2.1999/132, §5).	Plans should promote public health and counteract health inequalities. Planning should promote coherence through cross-sectoral coordination and collaboration, both vertically and horizontally (LOV 2008-06-27 nr 71, § 3-1).	Municipal strategies to promote the interaction between decisions made on environmental, transport, business, social, health, educational, cultural, and economic factors (LBK nr 287, 16/04/2018, §33).	Promotion of development that ensures a healthy and good environment for present and future generations (SFS 1998:808, §1). The value of ecosystem services should be known and accounted for in relevant decisions, which will include decision-making processes such as planning (Miljödepartementet, 2012).

1.3 Research aim and questions

Many of contemporary societal challenges, denoted as wicked problems, relate to urban living. Publicly available GI is a key resource for addressing them. This leads to a growing need to utilize urban GI to deliver an increasingly wider array of functions that are sustainable from a long-term perspective. Local governments are central for delivering multifunctional (including health promoting) GI. While new and more complicated actor relationships are needed to address these challenges, local governments are characterized by sectoral and hierarchical structures, which are associated with known challenges relating to collaboration and implementation.

To address these issues, this thesis explores the management of GI in light of cross-sectoral demands in Nordic local governments, from policies to operational activities. The overall aim is to describe, understand and critically discuss how local governments tackle these challenges from a long-term perspective. This leads to the following Research Questions (RQ)'s:

1. How are cross-sectoral demands on GI addressed in Nordic local governments?
2. How is the management of GI aligned across policy, tactical, and operational levels in Nordic local governments?

1.4 The structure of the thesis

The structure of the thesis is based on a classic conceptualization of an organizational structure, where each of the three included papers relates to one of three overall organizational levels: policy, tactical and operational (Randrup & Persson, 2009). This conceptualization is further detailed and discussed in section 2.5 and onwards. In the thesis, the cross-level perspective is primarily exemplified by how GI is managed across the organization to promote HH&W. The conceptual structure underpinning the research design allows for the exploration and further understanding of how cross-sectoral issues, exemplified via the GI-HH&W relation, is handled. This is addressed in municipal comprehensive plans at policy level (Paper I), how the relevant planners and managers perceive their work related to the GI-HH&W relationship at the tactical level in terms of collaboration and

implementation, (Paper II). Lastly, whether and how practices in park design, construction, and management align with nature-based approaches, affecting opportunities to strategically address long-term development at the operational level (Paper III), see fig.1.

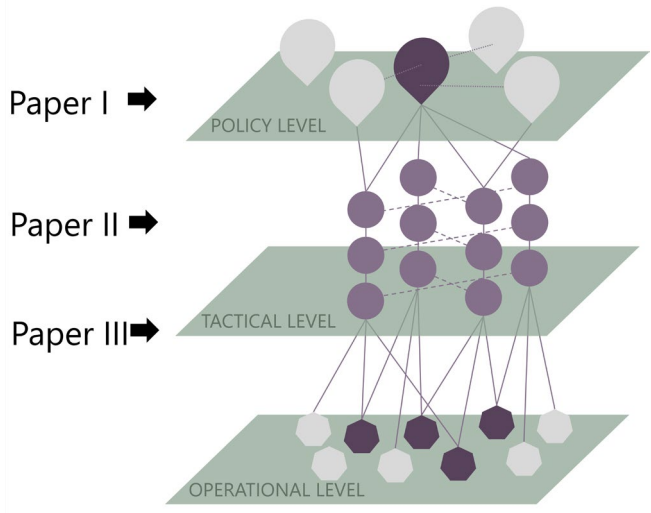

Figure 1. The three studies that comprise this PhD project within an organizational structure. Modified from Sunding and Randrup (2024).

To meet the aims and answer the research questions, the research is designed so that the overarching research questions are addressed in each sub-study, each with a different focus. In the first sub-study, policy documents were analyzed for how the GI-HH&W relation was described and envisioned in the planned development. The results from the first sub-study are one of the themes addressed in the second. The second sub-study explores how practitioners in GI planning, management and public health address the GI-HHW connection, and how they perceive barriers and support in relation to implementation and collaboration. The third sub-study builds on the challenges identified in the second sub-study, focusing on the tactical-operational interface aligning design ambitions with construction and management practices. Here, the cross-sectoral alignment has an 'intra-GI' focus, addressing differences within the GI sector between park management and nature management. See table 2 for an overview of the three sub-studies' research questions, aims and organizational foci as they relate to the overarching research questions.

The outline of the thesis

The thesis is comprised of five chapters, references and appendices. After this first introductory chapter, the second chapter addresses central theoretical concepts and frameworks. The third chapter details the overarching research design and the methodological approach for each sub-study. The fourth chapter presents the results of the overarching research questions based on the results from the three sub-studies. The findings are discussed in chapter 5, together with reflections on the study as well as the three sub-studies, concluding with some final remarks and outlooks.

Table 2. Research questions, aims and organizational focus of the three sub-studies.

	Research question	**Aim**	**Organizational focus**
I	How is the GI-HH&W relationship described in Nordic comprehensive plans?	Identify the conditions in Nordic land use planning for further strategic interventions to create health-promoting green infrastructure.	**Policy level content.** **Cross sector alignment** between GI and public health. **Cross level alignment** through stated vision and goals informing subsequent planning stages.
I **I**	How do involved practitioners address the relation between GI and HH&W in their daily work? Which factors support or hinder the promotion of HH&W in GI planning and management?	Examine how local government planners, managers, and public health strategists address the relation between GI and HH&W in everyday practice, and what factors affect the work.	**Tactical level interactions.** **Cross sector alignment** between GI and public health**.** **Cross level alignment** in related practitioners' perceptions of policy to implementation.
I **I** **I**	What characterizes practices and discourses in creating and managing urban GI? What are the organizational capacities needed to strategically address long-term nature-based park design and management?	Explore the extent to which design, construction and management practices align with emerging ambitions of nature-based approaches.	**Tactical-operational interface on a specific site.** **Cross level alignment** From design intentions to construction and long-term management. **Cross sector alignment** within urban GI, between practices in urban parks and urban forest management.

2. Central concepts and theoretical considerations

This thesis is situated in the field of landscape architecture, with a specific focus on the processes encompassing GI planning and management in a local government context. It contributes to the fields of urban planning and urban landscape management by drawing from fields related to policy implementation and strategic management. In this chapter, relevant concepts and frameworks are described with fig. 2 showing their interrelation and table 3 showing their role in the three studies.

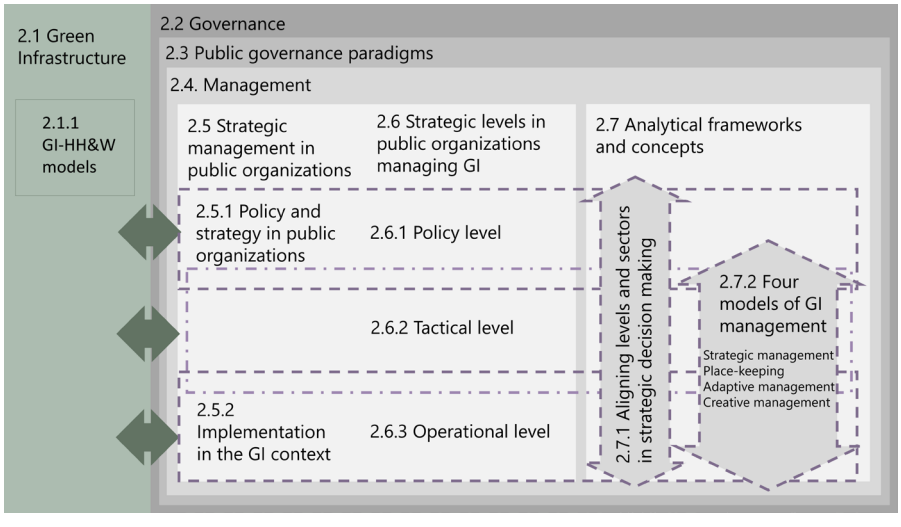

Figure 2. A schematic overview of the covered themes and how they are relevant in relation to the three studies (PI-III).

Table 3. An overview of the analytical models used in the three studies.

	Analytical model	**Organizational level**
I	Pathways between GI and HH&W (see also section 3.4.1)	Policy level: policy content and goals
II	Programmatic alignment and Strategic management	Tactical level: cross-level and cross-sectoral collaboration between GI and public health
III	Place-keeping, Adaptive management and Creative management	Tactical-operational interface and cross-sectoral perspectives in the intra-GI context

2.1 Using GI to describe urban green environments

A wide range of concepts are used to describe the 'green' in our cities: green infrastructure (GI), urban green space, urban nature and urban forest among others(FAO, 2016). GI is a broad concept (Davies et al., 2015), which has been extensively researched to address challenges related to environmental, sociocultural and economic matters (Matsler et al., 2021).

Perhaps because of this breadth, the definition of GI varies by sector (Matsler et al., 2021). In the literature, what is described as an element of GI can vary in function and size, with terminology also depending on the academic field (Cook et al., 2024). Consequently, the concept has been described as being ambiguous yet central (Lindholm, 2017; Pauleit et al., 2019), with many different definitions available. For example, there is a major difference in understandings of GI between Europe and the US, where the concept often pertains to storm water management (Fletcher et al., 2015).

In this thesis, the definition used follows the European tradition, where GI is understood as an umbrella term, describing all green and green-blue elements in urban and peri-urban environments. Its outset stems from challenges of urban sprawl, underpinned by the idea that the green in our cities should be understood as a fundamental infrastructure similar to others within a qualitative urban environment (Ronchi et al., 2020; Li et al., 2022). It should, therefore, be actively integrated in spatial planning, instead of being relegated to the spaces left after buildings and grey infrastructure is distributed (Benedict and McMahon, 2002), with key principles being connectivity and multifunctionality (e.g., Hansen et al., 2019). This strong connection also means that there is a wide range of planning models to develop urban GI, focusing on e.g. HH&W promotion (Tzoulas et al., 2007).

One often used definition of GI states that GI is a "*strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services*" (EC, 2013, p. 3). However, this definition does not necessarily include existing unplanned areas, or features that are not explicitly designed and managed to deliver ecosystem services (ESS), but which still offer important social and ecological benefits. Another commonly cited definition describes GI as a "*network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife*" (Benedict and McMahon, 2012, p. 1). The joint understanding is that GI is multifunctional and contains

a wide array of functions and benefits. Therefore, the concept of GI requires a multi-sectoral (or multi-departmental) approach to access knowledge on different physical and temporal scales, thus implementing the coveted multifunctionality that the concept is connected to (Lindholm, 2017; Hansen et al., 2019). This creates a need not only to construct and maintain but also to constantly develop GI in order to enhance its values (Jones, 2000). This thesis therefore adheres to the concept of GI as a key term to emphasize the organizational, spatial and temporal multiscale perspective in relation to its planning and management.

2.1.1 GI in the company of other terms

To further situate the thesis, it is relevant to understand GI as a concept in relation to adjacent terminology. While there is a wide range of terms describing similar ideas, two terms are particularly relevant in this context; nature based solutions (NbS) and ecosystem services (ESS)/urban ecosystems services (UES). Nature-based solutions have been described as being interventions inspired and powered by nature to address societal challenges and provide multiple services/benefits (including biodiversity gain), while being of high effectiveness and economic efficiency (Sowińska-Świerkosz and García, 2022). Conversely, ESS is understood as describing the benefits humans derive from (urban) ecosystems (MEA, 2005). Of the three, UES is more widely used to promote the value of nature in decision-making contexts (Haase et al., 2014). Conversely, NbS is more utilized in the contexts of planning and practice (Raymond et al., 2017; Pauleit et al., 2019); this means that GI and NbS are often geared towards the same policy aims (Pauleit et al., 2017).

The concepts are understood to have overlaps (Kabisch et al., 2016), influencing and learning from each other (Fang et al., 2023), and mutually reinforcing (Pauleit et al., 2017). The general overlap of the concepts has raised critiques as their shared goals, paired with a lack of coordination, leads to much duplication of research (Fang et al., 2023). Similarly, Matsler et al. (2021) mention that variations in terminology, combined with a lack of coordination between academic fields, hampers the integration of scientific development. The main purpose of using the concept of GI in this thesis is to highlight the physical structure existing and acting on multiple scales. It also emphasizes the incorporation of all types of existing or intended public urban green (and blue) structures, regardless of their administrative use in

the public organization. A key notion here is also the close ties between the concepts. They are not understood as conceptually separate, but pertaining to the 'same' green urban environments and elements. Consequently, this thesis refers to research addressing all three concepts, while primarily describing them as GI.

2.1.2 Models describing the GI-HH&W relationship

The strong connection between GI and ESS, in this case represented by human health and well-being presents a strong argument for combining them in spatial planning (Mell, 2009; Lafortezza et al., 2013). The connection between nature and health has been conceptualized as a "pathway" or "cascade" in a range of different frameworks developed in the last decade (Haynes-Young and Potchin, 2010; Hartig et al., 2014; Shanahan et al., 2015; van den Bosch and Ode, 2017). The pathways help to understand how properties in a physical space lead to health benefits for an individual human. These models use varying concepts to describe GI, such as "Natural environments" (Hartig et al., 2014) and "Green space" (Lachowycz and Jones, 2013; Markevych et al., 2017); further, terms such as "Ecosystem property" (Shanahan et al., 2015) describe a more detailed causality between specific biological properties and their effect on HH&W.

To illustrate the detailed relationship between GI and HH&W, Hartig et al., (2014) described a model where GI affects health through two pathways: i) direct effects gained from natural environments via an individual's contact with nature (e.g., reducing stressor exposures or impacting restoration) or ii) indirect effects via, for example, air quality having an effect on health without demanding a conscious interaction with nature. These effects in turn affect health and well-being, including subjective well-being and mortality. Hartig (et al., 2014) has further described four commonly investigated aspects of the effects that natural environments can have on health: i) air quality, ii) physical activity, iii) social contact and iv) stress. These can be seen as representative examples of the types of impact that nature can have on health. The model briefly mentions "effect modifiers" that affect "contact with nature as such". These are exemplified as distance and accessibility, and perceived safety (ibid, p. 213). By grouping the types of health effects that nature can have in three distinct domains: restoration, instoration and mitigation, Markevych et al., (2017) expand the understanding of these pathways. Here, restoration involves restoring exhausted capacities,

impacting stress and attention (Ulrich et al., 1991); instoration involves building or strengthening capacity to respond to risks of harm (Grahn et al., 2021); and mitigation involves the counteraction or reduction of potential harmful impacts. In addition to this, there is a recognition that nature can also harm humans (Delshammar et al., 2015; Eisenman et al., 2019), through, for example, allergens or disease.

The presented models all include either individual factors, such as frequency and durations of contacts with natural environments, or detailed examinations of biological causalities. While crucial to consider, neither are the main focus within GI planning. Rather, GI planning creates opportunities for contact with nature, or opportunities for enjoying the effects of nature. This creates a need to examine these aspects from the viewpoint of how user-groups interact with GI in different ways and which activities GI can be used for. Lee et al. (2015) created a framework specifically aimed at planning practice. While their model details these aspects more clearly by describing the pathways, based on the characteristics and functionality of green spaces, the authors claim that most health benefits likely come from the use of green space rather than by its mere presence. However, GI planning addresses these potential pathways in many ways, and environmental considerations, such as climate change adaption and temperature regulation, are key factors affecting human health, from a more holistic perspective.

In 2017, WHO presented the Causal model of the impacts of urban green spaces on health and well-being, (WHO Regional Office for Europe, 2017). This model is aimed at practitioners in planning, design and management, as well as decision makers and civil society organizations on a local level. The basics of the model are based on the work of Roué-Le Gall (2015, cit. Milvoy & Roué -Le Gall, 2015) and place the "green space-health" relationship in a frame that describes the interconnections between the two. In this study, the WHO model was adapted to fit a content analysis of planning documents (see section 3.4.1 and Appendix). The adapted analytical framework clarifies which, if any, connections are emphasized from the planning perspective between a city or municipality's GI structure and the health of its inhabitants. For a more detailed description of the analytical framework, see Appendix.

2.2 Governance

The main focus of this thesis is how GI is addressed in public organizations, making the concept of governance an important outset. While the concept of governance is broad and used in a wide range of ways two main strand can be found (Colebatch, 2014). One strand pertain to addressing the general steering or authority that is exercised by "*regimes of laws, rules, judicial decisions, and administrative practices that constrain, prescribe, and enable the provision of publicly supported goods and services*" (Lynn, Heinrich, and Hill, 2001, p. 7). The other strand understands governance as the shift "*from government to governance*" (Peters and Pierre, 1998). This sentiment addresses the ways in which administrative practices within public organization have shifted from a hierarchical, state centered approach to one emphasizing the need for involving multiple actors with a strong emphasis on collaboration. The two strands represents a "*particular form of rule*" (Colebatch, 2014, p. 309) in governing together with a broader array of actors, or alternatively "*the whole process of rule*" (ibid., 2014, p. 309). An example of this is given in the coming sections where the public governance paradigms (general forms of rule) are detailed (Torfing et al., 2020), exemplified by New Public Governance (a particular form of rule), which implies a more inclusive approach with a broader set of actors.

However, while acknowledging that the public organizations do not alone have the knowledge to solve complex, collective problems (e.g. Torfing et al., 2020), there are also counter-arguments that the relative relevance of the government is not diminishing as a broader array of actors become involved (Colebatch, 2014). The main point relevant here is the recognition that governance therefore comes to address more than the 'government' or the public organization. In relation to the intra-organizational focus of this thesis, based on the concept of management, further detailed in section 2.4 and onwards, becomes a subset of this broad idea of governance specifically addressing how intra-organizational processes are taking place in public organizations. This is however understood to be affected by aspects of governance in a range of ways.

2.3 Public governance paradigms

The normative foundations by which governance is performed, have been described as public governance paradigms (Torfing et al., 2020). These paradigms offers a perspective on how public organizations have evolved over time through governance reforms. A public governance paradigm can be understood as as a *"relatively coherent and comprehensive set of norms and ideas on how to govern, organize and lead the public sector"* (ibid., p. 8). In the following, a brief introduction is given to the governing paradigms which have been prominent in the last century. Governance paradigms tend to work both at a macro-scale with a vision or loose set of ideas, as well as on a more detailed set of recommendations and methods. They often arise as an answer to the problems of their predecessor, enter a state of "normal governance", and then themselves become criticised and scrutinized as new problems arise that they cannot solve. However, the emergence of one governance paradigm does not necessitate the previous ceasing to exist but rather that the different paradigms interact, producing hybrid forms.

2.3.1 Bureaucracy

Bureaucracy is arguably one of the most influential concepts in public governance in the last century. While the foundational ideas have been found in the works of Confucius and in French administration during the 1600s, the term was first explicitly mentioned in the 1800s. The concept as we understand it today was formulated by Weber in the 1920's (Sørensen and Torfing, 2024). The idea was formed in response to political patronage, corruption and ineffective administration, and presented an administrative system that was built around professional roles rather than individuals.

The concept, meaning roughly 'rule of desk', refers to an administrative unit that is separate from the political level (Torfing et al., 2020). This administrative unit is staffed by trained individuals who are hired based on specialized competence, addressing daily operations. Conversely, the role of the elected politicians is to formulate overarching goals and policies reflecting the values and opinions of the public (Sørensen and Torfing, 2024). Despite this divide, administration is dependent on political-level support (Svara, 2001). The ideal type bureaucracy puts a strong focus on organizational structure and formal rules, introducing hierarchical authority and thematically specialized administrate departments (Kanon, 2023). In relation to this thesis, four core competences (Sørensen and Torfing, 2024,

p. 145) represent the central governance principles of public organisations: i) top-down hierarchical governance of and within administrative units; ii) a compartmentalized division of labor with high professional specialization; iii) administrative decision-making based on means–ends rationality, rule-following, and written records; and iv) loyal and neutral civil servants who are recruited based on their merits.

Regarding the high professional specialization, this has played a significant role in public organizations, so much so that there are arguments for it to be denoted its own governance paradigm, while others claim it still a subset of bureaucracy (Torfing et al., 2020). The main point is to highlight the role of professional expertise, and the notion that specialized practitioners are responsible for delivering the major part of public services. The bureaucratic structure in combination with specialized roles have the advantage of focusing the attention and the resulting quality of decisions within the individual departments (Egeberg, 2003). But these structures can also turn into barriers in cross-departmental matters, as specialization often delimits challenges artificially, *"rather than presenting a more integrated conception of causes and possible remedies for the difficulties"* (Peters, 2015, p.5). Bureaucracy has received extensive criticism on its rigidity, its inability to offer high-quality, low-cost services, and an indifferent approach to the public using these services (Torfing et al., 2020). But despite these criticisms, it remains one of the most dominant paradigms in public governance (Sørensen and Torfing, 2024).

2.3.2 New Public management

The most influential recent public governance reform, New Public Management (NPM), was introduced in the late 1970s and more prominently during the 1980s, and accelerated even more as the term was coined in the early 1990s (Hood, 1991). Neoliberalist ideas worked to modernise the public sector by importing tools from the private sector into the (bureaucratic) public sector, which was perceived as inefficient and unresponsive. Core elements of NPM include marketization recommended by economic theory, and managerialism stemming from management theory (Hood, 1991; Torfing et al., 2020). Marketization involved the introduction of market logic to the public sector (e.g. legislating compulsive competitive tendering (CCT) for public services). Managerialism, meanwhile, introduced decentralisation and performance management, with continuous monitoring

and benchmarking. These ideas worked to reimagine the public sector into a producer of public services, effectively reframing citizens as customers. NPM has been a more or less prevalent governance structure in Nordic countries for almost 30 years and still shapes public governance; most importantly for this thesis, it is used in relation to the management of GI (Randrup and Persson, 2009; Randrup et al., 2020b).

2.3.3 New Public Governance

As the timeline comes closer to the present, a range of new ideas on governance have been introduced, most of them addressing the problems of NPM. In relation to the increasing complexity of current challenges, an umbrella concept can be found in New Public Governance (NPG). This paradigm is based on the idea that complex societal issues are better addressed through networked collaboration than through hierarchical governance and market-based competition. Within NPG, a major focus has been on public participation and varying forms of collaborative governance, stepping away from hierarchical structures (Jansson et al., 2018; Torfing et al., 2020). These forms are more flexible and collaborative, including co-governance and self-governance, with mosaic governance suggesting their varying application between contexts and projects (Buijs et al., 2016). While the NPG paradigm has focused on relations with external actors, such as civil society, it currently lacks focus on what this means for the structures and relations within the public organization (Krogh et al., 2024).

In this thesis, two notions related to these governance paradigms are of importance in how they can be seen to affect public organizations. First, while they are understood as a relatively coherent set of norms and ideas, these norms and ideas foundationally shape the work within public organizations. Second, the paradigms do not replace each other. Further, each reform with their accumulating demands do not stack neatly. Instead, the paradigms coincide in different ways and magnitudes in different parts of the organization, mixing into hybrids similar to a ‘marbled cake’ (ibid, p. 3), in various ways throughout the organization. In the context of GI, this can mean that the influences of the paradigms lead to differences between GI planning and GI management in terms of what is perceived as important values to pursue.

2.4 Management

When discussing the concept of management, the inevitable starting point becomes addressing its considerable scope of uses. In the following an overview of concepts related to management that adhere to different fields and traditions relevant to this thesis are presented.

The word derives from the verb manage, which means to handle or direct with a degree of skill, originating from the Italian verb ‘maneggiare’ meaning ‘to handle, train (horses)’. It is derived of the Latin word ‘manus’ meaning ‘hand’ (Manage, 2024). This implies both in a figurative and in a literal sense a very hands-on approach; an ongoing or repeated process both to care for, and to steer. As such, management implies an ongoing, and controlling act while also referring to the person or people executing the action. From the humble act of training a horse, the concept has spread and become commonplace to a point where it is arguably one of the most foundational concepts relating to organizations in general.

In this thesis, the notion of management can be seen as both an organization carrying out activities, and the activities they carry out (Gustavsson et al., 2005). Here management is understood in a broad sense, covering the daily practices of professionals, effectively overlapping with the concept public administration. The notion will mainly be discussed through the approach of strategic management. As opposed to the main strands in the academic field of strategic management, this thesis does not focus on management as mainly pertaining to the actions of the manager, or the leader (Randrup and Jansson, 2020). Rather, as an outcome of the highly professionalized employees (as detailed in section 2.3.1). While the role of the manager is not to be neglected, their practices are not the main focus of this thesis. This is better understood through the Swedish word ‘förvaltning’(Förvaltning, 2024), sprung from the German ‘vervaltung’, which means both public administration and public management, as well as ‘department’ in the local government context, and ‘manager’ as an administrator or steward, i.e. the person handling the daily affairs. As described in section 2.5, strategic management is here understood as an intra-organizational approach within public organisations, as opposed to governance, as addressed in section 2.2.

Further, in relation to this thesis, the notion of GI management is of central importance here. GI management pertains to handling existing green environments, by maintaining and developing them, which is further

discussed in section 2.6.4. The relative interconnection between the broader view of management as spanning the entire public organisation, and the applied GI management specifically addressing existing green infrastructure is further discussed throughout this thesis.

2.5 Strategic management in public organizations

Public organizations span a range of different institutions. In this thesis, the focus on local governments and the way they address GI means that the structure of the organization, and the approach that is used to address GI are of interest. In the Nordic countries local governments, constituted of municipalities, have a main responsibility to both develop GI policies (Slätmo et al., 2019), and to realize them (Carmona et al., 2004; Randrup & Persson, 2009; de Magalhães and Carmona, 2009). Therefore, it is local political priorities that decide on developments of urban public GI (Dobson and Dempsey, 2020).

As a response to increasingly complex challenges as described in section 1, strategic approaches are increasingly utilized by public organizations (Ferlie and Ongaro, 2022). Opinions differ on whether this strengthened focus on strategizing was introduced with NPM, and more specifically aspects of managerialism (George et al., 2019; Johnsen, 2021), or if it has been an approach of serving public purposes throughout history (Bryson and George, 2020). What is new(er) however, the explicit adaptation of private sector management approaches to the public sector (Ferlie and Ongaro, 2022). Regardless of its origin, the purpose of a strategic approach is to provide direction, in both the long term and the short term, taking into account the constantly changing conditions inside and outside the organization. This means that strategic approaches strives for all decisions and actions throughout the organization to be based on strategies that are strongly endorsed and understood as critical for long term improvements in the organization (Poister and Streib, 1999).

Strategic management has been defined as *"an approach to strategizing by public organizations or other entities which integrates strategy formulation and implementation and typically includes strategic planning to formulate strategies, ways of implementing strategies, and continuous strategic learning."* (Bryson and George, 2020 p. 8). Other definitions include Poister and Streib (1999, p. 308) seeing strategic management as

"(a) focusing attention across functional divisions and throughout various organizational levels on common goals, themes, and issues; (b) tying internal management processes and program initiatives to desired outcomes in the external environment; and (c) linking operational, tactical, day-to-day decisions to longer run strategic objective"

The concept of strategy stems from early forms of organization, specifically around organizing warfare, as exemplified by Clausewitz (1832), discussing the strategic, operational and tactical levels of war as pertaining to the different types of required approaches. These notions have evolved into organizations outside warfare, and have been adopted by organizational (business) theory, in which the terms operational and tactical are often switched. However, strategic approaches take on specific conditions when addressed in the context of public organization. In relation to classical military literature, the main goal is often relatively clear in relation to intended outcomes; a battle is either won or lost, and the war equally so. Within business theory, there is also a reasonably clear end goal of profit. While this might not be the only goal, it often constitutes an uncontested foundation of business in general. Khalifa (2021), for instance and among others, decries the lack of a unifying definition and goes on to define strategy as a *"theory of winning high-stake challenges through power creating use of resources and opportunities in uncertain environments"* (Khalifa, 2020, p. 136). In comparison, the end goals of a public organization can be more complex (Kuipers et al., 2014), rendering the best or most strategic outcome more unclear. As described in the introduction, many of societies' current challengers are complex, and cross a range of sectors and policy domains (Candel and Biesbroek, 2016). What constitutes winning in this context is harder to pin down, and might in itself create new challenges, as understood in relation to their conceptualization as 'wicked'. In short, public organization strategies need to address increasingly complex sets of demands, while the ideal outcome might be less clear.

2.5.1 Policy and strategy in public organizations

Based on the classical view of bureaucracy, a focus lies in how the obligations of the different roles are understood and structurally organized. This distribution of roles and obligations is here conceptualized as levels, and sectors. The three levels are used as a structure for differentiating between different types of roles, decisions and actions, and their respective

scopes. In the context and research fields related to strategy, the topmost of the three levels is often described as the strategic level. This notion assumes that only the strategic level can take strategic decisions (Khalifa, 2021). However, one decision in itself, or a series of decisions that are not interconnected, are not strategic decision making. Therefore, strategic decisions do not only take place on one level, or in isolation from other decisions, meaning that interdependence is a defining attribute (Poister and Streib, 1999, Leiblein et al., 2018). This interdependence spans three dimensions; i) other contemporary decisions, ii) other actors' decisions, and iii) other decisions over time (Leiblein et al., 2018).

In the context of a public organization, long-term visions, acting as overarching guidance are often denoted policies. To circumvent the assumption that strategic decisions can only be taken at one level, and to further highlight interdependence as a key attribute for strategic decision-making (Poister and Streib, 1999; Leiblein et al., 2018), this thesis refers to public organizations' top level, as the policy level. This also follows Randrup and Persson (2009) and Randrup and Jansson, (2020), adapting strategic management in the context of GI. In the topical context of this thesis, this also functions as a way to highlight the political-administrational divide that characterizes public organizations, see fig. 3.

2.5.2 Implementation in the context of GI

The concept of implementation is widely used, and equally widely understood. Colloquially, the term means "*the act of putting a plan into action or of starting to use something*" (Implementation, 2024). This meaning is broadened in academia to encompass a wide range of fields. In the dedicated field of implementation science, implementation is defined as *"the act of fulfilling or carrying out an intention"* (Peters et al., 2013, p. 4), for example, putting research evidence into (healthcare) practice (Braithwaite et al., 2018). In closer range to this thesis, fields such as policy-implementation (Pressman and Wildavsky, 1984) within public administration literature, and strategy implementation (Noble, 1999) within organization literature address the connection between the organization's vision and its realization. Consequently, the often referred to 'implementation gap' can mean an array of discrepancies between an outset and its (practical) outcome (see Geertman, 2017; Wickenberg et al., 2021).

In academia, implementation has been accused of being characterized by an unstated and uncritical assumption of linear progress (Hupe and Hill, 2016) and denoting a *"mechanistic and linear approach"* (Braithwaite et al., 2018), with obvious drawbacks in the face of complex systems. While dynamic complexity inevitably makes the challenge much harder, "*we must grapple with the world we actually inhabit, not the one we wish we did*." (ibid., p. 12). This has been complemented by calls for bottom-up approaches to implementation, arguing that policy cannot succeed without having a 'grasp on what actually happens on the frontline'. This view leads to the argument that policies and their implementation should be integrated (Hudson et al., 2019), and that "*connecting actors vertically and horizontally in a process of collaboration and joint deliberation*" (Ansell et al., 2017, p. 674) is required for more effective policy design. As such, for policies to be implemented, engagement with multiple levels, including the down-stream implementing actors (the front-line staff), is required (Hudson et al., 2019)

However, implementation becomes even more challenging when the policy requires a long-term perspective (Hudson et al., 2019). Ilott et al. (2016, p. 79) identified three reasons that can be seen as immediately relevant to this thesis: i) "*Costs and benefits are distributed unevenly over time*", meaning expenditures are immediate while effects might linger, cutting across political cycles; ii) they may be "*hard to deliver*"; and iii)"*causes and effects span government siloes*", which risk losing coherence over time, and demands coordination between departments. As seen from the perspective of GI as a resource for HH&W, these implementation challenges clarify how i) the costs of investments and their effects might not be immediately connected. Further, GI also requires ongoing maintenance, which is an added cost, ii) the complexity of both GI and HH&W means that their interrelation is hard to concretize and evaluate, and iii) the GI-HH&W relation requires cross-sectoral collaboration to develop. Here, the mentioned benefits might mainly fall on the HH&W department, while the GI department has to cover most of the costs.

In relation to the physicality of GI, the concept of implementation ultimately involves some type of modification or change of physical space, see fig. 3. This is superficially similar to the idea of placing implementation at the operational level. However, as GI is dynamic and continuously developing, the concept of implementation becomes challenging.

This also raises the question of when is GI implemented. A common understanding of implementation suggests that it is after construction, e.g. when the tree is planted. Research on urban tree survival would contradict this, as studies show that 30% of planted trees die within a span of five years, and 50% after 13-18 years (Hilbert et al., 2019). In effect, an implementation gap exists between the action of planting trees, and the resources required to care for them (Roman et al., 2014; Breger et al., 2019). Instead, understanding that trees take several years to reach the intended size and functionality, implementation of GI is not set at a precise point which coincides with the finalization of a construction phase, but a more long term process.

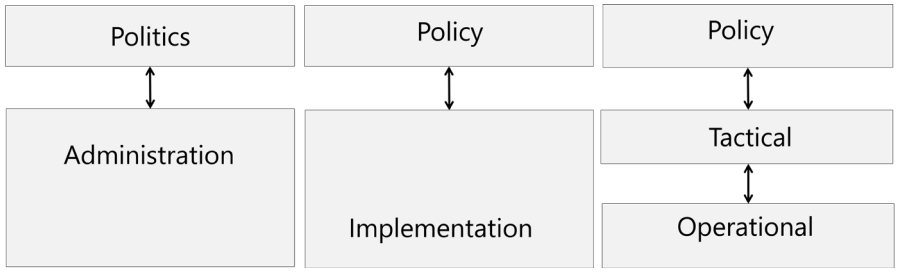

Figure 3. The differentiation of strategic levels in public organizations in the GI context through the lens of bureaucracy, policy implementation and strategic management

2.6 Strategic levels in public organisations managing GI

Based on the bureaucratic structure and the understanding of implementation described in the previous sections, three levels can be discerned in an organization. These three levels relate to different types of activities and decisions relating to a strategic approach to GI. Using the three levels as a strategic management approach have been used in landscape management (Borgström et al., 2006), but then primarily pertaining to different spatial and temporal planning scales. This entails that the strategic level refers to the regional scale and long term perspectives, down to the operational level pertaining to daily activities. This thesis refers to the three organizational levels (policy, tactical, operational) to signify different relations to GI, and how GI is handled in terms of overarching visioning or policy making, planning, design and management of GI, and GI implementation, see fig. 3.

2.6.1 Policy level as intention setting

The policy level refers to an overarching level in which visions and policies are drawn up, addressing the culture of the organization from a long-term perspective through norm setting (Randrup and Persson, 2009; Loorbach, 2010) and the creating of general guidance.

In building on the structure of the thesis, and based on the argument that actors on tactical and operational level are more than 'passive implementers' (Kanon, 2023, p. 2929) of policy, this thesis understands policy as 'intention' (Guba, 1984). This is in effect both a goal or vision, and a 'general guide to decisions' (Berke et al., 2012, p. 140) that serve to direct action on the other levels. While the policies are prepared and substantiated at the tactical level (Randrup et al., 2021), the policy level indicates the political level where these overarching visions and goals are set (see also section 2.5.1). Specifically, the comprehensive plan is understood as an urban policy document specifying and prioritizing land use on a municipality scale, also reflecting political long-term ambitions (Aguiar Borges et al., 2017) .The plans are expected to guide decision-making to reflect political intentions in succeeding planning phases (Norton, 2008). As such, they are crucial as long-term visions to guide use, development and conservation. In local government planning the comprehensive plans serve the three levels, by setting long-term goals on how to prioritize land use and establish a politically based vision on what values to prioritize in more detailed levels, see fig. 4.

2.6.2 Tactical level as unifying ideas guiding action

The tactical level is often described as a 'bridge' between the level above and below it (e.g. Gustavsson et al., 2005; Borgström et al., 2006). Kelly and Brennan define the tactical level as: *"the sequence of [operational] actions connected by a unifying idea"* (2009, p. 90), in effect coordinating and integrating the effects of operational decisions (Grey, 2015). The level is comprised of institutional interactions, ranging on the meso-temporal scales (Borgström, 2006, Loorbach, 2010). This is usually divided into sectors or subsectors; in a public organization this is often done through departments with a thematic focus, such as technical departments responsible for public GI or social departments responsible for public health. In the context of urban GI, the 'unifying idea' can be understood as the outcomes of planning and design, where both steps serves as guides for operational actions, albeit in

different phases and in different ways. Here, the long term and large scale perspective from the policy level is often broken down into shorter time frames and thematically or geographically delimited foci. This includes making plans and programs, regulations and frameworks, in effect translating the decisions made at the policy level into operational targets by choosing between possible approaches (Randrup and Persson, 2009; Loorbach, 2010). While referred to as one level, it is important to note that this level can be comprised of several hierarchical steps, both in the organization and as several levels of steering documents with increasing resolution.

Planning as tactical level practice

In the contexts of landscape, landscape planning has been defined as a *"strong forward-looking action to enhance, restore or create landscapes"*. (CE, 2000). Planning encompasses a broad field of practice and research, so much so that Alexander (2022) argues that there is no planning as *a* recognizable practice, suggesting instead three types of planning practices "i) Generic 'planning'—what people do when they are planning; ii) Knowledge-centered 'something' (e.g., spatial) planning; and iii) Real planning practiced in specific contexts." (ibid, p. 182). One part of knowledge centered planning deals with spatial matters, which is done through spatial plans such as comprehensively addressing land use visions, or detailed plans setting site-level building regulations. Planning is also interlinked with strategic matters (Randrup and Jansson, 2020). Plans can address existing spaces or planned developments as a part of a strategic planning approach (Mäntysalo et al., 2015). In practice, policies are also produced at this level, but politically decided. The role of planners is to coordinate, steer and facilitate other actors´ activities, but generally they do not have the funds nor any implementing powers themselves (Othengrafen and Keitel, 2019). Related to the described organizational levels, the roles responsible for GI planning address different but interlinked issues, at the policy and tactical level but not the operational level (Jansson and Lindgren, 2012; Whitten, 2020), see fig. 4.

2.6.3 Operational level as implementation

The operational level often refers to the practices and everyday activities that implement plans and goal. In this thesis, as it relates to GI, this is understood

as the level of practical implementation (Borgström et al., 2006), which involves dealing with the physical environment on the local or site scale. This level is often seen to be short-term, spanning varying lengths, depending on the focus, from days to one or a few years (Gustavsson et al., 2005, Borgström et al., 2006, Loorbach, 2010) in the case of a construction project.

Maintenance of GI as operational level practices

The notion of maintenance as operational activities are often understood as the short term and every-day actions of tending to GI. Gustavsson et al. (2005) exemplify this as the very physical activities of tending to the vegetation that comprises GI, whereas Randrup and Persson (2009) also include the steering documents that are used to operationally organize these activities such as action plans, tendering material and maintenance descriptions. See further in section 2.6.4. Earlier definitions of maintenance such as Tregay's (1983, p. 276) "*the complex of everyday operations involved in the care of a landscape*". This also, albeit vaguely, emphasizes a broader view than just pertaining to performing the operational activities. The term itself has the immediate meaning of preservation, or keeping in a fixed state, with a focus on keeping designed GI features in their intended form through, for example, lawn mowing, pruning or hedge cutting.

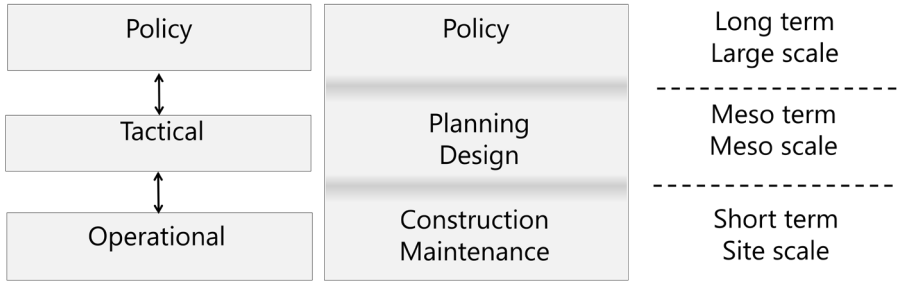

Figure 4. Organizational levels, types of activities, and their temporal and spatial scales.

To summarize, the thesis follows a traditional understanding of organizations, using the three-level structure to conceptualize and emphasize the hierarchical structure that characterizes public organizations. This is argued to still be relevant (Kanon, 2023; Sørensen and Torfing, 2024) despite the governance paradigms that have developed in response to the consequences of this structure. Here, the hierarchical approach to decisions are conceptualized as decisions taken at different organizational levels.

The organizational model is, as such, used to structure a hierarchy of decisions. The policy level relates to the overarching political decisions in terms of setting a vision and general, high level guidance for development. The tactical level is understood as the phases of planning and design which concretizes overarching visions, via unifying ideas to guide operational actions. The operational level is the actions that implement them in physical space, such as construction and maintenance.

This thesis does not take this view as a normative assumption, arguing that this is how an organization should be structured. Rather, it rests in the interface of a bureaucratic organizational structure and an increasing demand for a strategic approach. The division of the three levels is thus argued to be suitable to differentiate and interrelate different types of roles, decisions and activities currently affecting how GI is handled in how it is envisioned, created or developed, and handled over time.

2.6.4 The role of GI management – operational, tactical or strategic?

When looking at management as activity (Gustavsson, 2005), in the context of managing GI, the applied setting offers additional understanding, as well as some inherent contradictions. Efforts have been made to define management in a landscape context (Jansson and Lindgren, 2012), pointing to multiple subsector related usages that cater to its specific context but which are hard to translate to others. In their review, Jansson and Lindgren offer the definition of "*activities performed by a management organization in order to maintain and develop existing urban green space for users*" (p. 142). Similarly, Dempsey and Smith (2014, p. 24) describe management of a place as "*maintaining and enhancing [a place and] its quality to maximize the benefits for users*".

The first key notion of GI management is that it immediately refers to a spatial context; it is about managing a physical space (Dempsey et al., 2014). This presents a core difference to the concept of management in a more general term, since the phenomena that is 'cared for and steered' is the physical space, the vegetation and related elements that constitute urban GI. Second, both sets of definitions emphasize the developmental aspect, beyond maintaining existing qualities indefinitely. Later definitions, such as the one proposed by Jansson et al. (2020, p. 12), "*A strategic, inclusive and long-sighted approach of continued re-planning, re-design, re-construction and maintenance*", further highlight the long-term perspective. In this iteration,

the concept of GI management goes beyond the operational, also dealing with strategic and tactical issues. These three notions are combined in the Park-Organization-User model, as described by Randrup and Persson (2009), later developed by Jansson et al. (2020) to encompass urban open space, see fig. 5. By addressing GI management instead of 'green space management', this thesis focuses on the multiscale perspective, both in a geographical and temporal dimension, as well as green environments that might not immediately be understood as 'urban green space', such as peri-urban forests.

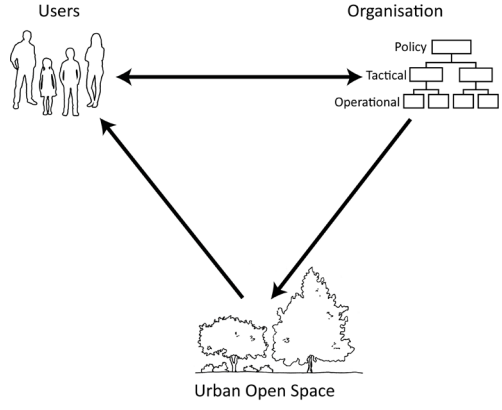

Figure 5. The Park-Organization-User model. Reproduced from Randrup and Persson (2009); and Jansson et al. (2020).

From the landscape perspective, the notion of management can be found in the European Landscape Convention (CE, 2000), understood as *"action from a perspective of sustainable development, to ensure the regular upkeep of a landscape, so as to guide and harmonize changes which are brought about by social, economic, and environmental processes"*. In this context, management is understood as one of three central pillars of the landscape perspective, together with planning and design, reflecting how the field is understood in practice (van den Brink et al., 2016). This division is often furthered as planning often lies in a 'planning department' and management and maintenance responsibilities in a 'technical department' (Dempsey and Burton, 2012; Jansson and Lindgren, 2012; Coquand et al., 2017). Despite this division, the interface between planning and management is not always distinct (Jansson and Lindgren, 2012) but is instead jagged and overlapping (Dempsey et al., 2016). Still, from an organizational perspective, the related processes are often separate, despite the fact that these practices are deeply

interwoven (Dempsey and Burton, 2012). This disconnect separating planning and management, together with a prevalent 'linear logic' of landscape development processes (Jansson et al., 2020), leads to a procedure where places are first planned, then designed and then managed (or rather maintained) ad infinitum. (Dempsey et al., 2014). This view results in GI management often being considered to be the 'end-phase', with little relevance beyond the maintenance of constructed spaces, with operational effectiveness being the main focus (Randrup and Persson, 2009).

This also offers a potential explanation for why management is often confused with, or used interchangeably with, the concept of maintenance (Jansson et al., 2020; Wiström et al., 2023) as exemplified by, for example, La Rosa et al. (2018) and Douglas et al. (2017). Confusing management and maintenance meaningfully removes the notion of continuous development, and the evaluation or experience gathering generated from created plans and constructed places. This effect can be seen in the general trend of declining political focus on the management of GI, for example, through a decrease in the organizational tier where responsible leaders are situated (Randrup et al., 2021). In conjunction with rising budgetary constraints (Lindholst, 2017; Fongar et al., 2019), as development of new spaces is more in focus, maintenance and long-term management becomes neglected (Dempsey and Smith, 2014).

This lack of resources has led to an increasingly operational (Randrup and Persson, 2009) and cost-focused approach in technical departments (Lindholst et al., 2015). This approach has been argued to be further increased through the NPM-ideals (Ferlie and Ongaro, 2022), stressing a focus on a technical overview of the areas to be procured (Lindholst et al., 2015). As external private actors perform the routine management tasks traditionally done by internal actors, work becomes based on technical descriptions of the maintenance to be performed. This results in a focus on creating detailed descriptions of fragmented GI elements (hedges, lawns, trees etc., (Lindholst et al., 2015), i.e. an object based approach, with no connections to overall green space function and use *(*Beer et al., 2003*),* resulting in a static approach to urban green spaces (Nuppenau, 2009; Lindholst et al., 2015). This means GI managers became managers of contractors (Kettl, 2000) rather than contributors to policy making or developers of the existing GI (Randrup and Persson, 2009). This means they are, in effect, "*Managing contracts not managing parks. Taking our eyes off*

the horizon" (Jones, 2000, p. 25). The way these contracts are managed has been described by Hansen et al. (2020) as contract management. There is a difference between 'hard' contract management, and 'softer' approaches. The former has heavy emphasis on what the formal contract details, which is seen as a foundation for the relationship, and the latter see the contract as a communication tool and the basis for collaboration (ibid.). In the softer approach, the exact details of, for example, maintenance descriptions are thus not as critical for the work and the collaboration.

2.7 Analytical frameworks and concepts

Based on the detailing of the organizational levels, and the discussion on the roles of GI management, the analytical frameworks used in this study are presented here. The framework used in Paper I was developed as part of the sub-study and is presented in the section 3.4.

2.7.1 Aligning levels and sectors in public organisations

When analyzing interdependencies in the chains of decisions and actions between the organizational levels within a specific issue, specifically those spanning more than one sector, the Programmatic alignment model (Singh et al., 2021) offers a lens through which these strategic interdependencies can be understood. The model highlights how a (cross-sectorial) policy objective connects vision and operational activities, and how horizontal and vertical alignment together form programmatic (overall) alignment. While the original model approaches the scales of national–regional–local governments, this adapted version addresses the intra-municipal scale, which is embedded in the larger model, with a focus on intra-organisational alignment. The increasing complexity of societal challenges entails demand for cross-sectoral, or cross-departmental, collaboration to rise, or at the very least the anchoring of intended directions among a range of affected departments or sectors. Cross sector collaboration can be defined as *"the linking or sharing of information, resources, and capabilities by organizations in two or more sectors to achieve jointly an outcome that could not be achieved by organizations in one sector separately"* (Bryson et al., 2006, p. 44). In this thesis, this means collaboration between different departments (e.g., technical department and health departments), which is crucial to move towards horizontal alignment, see fig. 6.

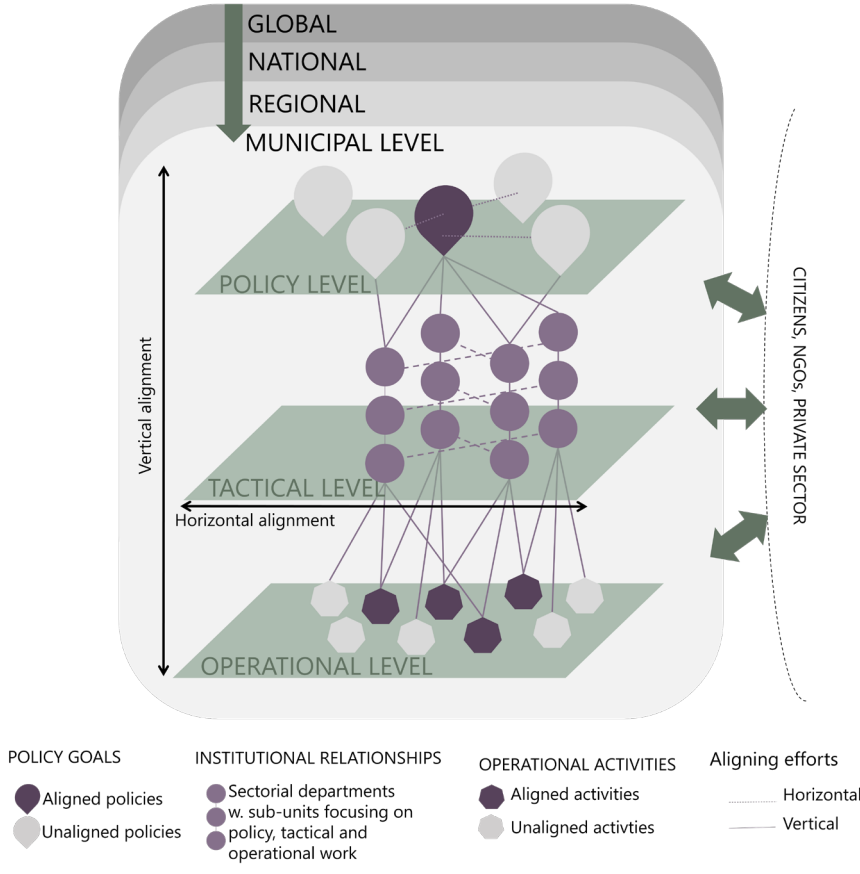

Figure 6. The programmatic alignment model, adapted from Singh et al. (2021) (CCBY). Modified from Sunding and Randrup (2024), with permission.

Beyond the need for horizontal alignment, an aligned approach across organizational levels (referred to as 'vertical alignment', see fig. 6) is required to ensure the transformation of cross-sectoral visions into action through the coordination of distinct and overlapping activities. The distinction between horizontal and vertical alignment can be slightly muddled in practice. For instance, in most local governments, GI planning and management are dealt with in separate departments or units (Carmona et al., 2004), while arguably addressing issues pertaining to the same sector (Coquand et al., 2017; Persson et al., 2020). Here EC (2020) defines cross-level as an integrated part of a cross-sectoral approach. In this thesis, they will however remain as two notions.

A core aspect of this framework is that it prescribes a combination of top-down and bottom-up approaches. As such, its primary focus is not only to analyze how policies are formulated but also how practical experiences, local knowledge, and professional initiatives can inform policy. As such, the framework offers a way to look at how different sectors and levels interact in order to identify which aspects support or hinder the implementation of pursued visions. Furthermore, the framework allows an evaluation of policies from an operational practice perspective.

Programmatic alignment occurs when both the horizontal and vertical components collaborate on a specific issue. In other words, the three levels must be synchronized, and simultaneously, overcome inherent barriers between thematically specialized departments (e.g., health and GI planning and management). As the notion of programmatic alignment goes beyond individual policies, actors or functions, it sheds light on the systemic aspects of continuity throughout the organization.

2.7.2 Four models of GI management

In relation to the contested role of GI management, the following models challenge the linear view resulting in management being understood and end-phase with a short term perspective. However, they do so with slightly different focus. A comparison of the four models detailing how they are used in this theses is presented at the end of this section.

Strategic (GI) management

Strategic GI management (Randrup and Persson, 2009; Jansson et al., 2020) emphasizes the cyclical nature of development, where public urban open spaces, including GI are re-planned, re-designed, and re-constructed in an iterative approach, see fig. 7. The model can be read in two ways. In the first way, the model represents an organization-spanning idea, including planning and design in their broader meaning The second way implies primarily addressing the GI management context, with the notion of 're-planning'(see definition in section 2.6.4), indicating that the initial planning phase is not part of the management process. This model clearly distinguishes a difference between strategic management as having an overarching, long-term perspective, and maintenance being a part of management, together with re-planning, redesigning and re-construction on a continuous time scale.

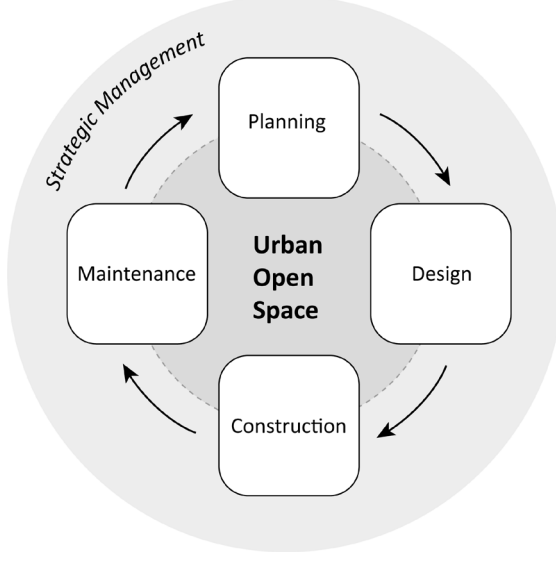

Figure 7. The process of strategic management. Reproduced from Randrup and Persson, (2009); Jansson et al. (2020).

Place-keeping

A similar concept can be found in place-keeping, which relates to the concept of place-making, which entails planning and design processes (Dempsey and Burton, 2012; Dempsey and Smith, 2014). Place-keeping is understood as "*responsive long-term management which ensures the social, environmental and economic quality and benefits a place brings can be enjoyed by present and future generations*" *(*Dempsey and Smith, 2014*,* p. 9). This understanding sees management as a process that both develops and maintains the 'product' of place-keeping, i.e. the created place (GI). It further emphasizes the multifaceted process of long-term management as encompassing policies, governance, partnerships, funding, and evaluation beyond the design, management and maintenance of the place. However, the notion of place-keeping is deepened by a conceptual analysis of the interrelation between design and management (fig. 8). Here, the relation goes from a linear process, where the design informs maintenance but not the other way around (fig. 8a), to a similarly linear process in which aspects of management and maintenance are taken into consideration at the design stage (fig. 8b). Ultimately, management acts as a driver, with design a part of the long term process, happening at varying intervals (fig. 8c).

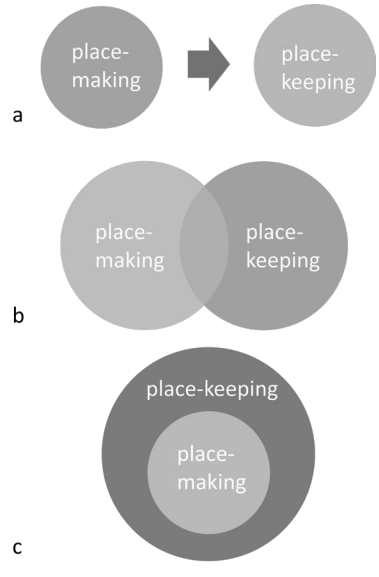

Figure 8. Three versions of the relationship between place-making and place-keeping Reproduced from Dempsey and Burton (2012) with permission.

Adaptive management

Adaptive management, rooted in urban forestry, can be understood as "*a systematic process for continuously improving management policies and practices by learning from the outcomes of previously employed policies and practices"* where *"management is treated as a deliberate experiment for purposes of learning*" (FAO, 2016, p. 125). Adaptive management adds to strategic GI management and place-keeping, emphasizing how policy and ongoing maintenance continuously feed into each other (Randrup et al., 2023) through ongoing feedback. This also highlights the need for continuous monitoring (Arhern et al., 2014; FAO, 2016), see fig. 9. Adaptive management thus offers a focus on the continuous feedback across levels and activities as a way to tackle wicked challenges that the organization is addressing (de Boo and Wiersum, 2002).

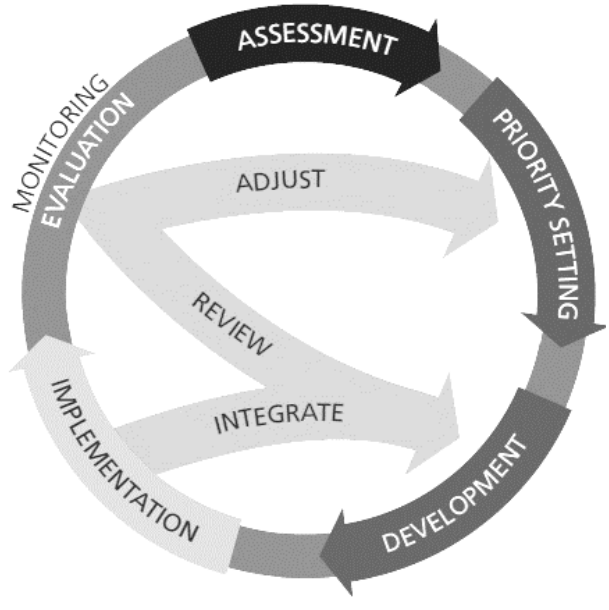

Figure 9. The urban forest management cycle as adaptive management © FAO (2016).

Creative management

Creative management (Nielsen at al., 2023), stemming from the urban forestry approach, further addresses the unpredictability, inherent dynamics, and opportunities of GI. Highlighting a common separation between 'parks' and 'forests', parks have been developed under the described linear manner expecting little or no change over time, while forests have been absent in landscape architecture, and instead been under the responsibility of foresters and ecologists (Nielsen et al., 2023). The notion of an initial design is here understood as a starting point (Gustavsson, 2004), where creative management becomes 'design over time' (Nielsen et al., 2023). This underlines the creative character of operational management, further disrupting the separate phases and clearly divided responsibilities, and introducing an open-endedness to the process of vegetation development (Nielsen and Szanto, 2023). Here, a direct, albeit very place-based, parallel can be drawn with place-keeping, where management is seen as a driver of the process, while also containing an element of place-making (Wiström et al., 2024), in effect meaning designing on site (Franch, 2018).

Contributions of the four management models

All four presented models are used in varying ways in the Thesis. Table 4 describes each characteristics, and how these are applied in the sub-studies. They all move away from the linear understanding of policymaking, planning, design and maintenance, and the view of operational activities in GI as pertaining to maintaining stasis or simply enacting a policy. Likewise, they emphasize (to different degrees) the cyclical process of development through repeated, strategic action acknowledging the long term nature of GI, but they do so focusing on different aspects and parts of the process. Each model contributes to the development, description and analysis of the various sub-studies. In the context of the thesis, they represent a unification and documentation of the importance of a long-term approach to GI management, as an overarching process to GI development.

Table 4. An overview of the four GI management concepts, their relative foci and how they are used in this study.

	Thematic focus	Main point	Use in this thesis
Strategic(GI) management	i) Descriptive ii)Organizational	a) Management as a developing process (including maintenance) b) Management as an overarching process encompassing all activities pertaining to the long-term "handling" of GI	Used to develop and clarify the temporal aspects of programmatic alignment in Paper II
Place-keeping	i) Descriptive ii) Conceptual	a) Management as process (more than maintenance of a product) b) management as driver for development	Used to describe the interrelation between design and management in Paper III
Adaptive management	Processual	Capacity building in the face of uncertainty	Complementing place keeping in Paper III, adding a processual notion to management as a continued driver
Creative management	Conceptual	Design-by-management: design as a continuous process based on strategic operational interventions on vegetation	Complementing place keeping in Paper III, in describing how management becomes design

3. Research design and methods

This section outlines the research design and briefly introduces the project which the study was part of. The municipalities comprising the case study are introduced, and the data collection and analysis methods are detailed for each of the three papers.

3.1 Research design

To meet the aim of the study and respond to the research questions, this study applied a qualitative (multiple) case study approach. This approach is often focused on exploring the nature of the research problem (Baškarada, 2014) and also the related processes that surround it (Flick, 2007). Adhering to a qualitative approach, the point here is not to find the one true answer for the research questions but see the value in providing insights into different perceptions and understandings on the topic of the study.

The structure and methodology of this study grew out of the increasingly crystallized focus on the three organizational levels, as they are described in section 2.6, see fig. 10. As such, this study was not 'designed' in the sense that it was not fully planned beforehand and then executed (for a similar notion see Becker, 1961, p. 17). The outset of the larger research project detailed in the next section constituted a starting point, and my own research interests, spurred by the insights I gathered along the way, functioned as pathways for development as time went on. Here, the programmatic alignment model was an important waypoint, which was ultimately used to structure the interrelation of the three sub-studies and shape the overall narrative of the study.

With the assumptions that follow the view of organizations presented in this thesis(see section 2.6), the structure allows for an exploration of GI in terms of i) what formal (cross-sectoral) visions are set up, ii) how they are formally and informally addressed in the everyday work, and iii) how this affects site specific projects and processes. Table 5 details the research questions for each sub-study.

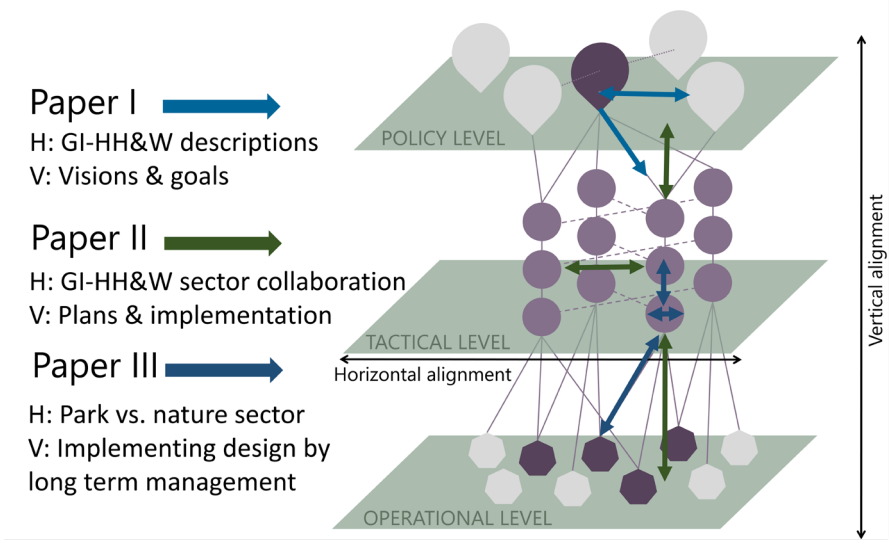

Figure 10. The three sub-studies and their interrelation in an organizational context. H: Horizontal focus V: Vertical focus.

Table 5. Research questions for each of the three sub-studies.

	RQs per sub-study
I	How is the GI-HH&W relationship described in Nordic comprehensive plans?
	a) How is relevant terminology used to describe GI and HH&W?
	b) How are the concepts of GI and HH&W connected?
	c) Which goals are mentioned as regards the GI-HH&W relationship?
II	How do involved practitioners address the relation between GI and HH&W in their daily work?
	Which factors support or hinder the promotion of HH&W in GI planning and management?
III	What characterizes practices and discourse in creating and managing urban GI?
	What are the organisational capacities needed to strategically address long-term nature-based park design and management?

A multi method approach combining document analysis, interviews and workshops was used to address perspectives on how GI is handled in a multilayered and cross-sectoral context in different settings, see table 6.This was further done to methodologically triangulate the cases to gain deeper insight into the study at hand.

The document study on comprehensive plans (6 cases) constituted a starting point to gain insight into how GI and related goals are described, specifically in relation to HH&W. The semi-structured interviews (4 of the 6 document analysis cases) allowed for a wide perspective on different professional's perceptions on their general everyday work, addressing GI-HH&W relations. The workshops (held in one of the 4 interview cases) further put these general perspectives and perceptions together in the context of a particular site, where all the challenges, demands and processes in the spatial, administrative and organizational domains come together to affect the potential outcome of the ambitions.

Table 6. An overview of data collection and analysis methods.

	Case focus	Data collection	Data analysis
Paper I	6 Nordic municipalities	Textual data	Content analysis
Paper II	4 Nordic urban municipalities	Semi-structured interviews	Thematic analysis
Paper III	1 Swedish urban municipality	Workshop and semi-structured interview	Thematic analysis

3.1.1 The study in the context of the NORDGREEN project

This study was done as a part of the NORDGREEN project, (https://nordregioprojects.org/nordgreen/), funded by NordForsk, the Nordic Council of Ministers. The aim of NORDGREEN was to support integrated planning efforts for urban sustainability by developing and implementing smart planning and management solutions for well-designed, high-quality greenspace that promotes equity, health and wellbeing. Here, Nordic practice was studied in order to understand how different local approaches to planning and management influence the outcome, with a particular focus on health, social sustainability and co-production.

The NORDGREEN project, led by Nordregio, included three work packages: WP1) Monitoring and Assessment, led by Norwegian University of Life Sciences NMBU in Norway and Swedish University of agricultural

Sciences, SLU in Sweden; WP2) Citizen Engagement, led by Aalto University in Finland; and WP3) Governance and management led by SLU in Sweden. This PhD-study comprised the entirety of WP3, starting with public organizations and its role in delivering health promoting GI. The other WPs focused on statistical analysis of GI and HH&W characteristics (Nordh et al., 2024), the evidence based, health-promoting design of GI (Bengtsson et al., 2024), and public participation in using GIS (PPGIS) (Kyttä et al., 2024). The overarching interrelation of the WP's is described in fig. 11.

A key outcome of the project was a handbook created to address the relationship between GI and HH&W through organizational, statistical, technical, and design approaches. The chapter produced in conjunction with this PhD-project presented the programmatic alignment model in a manner that is practically applicable for practitioners (Sunding and Randrup, 2024).

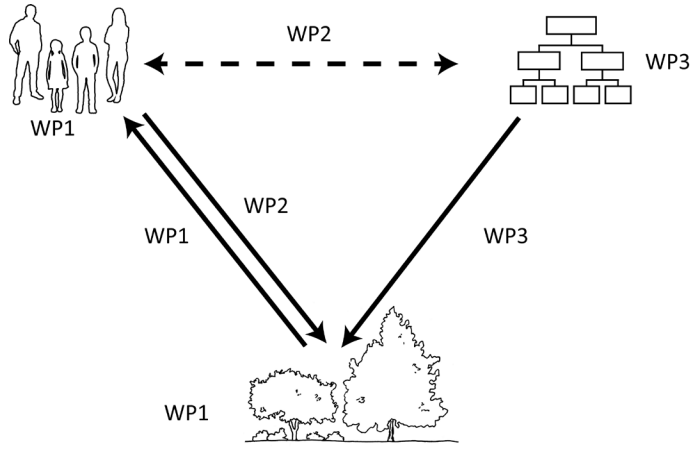

Figure 11. An overview of the NORDGREEN work packages. Based on and reproduced from Randrup & Persson (2009).

3.2 The collective (and the single) case study

The overarching methodological approach starts as a collective case study, comprising six municipalities. While the cases are selected as instrumental (Stake, 1995), meaning they are used to get more insight into a specific issue, the intention of this specific sub-study is to explore the local context, rather than to create a generalization, described by Stake (2006) as 'particularization'. The six municipalities from four different countries adhere to different legislation and regional contexts, just as they differ in spatial size and population. However, in relation to the overarching aim of this thesis, they all address similar societal challenges and respond with intended future developments, and they all address visions via planning and management approaches.

In multi-case studies, the balance between the focus of the overall study, and those of the individual cases needs careful consideration. In this thesis, a combination of factors led to the choice to decrease the number of cases across the individual studies. While remaining in a situated and qualitative context, moving from six to one municipality means tightening the focus from more general and overarching perspectives, and going into the particulars of a specific project to explore the myriad of interrelated issues that affect it. In effect, successively decreasing the number of cases allows a progressively more situated insight into the studied phenomena.
Secondly, this approach mirrors the overall research design, starting with a more overarching view on the general and overarching planning documents. The focus successively moved to a more place-based perspective, where a deeper view of administrative and processual details was explored; *"It all becomes more complex as is becomes better known"* (Stake, 2006, p. 8).

3.2.1 The municipalities and selection criteria

From a global perspective, the countries often viewed as making up the Nordic model (Knutsen, 2017), Sweden, Norway, Finland and Denmark, share many commonalities. The empirical basis for this study is based on the six Nordic municipalities: Täby (SE) and Espoo (FI), which are part of metropolitan regions; Aarhus (DK) and Stavanger (NO), which are medium sized cities; and Vilhelmina (SE) and Ii (FI), which are small rural towns, see table 7 and fig. 12. The six municipalities acted as partners in the NORDGREEN project and, as such, were used across all WPs to facilitate deeper insights and collaboration across the WPs.

Table 7. Population, urbanization, geographical location, and area of the six selected municipalities.

	Täby SWE	**Espoo FIN**	**Stavanger NOR**	**Aarhus DEN**	**Ii FI**	**Vilhelmina SWE**
Pop. (2021)	73307[1]	293576[2]	142985[3]	352341[5]	9848[2]	6667[1]
Urbanization	Town	City	City*	City	Rural	Rural
Geographical setting	Capital area	Capital area	Second-tier city	Second-tier city	Rural	Rural
Area tot. km^2	71[1]	528[3]	262$_4$	468[5]	2873[3]	8740[1]
Area land km^2	60[1]	312[3]	256[4]	-	1614[3]	8047[1]

[1]SCB (2021) [2]Statistics Finland (2021) [3]Lantmäteriverket (2021), [4]SSB (2021), [5]DST (2021)
*before merger with two rural municipalities.

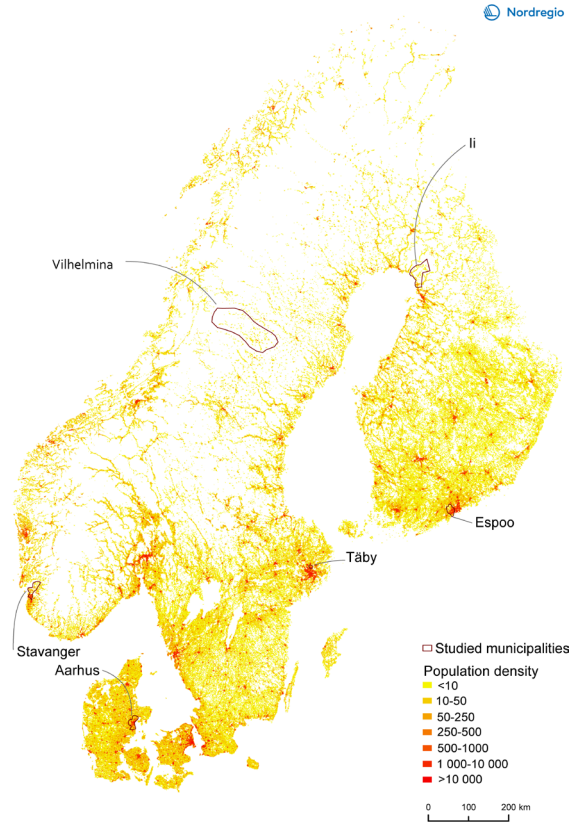

Figure 12. The spatial distribution and overall population density of the six selected Nordic municipalities Reproduced from Paper I, Sunding et al. (2024). Image: Oskar Penje, Nordregio.

As a collective case, the municipalities were chosen as potential sources of best practice, based on experiences in related fields, such as being acknowledged for sustainability ambitions as was the case for Espoo (Zooteman et al., 2016), smart city research in Stavanger (Haarstad, 2017; Stavanger, 2016), and comprehensive participation in research projects in Aarhus (Hansen et al., 2016; Frydenlud et al., 2020). The GI-HH&W relationship has been the focus of research in Täby (Åshage and Bengtsson 2021; Bengtsson et al., 2025), and green comprehensive planning research has been the focus in Vilhelmina (Storslagen Fjällmiljö, 2023). Further, Ii has had a success in their of carbon neutrality goals, which has been recognized in a European context (EC, n.d.). The cases can therefore be expected to be instrumental (Stake, 1995, p. 3) as potential forerunners in terms of contributing to and applying research generated knowledge to every day work, meaning that both their common traits distinctiveness are of interest (Stake, 1995). In particular relation to the third sub-study, Täby has a long record as an innovative public organisation when it comes to applying new GI management approaches (Bretzer et al., 2020; Kristoffersson et al., 2020).

3.3 Data collection methods Paper I-III

For the first sub-study, textual data was collected. In the second sub-study, semi structured individual interviews were conducted, and in the third, data collection consisted of recordings of a series of workshops conducted with a group of stakeholders.

3.3.1 Textual data

In the first sub-study, the aim was to identify the conditions in Nordic land use planning for further strategic interventions in the use of GI, here exemplified by health-promoting GI, see table 5. The comprehensive plans of the six city-partners were used as central policy documents, guiding the intended spatial and strategic development of the respective municipalities (Norton, 2008). In the Nordic context, it is a statutory requirement to have a comprehensive plan, but there are national variations on whether the plans themselves are legally binding or just advisory. The comprehensive plans function as the most overarching spatial planning tool on a local government level, highlighting political long-term ambitions (Aguiar Borges et al., 2017).

Therefore, studying the comprehensive plans provided an insight into the formal visions each city formulated at policy level.

Selection of plans

The currently valid comprehensive plan was selected for each municipality. For details on the plans, see table 2 in Paper I. The plans were found via the webpage of the respective municipalities.

The data collection protocol

A protocol (see appendix B in paper I) inspired by Woodruff and BenDor (2016) was created to guide the data collection in answering the RQ. To test the protocol, two plans were independently read and coded by me and a co-author, followed by a systematic comparison of selected codes, similar to Baker et al. (2012). The comparison proved that the selection criteria were sufficiently clear, with only minor adjustments needed for the interpretation of selected codes.

Inspired by Cortinovis and Geneletti (2018) and drawing on Baker et al. (2012), two types of data were collected, i) the information base, i.e. background or general information used to support planning decisions, and ii) the visions and goals which state the "long-term vision of the plan and the targets (either qualitative or quantitative)" (Cortinovis and Geneletti, 2018, p.299), meaning statements that describe the ambitions of the general and specific objectives of the plan. To complement the goals, strongly worded polices (i.e. containing words such as "must" or "shall") were included. As comprehensive plans are the most overarching planning document on municipal level, few direct actions were expected to be found, and therefore these concepts were left out of the collection procedure.

The data collection process

As described in the previous section, two of the plans were read by me and one of the co-authors (STA, TÄB). The remaining four plans were read and coded by me to ensure consistency (see also Baker et al., 2012). All six comprehensive plans were re-read twice or more, and key sections, sentences, or terms that corresponded to any of the data collection criteria were marked and copied to a spreadsheet.

All plans were read in their original language except the Finnish plans (ESP, II), which were translated to English using an automatic online translation service that maintained the layout of the original document,

enabling side-by-side comparisons. When the English text was checked, nonsensical translations were compared with the original document. The two translated plans were also read by a native Finnish speaker (a partner in the NORDGREEN project), in order to confirm the quality of the translations, re-translate specific sections, and ensure no relevant meaning was missed from the Finnish original text.

3.3.2 Stakeholder interviews

For the second sub-study, the aim was to explore how relevant practitioners address the relation between GI and HH&W in everyday practice, and what factors affect the work, see table 5. A semi structured interview approach was applied to ensure flexibility around the topic and to better understand the differing perspectives of the different roles represented among the stakeholders (Baškarada, 2014). Three different roles (GI planner, GI manager, and health strategist) were selected to capture both cross-sectoral and cross-level perspectives from policy to operations. Each interview was based on the interviewees' current job situation and thus assessed how interviewees perceived the local context.

Selection of stakeholders

Stakeholder interviews were conducted in four of the six NORDGREEN case cities. Invitations were sent out according to Appendix A in Paper II, and the two smallest municipalities declined to participate, primarily due to a lack of personnel at the time of interviews. In order to gain the benefits of a multi-case study, Stake (2006) suggests no fewer than four cases. Therefore, the four municipalities involved were deemed suitable, representing a more urban focus than the first sub-study.

Three interviewees were selected from each of the four municipalities. They covered the overarching and/or tactical planning levels, green space management responsibilities which pertain to the tactical and operational levels, and responsibilities for public health, as seen primarily from a strategic perspective. Interviewees were selected by the formal NORDGREEN city partner representative with written role descriptions (see Appendix B in Paper II), who suggested relevant interviewees. In all cases, the municipal contact was either a physical planner or a park manager familiar with the different roles within the various planning processes and subsequent construction and management phases.

The interview guide

To gain a broad insight into the differing perspectives of the selected roles, the interview guide consisted of 5 themes related to the organizational setting of the GI–HH&W nexus. The themes include i) professional role and work, ii) cooperation with internal and external actors, iii) use of plans and strategies, iv) monitoring and evaluation, and v) looking forward/future development. Each theme consisted of a group of questions, presented in Appendix C in Paper II.

The data collection process

Semi-structured individual interviews (Baškarada, 2014) were conducted as video calls between September 2021 and February 2022. The interviews lasted between 50 and 85 minutes. A week before the interview, the interviewees received an email describing the overall focus of the study, stating that the interview was voluntary and anonymous, and describing the overarching topics to be discussed during the interview (see Appendix B in Paper II). The choice to present the overarching topics was made to allow interviewees to reflect on the themes beforehand without the risk of over-preparation in terms of formulating specific responses to the detail level of the interview questions.

Swedish, Danish, and Norwegian interviews were conducted in their respective languages, i.e., the interviewer spoke Swedish and the interviewees their mother tongue, using English terms when clarifications were needed. Two Finnish interviews were held in English and the third was held in Swedish, which is an official language in Finland and is spoken by 5% of the population. Interviews were recorded using the software Zoom, transcribed verbatim, and timestamped using Word 360, an automatic transcription service. The interviews were then listened to in their entirety, and the texts was corrected for mistakes with appropriate clarifications made, with the final texts spanning between 7000 and 13,700 words.

3.3.3 A single case study

For the final sub-study, the single-case study approach was used to gain a deeper understanding of the extent to which design, construction and management practices align with emerging ambitions of nature-based approaches, see table 5. In effect, this entails a particular focus on the interface between the tactical and the operational level. In a European

context, Täby municipality is here argued to represent an 'extreme case' (Flyvbjerg, 2006), in effect, *"unusual cases, which can be especially problematic or especially good in a more closely defined sense."* (ibid. p. 230). What is unusual or extreme about Täby is the fact that it has all of its operational park management outsourced, combined with a history of innovative approaches to contracting out. The 'Täby model', introduced in 2004, was an experimental approach with a strong focus on collaboration and joint interpretation of output-based descriptions and ambitions (Kristoffersson et al., 2020). In this sub-study, the story of the innovative approach to contracting out park management is addressed in the context of ambitions for a new city park, which utilizes a design-by-management approach (see section 2.7.2). This approach demands a longer establishment period than conventional projects, as well as having a different approach to the relation between design and management than 'conventional' parks. The case study approach taken here permits a deeply situated exploration of the interface between the unique context of a new park design, and the governance of park and forest management in Täby.

Workshops

In order to explore the alignment between design and management practices, this sub-study utilized workshops as research methodology, following the definition given by Ørngreen and Levinsen (2017). In this format, the workshops are authentic and aimed at achieving predefined goals; they also produce data about a specific domain or topic. The workshops were authentic in that they were intended to provide the participants with opportunities to discuss and develop approaches to the current challenges and the demands that came with the proposed park. This was done while addressing and reflecting on the different perceptions and experiences that came from the different practices represented by the participants.

To align the expectations and contributions from the researchers and the municipality (e.g. Darke et al., 1998), the agreement was that the researchers managed the workshops and contributed with a report detailing the results. The participants agreed to partake in as many workshops as possible, and to contribute with comments on report drafts and answer additional questions that arose based on the workshops.

The purpose of the workshops was to promote active and genuine participation (Ørngreen and Levinsen, 2017) from a small group of stakeholders with domain specific knowledge in order to facilitate

collaboration that could affect future organizational change. To achieve this, a series of three workshops were conducted. The first workshop focused on the different working teams' perception of their current work, and the current challenges that exist in GI management and maintenance, in projects, and in the interface between them. The second workshop explored the future aspirations for the new park and its intended design. In the third workshop, the focus was on exploring pathways to upscaling on a city wide scale and considering management from a long-term perspective, exploring different scenarios to understand organizational outcomes and strengths within current routines and practices.

Selection of workshop participants

Relevant participants were identified by the Täby contact person in the NORDGREEN research project. The participants represented different central roles in relation to the municipality's GI, from either green investment projects, park management, or nature management. The participants constitute approximately half of the staff working in GI planning, design and management in the Täby municipality.

The data collection process

The three workshops were convened in late spring 2023. The on-site workshops lasted 2-3 hours with 6-8 participants in each, and were audio recorded. One complementary semi-structured interview was performed with a stakeholder responsible for park management. This was done to collect potential aspects overlooked in the workshops. These include administrative and technical details around current maintenance contracts and routines, as well as historical aspects of the previous contracts and relations with the contractor.

3.4 Data analysis methods Paper I-III

For the first sub-study, the textual data was analyzed based on a framework developed as a part of the study. In the second and third sub-studies, thematic analysis was utilized in slightly different ways to analyze the collected interview and workshop data.

3.4.1 Document content analysis

In order to fit the specific aim of highlighting the GI-HH&W relation in the context of the comprehensive plans, the 'Green Infrastructure - Health pathway analytical framework' (GI-HH&W Pathway), was developed (see Section 2.12 and fig. 13). The focus was on content relating to the GI-HH&W relationship rather than on assessing the quality of the plan. In the following, the framework is briefly described (please see the Appendix for a more in-depth description). The framework builds on a three tiered structure addressing two domains (Ecological and Human) and four dimensions (GI Properties, GI Functions, Effects on humans, and HH&W Outcomes). Each dimension contains between two and four categories.

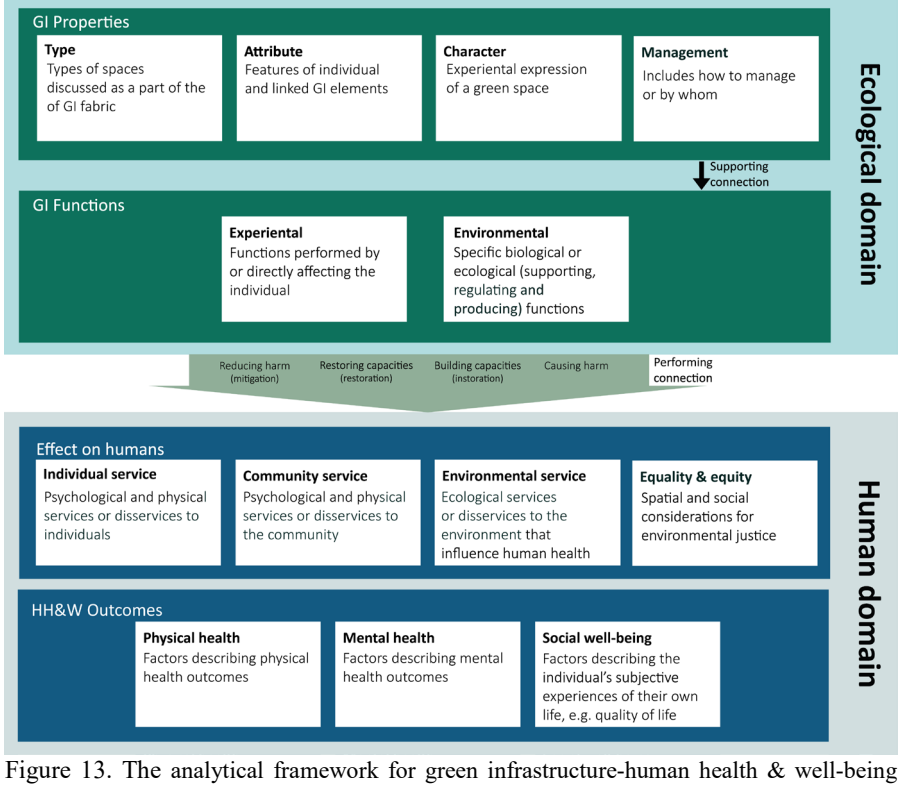

Figure 13. The analytical framework for green infrastructure-human health & well-being pathways. Adapted from WHO Regional Office for Europe (2017).

To answer the first sub-study's RQ, see table 5, the presence of specific notions or contexts was addressed on a terminology level (Nordh and Olafsson, 2021). The presence of a specific term indicated that some form of information or goals on that topic were addressed in the plan. For the three sub-RQ's, the texts were coded and categorized related to the terminology used, in terms of the overall domains (Ecological and Human) and then the four dimensions (Properties, Functions, Effects and Outcomes) (RQ 1a). From the categories, links were made to show how the different categories on GI and HH&W were interlinked (RQ 1b). Finally, sentences or text sections describing specific goals related to the GI-HH&W relationship were identified (RQ 1c).

The terminology used within the plans was categorized in two steps. After re-reading the collected sections, sentences, and terms, the individual terms were coded in a directed qualitative content analysis approach inspired by Hsieh and Shannon (2005), using the categories of the analytical framework in a deductive approach. Then, terminology deemed relevant within one of the categories in the four dimensions was the grouped accordingly. Here, mentions of health that did not relate to any aspect of GI, or its functions and effects (as described by the theoretical framework), were not included.

3.4.2 Thematic analysis

Thematic analysis was used to summarize the data and to identify common themes addressed by the interviewees. The methodology allows for flexibility when interpreting the material, using either an inductive or deductive approach (Braun and Clarke, 2021).

Analyzing stakeholder interviews

Individual interviews constituted the main source of data for the second sub-study, and one interview was conducted as a complement to the workshops in the third. In all instances, the transcribed material was read and inductively coded using thematic analysis (Braun and Clarke, 2021) in the software NVivo. In general, a manifest level (ibid.) of the text was analysed based on the expressed perspectives and understandings provided by the transcriptions. In the cases where the written material was potentially unclear in its meaning, the recordings where revisited to clarify the sentiment conveyed by tone and phrasing. For the interviews in the second sub-study, the analysis then examined the codes created from the perspective of

programmatic alignment, focusing on aspects addressing either horizontal or vertical matters, as described in section 2.7.1.
In the third sub-study the interview was coded, highlighting discourses within park management and its interrelation to project management and nature management.

Analyzing workshops

The recordings of each workshop were transcribed verbatim, and a summary of the main points was sent out to the participants for approval/ clarification. The transcribed data was then analyzed using inductive coding and thematic analysis (Braun and Clarke, 2021), highlighting discourses within and between the project management, park management and nature management. Prominent themes that were expressed recurrently, either strongly by individuals or jointly within the group were also highlighted.

3.4.3 Ethical considerations

Due to the focus of the interviews and workshops, no sensitive data was collected. Appropriate measures were taken to ensure that participants were made fully aware of the purpose of the research, what was expected of them, that the interview was voluntary and that they could end it at any point without negative consequences. The level of anonymity was also addressed prior to interview. Oral consent was given before the interviews and workshops started.

4. Summary of the results

This chapter presents a summary of the results of the three studies structured to answer the two research questions of the thesis. Table 8 summarizes the three papers and how they respectively relate to the thesis research questions.

4.1 How are cross-sectoral demands on GI addressed in Nordic local governments?

The first two studies expressly focus on the cross sectoral demand of utilizing GI as a resource for public health. An initial insight into how Nordic municipalities address the relationship between GI and HH&W is presented in Paper I. Here, the policy level is addressed through comprehensive plans, the most overarching planning policy document on local governmental level in the four countries studied.

Overall, the studied plans present similar patterns, indicating a common GI discourse. This is despite the differences between the four countries in terms of legislation on the responsibilities relating to health in planning processes. Terminology relating to the ecological domain, described as *Properties* and *Functions* of GI, was nuanced and largely consistent across the plans. The plans mentioned many different types of typologies and their attributes. This required sub categories to meaningfully reflect on the nuance presented. Similarly, the large number of unique terms in the categories describing experiential functions and environmental functions also required sub-categories.

In general, there were few differences between the municipalities in terms of aspects addressed within the ecological domain, even on a subcategory level. This only served to strengthen the contrast with the terms relating to the human domain (*Effects on Humans*, *HH&W Outcomes*). While *Effects on Humans* were mentioned in all plans, they were often described in terms of risk, or avoidance of risk, of harm to the environment or the individual. There were major differences between the six plans in the extent and categories considered.

HH&W Outcomes were rarely mentioned or broadly described, with only two of the six plans differentiating between physical and mental health. Overall, the studied plans do articulate the GI-HH&W relation, but the actual content is lacking in terms of clarity.

Table 8. An overview of the three papers research questions, organisational focus and claim related to the overarching research questions.

Research question	Organizational focus	Claim related to thesis RQs
Paper I How is the GI-HH&W relationship described in Nordic comprehensive plans?	**Policy level content** *Cross sector alignment* between GI and public health *Cross level alignment* through vision and goals	Policies addressing the GI and HH&W relationship are general in their focus. While a common discourse on GI is found, the connections to HH&W are scarce and shallow. The vague and generic formulation of goals risk not being strong enough to offer support in subsequent planning phases.
Paper II 1. How do local government practitioners in GI planning and management, and public health address the relation between GI and HH&W in their daily work? 2. Which factors affect collaboration for, and implementation of the promotion of HH&W in GI planning and management?	**Tactical level interactions** *Cross sector alignment* between GI and public health,. *Cross level alignment* through perceptions of policy to implementation	Despite ongoing formal cross sectoral activities, there is a perceived lack of resources for coordination between departments to secure a more systematic approach to green space development. In combination with a mismatch between policy formation and implementation, vertical alignment becomes under prioritised at the expense of long-term sustainability.
Paper III What characterizes practices and discourses in creating and managing urban GI? What are the organisational capacities needed to strategically address long-term nature-based park design and management?	**Tactical-operational interface** *Cross sector alignment* within GI, between urban parks & urban forests *Cross level alignment* through project to GI management pathways	A mismatch is shown between expectations in planning and design of GI, and capacity within park management. Approaches that utilize natural processes are necessary to meet current challenges but conflict with technical rationales in park maintenance regimes. In comparison, nature management is better suited to achieve long-term development of green spaces. Taking management into account in early design phases offers opportunities for capacity building to secure the long-term implementation the pursued nature-based strategies demand.

Putting perspectives on the first sub-study's results, the second sub-study addressed how practitioners within GI planning and management, and strategic public health view their work. In general, practitioners working with planning and management of GI primarily discussed the HH&W relationship in terms of access to GI, with an emphasis on GI's ability to provide a basis for physical health. They did not address the health perspective as a clear and singular focus. Instead, they perceive their work as the promotion of a multifunctional agenda, including a range of sometimes conflicting interests and societal challenges simultaneously. The lack of an explicit HH&W focus by planners and managers is confirmed by the health strategists, who saw planners' and managers' focus as more technical than social. The health strategists did describe a wider conceptualisation of health and saw potential in complementing planners' and managers' current foci.

As such, there is an interaction, if sometimes tentative, between GI and HH&W. However, the relation is rarely strongly emphasized. Cross-sectoral collaborations are ongoing in different forms, either via more formal cross sectoral groups, through strategic advisory roles, or roles responsible for project management with a GI-HH&W focus. The green bridge builder in Aarhus deserves particular mention as an example of an innovative role with an explicit cross-sectoral GI-HH&W focus. The bridge builder is employed by both the Technical Department and the Health and Care Department, with the task of connecting the two departments. Practically, their responsibilities entailed project management in smaller projects with an explicit focus on combining GI development (e.g. storm water management) and human health by 'activating' green spaces that were identified as underused.

The second sub-study shows that, in general, all interviewees saw GI as a viable approach to addressing a range of challenges. However, there is also a joint struggle to guard existing spaces from urban development and to ensure other departments and the political level accept GI as important. The interviewees also express a need for specific and situated documentation of the relationship between GI and HH&W to 'prove' to politicians that investment in GI is worthwhile, and to withstand urban development interests which have clearly stated economic benefits.

There is however, still a generally positive view among GI planners and health strategists on strategic development and the increase of cross-sectoral ambitions in the organization. In contrast, GI managers are primarily and strongly concerned about the more general challenges. They feel that long-

term development of GI is challenged by a lack of budgets and GI management perspectives not being sufficiently included in early stages of planning (described further in the next section).

In Paper III, the involvement of GI management in early development stages constitutes a main focus. Here, addressing a more situated and intradepartmental context, in the process of creating a new city park in Täby, Sweden is characterized by an attempt to merge multiple demands with restricted budgeting and ongoing challenges related to park maintenance. While HH&W was mentioned as one of many drivers for the park by one of the project managers, it is not addressed as a specific and isolated focus. Instead, the main task is to unify the demands of ecological, social and economic interests.

As such, the cross-sectoral focus in the third sub-study addresses the different contexts *within* the 'GI-sector' by which investment project management, park management, and nature management operate. Crucially, the Täby case was partly chosen for its history of innovative and collaboration-based park management, which now is perceived as a failure. This is one issue that is addressed in the design concept for the new park. The design concept is underpinned by a shared view between project managers and park managers that current park construction and maintenance practices are not sustainable and that radically new methods and approaches are required to face current and future challenges.

Here, the perceptions of project management and park management are set against the views of nature management in terms of how public-private partnerships are understood and approached. The three groups all work with external contractors to create new GI and manage existing GI. They adhere to the same formal NPM procedures and utilize similar tools, procurements and documents detailing intended outcomes, albeit in critically different ways. Project management and park management use detailed, object-based descriptions of construction and maintenance activities, and follow a hard contracting approach (Hansen et al., 2020). Conversely, the nature management group applies a softer approach, backed up by strategic documents detailing vision and goals, and work with site-based dialogues to ensure joint understanding with the contractor. They are currently very satisfied with the collaboration.

In short, the results of the three studies show that efforts towards cross-sectoral alignment exists but present challenges on all three organizational levels. On the policy level, the GI-HH&W relationship is characterized by being vague and unspecific. On the tactical level, GI planners, managers, and health strategists do collaborate on GI-HH&W issues, but this is perceived as only one of many foci. In the tactical-operational interface, the results show that intra-departmental practices differ significantly, in this case those relating to park and nature management respectively, leading to challenges when new park designs are to be implemented. This is further detailed in the next section.

4.2 How is the management of GI aligned across policy, tactical, and operational levels?

When addressing vertical alignment, the general vagueness of comprehensive plans' statements addressing cross sectoral ambitions also characterizes the visions and goals, and related guidance in subsequent planning stages. In the first sub-study, goals addressing either GI or its relation to HH&W are found to be scarce and shallow. The clarity of visions and goals can be understood as setting the scene for prioritizations and setting paths for concretizing and implementing the visions. The comprehensive plans were not expected to provide detailed guidelines, but the described visions were still vague often lacked clear prioritizations. The general lack of nuance in the comprehensive plans was confirmed by the interviews with planners and managers at the tactical level, claiming a need for more clarity in terms of both visions and prioritizations. The lack of clarity is seen as a challenge, as the policies fail to provide sufficient support to withstand strong economic rationales and short-term foci in capital investment projects. The perceived lack of strong visions and prioritisations to guide implementation results in intensive discussions around which values are to be prioritised within each new project. Beyond this, challenges in coordination across both sectors and levels risk creating redundancy in tactical plans

As mentioned, Paper II highlights a joint struggle for GI planners and managers to guard existing GI from urban development. Further, the managers' strongly voiced concerns show that while capital investments (i.e. development projects) are at times rampant, this is not mirrored by budgets

for management and maintenance. In effect, the longevity and potential development of existing spaces is at risk, as funds need to be spread across more space. As a result, managers struggle to 'make ends meet'. This is exacerbated by the perceived lack of managers' involvement and resources for their involvement in early planning and design stages, leaving input on these concerns out of the equation.

The investment-management gap described in the second sub-study is the centre of attention in the third sub-study. The case study consists of a new city park, which is part of a planned city development, backed up by political ambitions for a biodiverse, multifunctional and sustainable city district, currently being drawn up by the municipality's planners and designers. Heavy investments in urban development combined with a perceived lack of political awareness of budgetary effects on management have led to budget shortages and demands to reduce costs in park maintenance. Therefore, minimizing maintenance becomes a key demand in the new park design. Thus, the design for the new park is a response to political demands, with a joint understanding among the interviewed practitioners that current 'standard' management regimes are not sustainable. The response is a design-by management approach which allows for more nature-like development with less intensive but more specific and adaptive management for incremental change as the park matures. Crucially, the operational activities needed to ensure the new park's long-term development is not complicated to perform but is hard to describe within the standardized park maintenance protocols. However, park management is currently concerned with mitigating the effects of the current collaboration-based management contract which is considered a failure. Their intention is now to go back to a more controlling approach and static maintenance descriptions. In effect, despite specifically addressing current challenges in park management, the new design is hampered by the standardized practices that are now preferred, to mitigate the perceived lack of control in a contract lacking resources to be properly managed.

In the case of Täby, a main point is that due to the design-by-management approach, the perceived management challenges are considered as a strategic issue ten years before the park is built. This leaves time to address the mentioned challenges, test out suitable methods, their impact on current organizational routines, and thus test the paths to scaling up (and thus testing the test). In effect, testing meadow maintenance in running management is

used to test not only the method itself but also the collaboration with contractors, while also monitoring the time required for the manager to work more intensively on site.

In short, the results from the three studies show that the alignment of demands on GI and related levels across the organization is challenged by a range of factors, including a mismatch between expectations and resource allocation. On the policy level, goals and visions pertaining to GI are vague and unspecific, leading to prioritization challenges on tactical level. Specifically, an economic rational endorsing urban development and short-term investments without taking management effects into account presents a main and major challenge for operational levels. This leads operational levels, specifically in park management, to move away from a strategic focus, and instead trying to make ends meet. While novel GI design approaches are utilized to address these issues, rigid administrative structures show that long-term management has to be addressed as an active part of the setup in order to face these challenges in a strategic manner.

5. Discussion

This thesis studied the alignment between local governments' overarching policies and every-day operational activities, with a focus on how GI is addressed, by three sub-studies (Paper I, II and III), with cross-sectoral alignment addressed through the lens of the GI-HH&W relation. This section provides a synthesized discussion based on the results. The first two sections, 5.1 and 5.2 discuss the research questions on horizontal and vertical alignment, respectively. Beyond this, 5.3 serves as a reflection on the notion of temporal alignment, which was uncovered during the project. This reflection is followed by 5.4, implications for policy and practice, 5.5, methodological reflections, and a conclusion, 5.6.

5.1 Horizontal alignment in demands on GI

The first two studies address horizontal alignment in utilizing GI as a resource for public health in policies and within institutional interactions. Both studies show that there is a tentative presence of horizontal alignment in policymaking (Paper I), as well as in daily GI planning and management (Paper II). However, in both cases, the GI-HH&W relation is rarely strongly emphasized. While the comprehensive plans do articulate the relationship, detailed content is lacking in terms of clarity to provide support for further planning. This lack of clarity is given greater nuance in the second sub-study by the lack of stated priorities to guide decision-making. In other words, the issue is seldom *whether* public health, biodiversity, or any other key value should be promoted. Instead, the question is what is to be prioritized which is highlighted in the second sub-study. These findings are corroborated by Lisberg Jensen et al. (2023, p. 12), who describe how 'all good things […] are promoted simultaneously', with little or no mention of goal conflicts (in comprehensive plans). Similarly, Hautamäki et al. (2024) show how potential conflicts between urban developments and GI are either only vaguely addressed or not addressed at all. This is a major issue considering that these tradeoffs are crucial to address in the planning process if GI is to be prioritized in the outcomes (BenDor et al., 2017). This leads to the risk that vague GI-HH&W relationship goals in the comprehensive plans (Paper I) are counteracted by other goals, such as urban development. It is therefore crucial to address these issues sufficiently in policy formation (Barton and

Grant, 2013), rather than repeating the prioritization process within each capital investment project, as the second sub-study describes.

Adding to the currently sparse knowledge on the practical implications of cross-sectoral policies (Candel and Biesbroek, 2016; Karlsen et al., 2022), the results of this thesis show that cross-sectoral collaboration is ongoing in different forms, such as formal groups, advisory roles or as part of project management with a GI-HH&W focus. However, even in municipalities where legislation demands cross-sectoral collaboration, the challenge becomes integrating of the work done in the formal groups back into the representatives' respective departments, and for it to permeate the entire organization. This is paralleled with a general perception of insufficient resources for cross-departmental collaboration, meaning that no additional resources are allocated, even if cross-departmental collaboration is actually initiated. This is described in a broader governance perspective by Kettl (2015), noting that horizontal relations do not replace vertical, but are added on top of them. As this study shows, this is also the case within the organisation, between the departments. These challenges to horizontal alignment can potentially be the reason for plans and formal documents that are produced without concern for their role or coordination with other departments in the organization, as shown in the second sub-study. As such, formal approaches to horizontal alignment are still challenged in vertically oriented organization structures, as shown by Svensson, (2019), which in turn also challenges vertical alignment and implementation.

In the tactical-operational interface addressed in the third sub-study, the 'internal' alignment within the GI sector puts a complementary lens on horizontal alignment. Representing the organizational micro-setting, the internal differences between park management and nature management, showcases the differences in how GI is approached confirming Piana et al. (2023). Here, the third sub-study adds on the notion that the show that the hard contracting approach to maintenance descriptions, contracts and relation to contractors utilized in park management presents a potential barrier.

The consequences of rigid maintenance descriptions within park management have been attributed to NPM (Randrup and Persson, 2009; Lindholst et al., 2015; Ferlie and Ongaro, 2022), as GI quality has to be defined in a way that can be operationalized in procurement processes. However, the notable difference between the approaches in park

management and nature management, despite them working within the same unit and within the same NPM processes (procurements and external contractor), implies factors outside the immediate effects of NPM.

Here the third sub-study suggests that parks are built and maintained as a part of a grey infrastructure discourse. GI maintenance is thus subject to a technically informed rationale inherited from the construction sector in administrative structures such as construction drawings and maintenance descriptions which are driven by financial predictability and contractual rigidity. Coupled with the lack of focus on long term perspectives, the dynamics of GI and nature, its constant and fluctuating discrepancy, is considered a liability. This has a direct and detrimental impact on the ambitions to create environments that can meet the increasingly complex demands and are robust enough to develop in a way that is sustainable in the long term. This is further discussed in 5.2.3 and 5.3.

5.2 Vertical alignment of policy and implementation

5.2.1 The role of policy

The second main perspective in the thesis addresses the lack of vertical, or cross-level alignment of cross-sectoral polices and ambitions. Paper I concludes that comprehensive plans, as an example of policies, fail to set goals that are clear enough to be used as guidance in further planning stages. While the comprehensive plans cannot be expected to provide extensive detailed guidelines, most goals found were indeed generic to the point of providing little potential guidance for future decision-making. This is further supported by Kauark et al. (2023), who suggest that the mere presence of a theme in a policy is insufficient to warrant the conditions for its implementation or its long-term presence. This is exacerbated by the lack of prioritizations addressed in section 5.1. The vagueness of goals and visions makes them hard to utilize, as actors representing conflicting interests can interpret the goals to their advantage. This was showed in the interviewed practitioners' perceived need for more detailed evidence to argue for a need for GI in each development project (Paper II). This further points to two interrelated issues: the role of evidence and the role of policy.

Despite a generally emphasized notion that evidence should inform policy (Sallis et al., 2016; Giles-Corti et al., 2015; Lowe et al., 2019) the

presence of evidence does not immediately guarantee implementation (Davoudi, 2006). However, evidence that can support policy is still perceived as important by practitioners related to both GI and HH&W. Randrup et al. (2021) note that densification is perceived as a main challenge by Nordic GI managers. This study confirms that notion, adding on how evidence is perceived as necessary to safeguard GI from urban development.This in turn addresses the role of policy, and what purpose the evidence serves. Rather than informing the policy visions and subsequent developments, is seems as evidence is needed to provide counter-arguments for development.

The comprehensive plans studied in the first sub-study are all created due to legal demand. However, in the Nordic countries, public space, including GI, is less regulated in terms of what it should offer the public (Lidmo et al., 2020), a notion common to many other countries (Haaland and Konijnendijk, 2015). In effect, there are legal demands on planning, but, with the notable exception of the recent European Nature Restoration Law, no such demands to sustain or develop these sites once the plans have been realized. If policy formulations act as 'minimum standards', their vagueness serves an important function in allowing for generous interpretation, serving any and all interests in subsequent stages.

The second sub-study gives examples of where GI related policies are either ignored or used as a 'bar' to clear, rather than acting as a general guide (Berke et al., 2012) on the intentions for urban development. This differentiation in the role of policy is explicitly highlighted in Täby's policy 'Half of Täby green' (Paper I). This vision gets a very different connotation if adding the subtext '.− and not a square meter more', as implied by the heavy debates and detailed calculations on amount of GI in ongoing development projects (Paper II). Thus, the question becomes whether introducing evidence will be enough to counteract the lack of prioritization. While evidence informed policies with clear prioritizations probably would provide much needed support in early stages, this is by no means guaranteed to change the political view of subsequent steps, such as GI management.

5.2.2 Tactical bridgings and gaps

When looking at the tactical level from the perspective of strategic management, two main gaps become central: (i) The gap between plans and implementation, and (ii) the gap between short-term budgetary focus, and long-term budgetary consequences for GI management.

First, as discussed in section 5.1, the second sub-study shows that plans are developed without sufficient coordination between potentially relevant departments, or without a formal recipient. This results in a flora of strategic documents with no internal coherence, overlaps and potential redundancies. Seen in the perspective of strategic management, strategic planning (as conducted at the tactical level) seems separated from the notion of implementation (at the operational level). In effect, due to lack of sufficient horizontal and vertical alignment, strategic planning becomes a goal in itself. However, while (strategic) plans might identify relevant strategies, they will not solve the challenges or achieve the related visions (Poister and Streib, 1999; Hudson et al., 2019; Kools and George, 2020). Strategic GI ambitions are essentially not realised in the plans – but on the ground. In line with Kabisch et al. (2016), this thesis claims that the lack of connection to responsible for implementation risk hampering long-term realisation.

The second sub-study also identifies a mismatch between capital investments and long-term maintenance budgets with strong political and economic emphasis in early planning and design phases informing investment budgets, without an increase in management budgets. This confirms the findings of Dempsey and Burton (2012) and Kotze (2024) and adheres to the linear logic as described by Jansson et al. (2020). This is further illustrated in the third sub-study, showing the interviewees' perceptions of politicians being oblivious to the consequential management costs of heavy investments in urban developments, until after the fact, also shown by Carmona et al. (2004). This 'municipal short-termism' (Sarabi et al., 2020), can be partly attributed to the fact that the long-term impacts of GI management are less directly visible to the public and decision makers, in comparison to capital investment projects (Dobson and Dempsey, 2020). However, this practice challenges the long-term perspective required for a sustainable approach to public space and urban GI specifically (Dempsey et al., 2014; Kabisch et al., 2016; Mercado et al., 2024; Randrup et al., 2021; Randrup and Jansson, 2022). While details and nuances vary, research unanimously tells us that budgets for GI management either decrease (Kabisch, 2015: Rupprecht et al., 2015; Hauer and Peterson 2016; Whitten, 2018) or stay the same, as is the case in the Nordic countries, while responsibilities of GI managers increase (Randrup et al., 2017; Fongar et al., 2019; Randrup et al., 2021). This means that time and funding are stretched over larger areas and more tasks, shifting the focus to making ends meet.

5.2.3 Implementation – when plans hit the ground

In current GI research, concerns around overlooking maintenance aspects in planning and design is increasingly being addressed (e.g., Dempsey and Burton, 2012; Dempsey and Smith, 2014; Graef et al., 2023; Langeveld et al., 2022; Winslow, 2021), as are issues with the relation between GI design and construction (Cook et al., 2024). The outset of the third sub-study is a design approach based on vegetation growth, effectively utilizing time as an active component. Here, the focus lies with the interface between tactical level ambitions, and conditions for operational level implementation. Here, political mandate support the creation of a park that addresses a long list of demands, including budgetary challenges in management. Despite this promising outlook, the administrative structures are identified as the main challenge. In effect, the procedures and documents that steer construction and maintenance processes are perceived as being too rigid to address the design-by-management approach that is required for the more cost effective implementation of the new and more robust park design concept.

This highlights the diverging trajectories between ambitions in early stages, where the design is expected to address more and more complex demands (Dempsey and Burton, 2012), and operational practices that are not adapted to address this complexity over time. Crucially, the required maintenance activities are not complicated, but they do not fit the mode of communication that is standard within the current administrative structures, where every demand needs to be specified beforehand. The approach of detailed descriptions has long been criticized (Beer et al., 2003), as broader values such as social and ecological functions are rarely specified, and are therefore not taken into account (Bell et al., 2008). In comparison, the approach within nature management focuses on strategic plans geared towards development, and the work is characterized by on-site discussions to ensure a joint view with the contractor. Critically, the previous collaborative ambitions in park management failed partly due to lack of resources manage the contract and communicate with the contractors. The new contract will go back to detailed formal descriptions to address the perceived loss of control of the contractor. As such, while collaborative approaches are understood as an important prospect for GI management (Dempsey et al., 2016*)*, they are not immune to reverting back to more contract-based steering (Hansen et al., 2020) if resources are scarce.

This technical approach to park management sees GI designers as ‘thinkers’ and the operational staff to ‘doers’ with a division between them, as noted by Hahn (2023). This clearly reflects the linear logic present in landscape architecture (Jansson et al, 2020), and the view of implementation as a mechanistic approach see fig. 14. Efficiency with regard to resources (i.e. time, costs) is often the reason for organizational change (Merkus et al., 2019). If GI maintenance is perceived to have no expectations on development and is just viewed to keep stasis indefinitely, the only outcomes of efficiency improvements is to make the maintenance more resource effective. However, the value of GI maintenance is not primarily in being fast and cheap, but in the accumulated results and related functions it produces. In short, current understanding of park maintenance is at best a legally hard-wired technical procedure to maintain stasis, and at worst a necessary evil – and crucially not as long-term strategy in action. In effect, if GI managers are forced to focus on delivering the lowest possible number of services at the cheapest possible costs, more strategic, analytical, or evaluative measures, such as involvement in early planning stages or throughout project implementation, will go unpursued (Dobson et al., 2021).

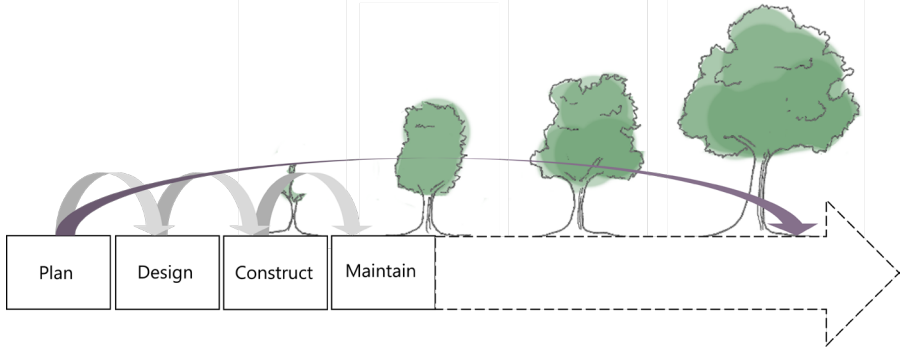

Figure 14. A linear understanding of processes related to landscape architecture.

This thesis confirms the relative lack of focus on the long-term perspectives of management as highlighted by previous research (Kabisch et al., 2016; Duivenvoorden et al., 2021; Winslow, 2021). The overemphasis on early development stages overlooks the understanding of strategic management of GI as a continuous process, where planning and design is part of a strategic, long-term approach (Jansson et al., 2020), and where long term and short term decisions are aligned. This introduces the importance of strategically addressing a third alignment dimension – time.

5.3 Temporal alignment for strategic management of GI

In the public organization context described in this thesis, the comprehensive plans in the first sub-study represent an overarching and long-term policy document to guide the strategic development. Subsequently, the plans and practices on tactical and operational levels are seen as increasingly concretizing and short-term in their focus mirroring the general view (e.g. Gustavsson et al., 2005; Borgström, et al., 2006; Randrup and Persson, 2009; Loorbach, 2010). The three studies indicate that the political discourses between policy level (Paper I and II) and operational level (Paper II and III) have significantly different foci. Vague yet ambitious focus on policy are followed by horizontal, vertical and temporal mismatches on tactical level, and met by strong demands for savings and control on the operational level. So, how does this relate to temporal alignment, and GI as a resource for promoting HH&W?

As shown by Ilott et al. (2106), the challenges of implementing policies that requires long term perspectives include uneven distribution of costs and benefits across both sectors and time. As addressed in section 5.2.1, depending on how the role of policy is understood, evidence on health benefits in policies does not necessarily lead to increased management budgets. Further, as noted by Dobson et al. (2021), the supportive functions of GI are dependent on long-term management, meaning that it is vital that management and maintenance are seen as important as strengthening policy. While HH&W is understood by practitioners as having strong relations to GI, it primarily becomes another argument in a long line of arguments for why GI is important for sustainable cities. However, the described mismatch also entails that HH&W become yet another demand to solve in early stages of planning and design, while remaining oblivious to the implementation conditions and the long-term development. But as noted by Hudson et al., (2019), the engagement with the implementing actors is crucial.

By adding a time dimension to programmatic alignment, the relation between policies or visions, and the incremental but long-term effects of the everyday operations become more tangible. For instance, it highlights the temporal discrepancies within the described linear approach, emphasizing long term perspectives in early policy and planning stages but overlooking the conditions of ongoing implementation, in effect the day-to-day of ‘ever after’. As the complexity of demand grows, it is vital that there is an

organisational approach, on all levels, that is equipped to deal with these demands.

Calls to rethink the traditional linear logic are increasing (e.g. Fongar, 2020) to initiate organizational transition and cross-sectoral approaches, based on increased holistic thinking within the organization (Hagemann et al., 2020). This is combined with adoptions of a more systemic thinking to GI planning and development (Cook et al., 2024), specifically accompanied by ideas on nature-based approaches (Randrup, 2020a; Ignatieva, 2021). Based on the notion that living systems are dynamic, experimentative and adaptive approaches to planning, design and management are required (Ahern et al., 2014; Kabisch et al., 2016; Moosavi, 2018). While these ideas are by no means new (McHarg, 1969; Spirn 1984; Hough; 1984, Woudstra, 2004), the renewed interest in nature-based processes driving the development of urban environments (e.g., Randrup et al., 2020a) presents an opportunity to discuss organizational and temporal alignment in relation to the development of GI.

However, the challenges of scaling up these innovations have been highlighted as a major challenge (Cortinovis et al., 2022; Hölscher et al., 2023). Starting from the multiscale approach across spatial and temporal scales inherent in the concept of GI, this thesis shows that the same thinking also need to apply to the organisational setting. The individual space within a larger GI context has to be understood in both the spatial dimension and the organizational dimension to be viable in the long term. In the Täby case (Paper III), having one single 'sustainable' park in the municipality, with completely separate methods and routines, stands a major risk of being rationalized away as producing separate documents, routines and approaches will require considerable resources. In effect, such innovative experiments risk becoming 'demonstration projects' (Hölscher et al., 2023), that eventually gets rationalized away (Burton et al., 2014) in pursuit of resource efficiency on operational levels.

As this thesis shows, the related technical sectoral culture and administrative structures that currently characterize the construction and maintenance of parks are in direct conflict with an approach that is inspired by nature, confirming Randrup et al. (2020a). There is a significant difference between keeping green elements in a fixed state, and to sustain a green environment's continuing existence. This disconnect immediately hampers the (short-term and long-term) implementation of approaches that

understand nature as dynamic and responsive to evolving developments over time, also argued by Moosavi et al., (2021). Changing GI management and maintenance regimes in a way that can support ever more complex and cross-disciplinary needs requires an understanding of these activities as more than simply enacting and upholding the planning and design ambitions. Experimenting with new practices, which are not separated from current management regimes, but within them means that the the organizational and administrative context must become part of the experimentation rather than to left as an afterthought.

As such, the new methods, maintenance descriptions and resources required to manage the developments, can be tested to explore the organizational consequences of the intended approach, beyond just the methodological. This means that experiences can be generated within the existing organizations, as part of the daily routines. With a deeper insight into operational implementation and the large scale and long-term consequences of everyday routines, experiences can be built up incrementally. While both the process outcome and the long-term development of the new park design in Täby is still filled with uncertainty, the third sub-study offers an example of how to understand long-term management as a strategic process.

For GI development to be able to become truly strategic, it is not enough to start the GI management process after a site is created, and then manage strategically and with long term perspectives in "*re-planning, re-design, re-construction and maintenance of UOS*" (Jansson et al., 2020, p. 12). If strategic management is indeed understood as an organisation-spanning approach, the approach spans from operational to policy levels, also in a temporal perspective. This also means that, similar to strategic management as defined by Bryson and George (2020), strategic planning becomes a subset of strategic management, rather than a chronological and hierarchical predecessor, see fig. 15. Here, the broader notion of strategic management entails an ongoing process, interspersed with phases of planning, design and construction or vegetation establishment in cycles, in varying different scales and scopes. Ongoing maintenance is seen as a tool that contribute to sustain and develop the vegetation, not only keeping it in a fixed state. These on-site practices also allows for continuing evaluation to act on the ongoing development as needed, and use that to underpin shifts in the vision.

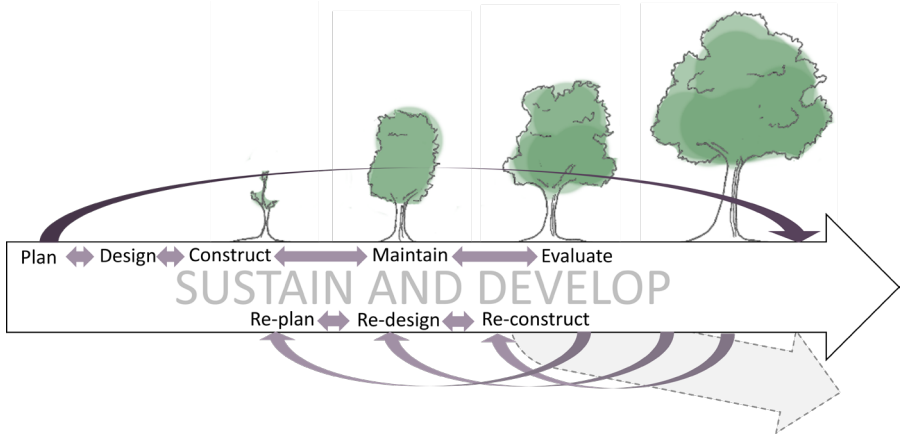

Figure 15. Strategic management of GI as an adaptive process over time.

Seeing strategic management of GI as an ongoing process, being ever-present in all phases offers opportunities to address organizational issues to secure the operational level conditions for implementation from a long-term perspective. To fully harness the potential of GI in addressing the current global challenges, a strategic approach to the current practices, including operational practice is required. This understanding needs to guide an adjustment or reframing of the public organization that can meet the visions, by constantly develop to address them.

5.4 Implications for practice

The findings in this thesis underlines the importance of a strategic and organization-spanning approach to management of GI. As demonstrated in this thesis, policy does play a role in securing conditions for implementation. However, the lack of clear prioritizations renders utilization of current open-ended policies difficult, as shown in the first and second sub-study. Visions that are too general risk serving every interest equally, negating the guiding function. There is a finite amount of space in each municipality, which leads to a clear need for prioritizations between values (Hislop et al., 2019). Here, multifunctional solutions that create synergies between many pursued values are key but can prove deceptive if too generally handled. While increased multifunctionality is a valuable and necessary goal, it is important that it is not used to evade a critical look at what is actually possible in terms of multiple functions. Assuming that any and all functions can be stacked on

top of each other will not lead to more functional GI. Prioritizations are still needed, as it is impossible to do everything, everywhere.

Strategic goals and visions require practical alignment among municipal networks to be translatable into real-life outcomes for sustainable long-term green space design and management. As such, the main thing to highlight is the need to reimagine what is still often understood as a technical and linear approach and to question what is understood as a long-term process. Based on the studies, one approach is to understand strategy as practice and to look at how the organizational routines are adapted to fit the strategy. In effect, utilizing a more nature-based approach demands practices that are compatible with unpredictability and iterative and adaptive management.

The Nordics represent a small and relatively coherent sub-set of public organizations worldwide. As such, it is not immediately obvious that the results from this thesis are directly generalizable to a larger setting. However, the invitation to address the tactical-operational interface and operational levels as strategic rather than technical is relevant as an approach to be locally adapted and applied in a variety of contexts. While the answer may not be the same everywhere, the contribution of this thesis is that the question should be.

5.5 Methodological reflections

5.5.1 The research design

The three organizational levels in public organizations

The overall structure of the study reflects the three different organizational levels that can be understood as making up a local government organization. This model has the purpose of organizing different types of decisions and activities. However, the hierarchical and sectoral structures that constitute public organizations are still very prevalent, underpinned by the bureaucratic arrangements that are again gaining focus in the research spotlight (Kanon, 2023; Sørensen and Torfing, 2024). As such, this view of organizations and its related drawbacks (siloes and policy-implementation gaps) still seem to affect current day-to-day work, as shown in Paper II.

Furthermore, this organizational model often comes with a range of assumptions, one being that the policy (or strategic) level provides the long-term perspective, with the operational level generally representing the short-

term perspective (Loorbach, 2010). As such, I chose to take on the research design following a top-down, linear, long-term short-term divided approach that the papers and the thesis increasingly criticize. This means that a tension appears between the chosen research design and the argument of the thesis. If I were to take inspiration from, for example, Elmore (1979) and his backwards mapping approach starting off on operational levels and 'backing up' through the organization. Such an approach would probably allow for a sharper and more quality focused analysis of the comprehensive plans, based on an understanding of what is needed for successful operations and activities. However, the purpose and argument of this thesis was never to merely propose how to make 'better' policies, but to address how we understand the different levels in a public organization.

The selection of cases

The particular combination of municipalities that were part of the study were selected to fit a range of purposes but, crucially, not only my purposes. Spreading cases across the Nordic region presents a tricky challenge, as they are both similar and distinct. A larger number of cases in each country would potentially allow for a better understanding of which characteristics could be argued to be of a national character and which actually span across the region as a whole. However, in combination with the high level of autonomy in Nordic municipalities, it can be argued that they act as 'city states' and are disparate enough between municipalities to be more or less impossible to generalize from, regardless of country.

Relating the focus of the overall study to the individual cases, another point of question is why I chose to address a smaller number of cites as the study went on. From a practical perspective, becoming familiar with the topic of study, the municipalities, and the involved practitioners took some time. The ongoing interactions with the cities meant that a deeper insight was established, increasing the potential for addressing issues that were immediately useful for the partner cities. For the Täby case, this also coincided with the design and planning processes in the municipality, which were at the stages where the need for new ways of addressing design and management had been identified. This would probably not have been possible earlier in the project, for either Täby or me.

Here, the choice of Täby also allowed me to use the experience I already have with the Swedish context, which allowed for a more in-depth exploration of the administrative structures around the tactical-operational

interface. The general notions found in paper I and II offered some weight to the assumption that they face similar challenges.

Reflections on my role as a researcher

As a researcher in qualitative research, I am not a neutral or invisible recorder who gathers objectively suitable material and then extracts the relevant data.

Specifically, my situated experience as a practitioner was very helpful in some cases. I was familiar with certain administrative procedures in a way that a researcher without practical experience might not be, meaning that I could ask more detailed questions and get a deeper insight. However, my immediate recognition of phenomena sometimes prevented me from asking follow up questions or additional details, since I believed this to be something that is already well articulated by the interviewee. This means that I might risk transferring my pre-understanding onto how I interpret the interviewees' perceptions, and their deeper insight might not be exactly the same as my own. Being aware of this, I tried to systematically address this risk by asking questions such as "I interpret you to say *this*, is that interpretation correct?". In this way, the interviewees got the opportunity to immediately respond to the interpretation with a yes or no, which sometimes led to further clarifications or nuances of the initial statement.

5.5.2 The three sub-studies

The first sub-study

In the first sub-study, the focus was to understand the content of the comprehensive plans in terms of how the relation between GI and HHW is expressed. Method wise, the applied approach proved to be very resource demanding, as plans were read through at least twice, and terminology, links, and goals were collected manually. This is the main drawback of the method as it effectively hampers upscaling to a larger number of plans. However, this allowed for a deeper insight into how the plans are formulated and what they address. More automated and scripted measures could probably be taken in future studies. In relation to this project, the thorough read through also served as a way of becoming familiar with the language used, and the national differences between the plans regarding, for example, their structure and disposition. This also served as important groundwork early in the studies.

The analytical framework was developed based on a framework produced by WHO (2017), which they aimed directly at practice. While similar flowcharts or relational frameworks have been produced in scientific studies (Shanahan et al., 2015; Hartig, 2014; Markevych et al., 2017), this framework can thus be expected to be more easily utilized by planning practitioners. Many frameworks also start with the individual, rating time spent in green space and other individual factors as key. However, the focus of Paper 1 was intended to understand the relationship from a planning perspective, where detailed individual aspects are harder to take into consideration.

The second sub-study

The second sub-study focused on the experiences and perceptions of practitioners, based on the same six municipalities investigated in the first study. Crucially, the two smallest municipalities declined to participate due to a combination of a lack of time and a difficulty identifying relevant roles in relation to the suggested role descriptions (see Appendix B in Paper II). It would have been interesting to unfold the results of the first sub-study, where Vilhelmina represented the most ambitious comprehensive plan while not having a formal planner. It could potentially have provided further insights into how cross-sectoral collaboration can contribute to creating policies that are functional and immediately useful for actors on all organizational levels.

The intent with the interviews was to have a broad and scoping function in order to reflect what the informants chose to focus on. This approach was chosen in order to allow open and reflective dialogues. In retrospect, each interviewee's understanding of the GI-HH&W relationship could have been further elaborated. However, partly as a result of Covid-19, all interviews were held online. One consequence of this was that interviewees often had scheduled back-to-back meetings and thus limited time. On the other hand, the results showing that the issue of HH&W is only seen as one of several central issues to address, reflects the fact that the HH&W issue might not be fully articulated as an expressed focus for many interviewees.

The third sub-study

The third sub-study represents the most noticeable side-step from the GI-HH&W progression of the papers. I chose to slightly shift the focus for two reasons.

First, while the evidence in the relationship between GI and HH&W is ample, models for implementation are still scarce (Beute et al., 2023). Evidence based methodological approaches to HH&W promoting design are emerging (Stoltz and Gran, 2021; Bengtsson et al., 2024) constituting one part of the NORDGREEN project, and were ongoing in parallel with my studies. However, these models are still in the development stages for public space and are still not readily utilized in current everyday practice.

Second, health is not understood and addressed as a clear and singular issue in GI planning and management (Paper II) but as one of many aspects to address. While public health is a main driver for the design of the park in the third sub-study, the primary challenge for the involved practitioners lies not in creating a park that promotes HH&W. Instead, the challenge lies in being able to create a park that can be constructed and is robust enough to keep functioning in the face of limited resources. Dobson et al. (2021) have concluded that preventing benefits by withdrawing investment is much easier than securing beneficial outcomes by applying investments. The relevance of sustaining GI in periods of cutbacks or increased expenditures is as such foundational for GI's ability to support HH&W in the long term.

Further, what became clear early on when writing the third paper was the number of potential foci within the case. The uncomfortably wide range of different but highly interrelated aspects was challenging to synthesize, meaning that a balance had to be struck between conveying a breadth of challenges and presenting a clear message. Borrowing from Carmona and de Magalhães (2008, p. 4), I use the metaphor of the onion; If you cut it apart and address all the layers separately, the complexity is lost. I see a need for more research making these complexities explicitly visible, as it would contribute to further learning and examples of best practice (Cook et al., 2024).

When it comes to assumptions on the setup of the construction sector, or whichever sector has a central role in the creation of GI, this study has an obvious limitation, as sectoral setups, and thus processual challenges, will inevitably vary by country. Even so, the notion that any country would present a perfectly smooth process in design-construction-maintenance seems unlikely, and it could further serve as inspiration between different countries' practices and challenges.

5.5.3 Transferability and generalization

The geo-cultural contexts of the Nordics can be argued to be specific in their large amount of GI, high nature per capita (Haase et al., 2019).There is also a long-standing tradition of "friluftsliv", directly translated as 'open-air-life', which has historically shaped Nordic citizens' relation to nature (Gelter, 1999). From a European and global perspective, the view of nature, and its potential for good or harm, potentially differs even more, with ideas of nature as harmful or dangerous being stronger in other countries (Fischer at al., 2024). As such, introducing a nature-based approach to urban environments might not be unanimously understood as immediately beneficial unless the cultural understanding of nature is taken into consideration as a part of that strategy. However, the results from this and similar studies show that there is a potential long-term challenge regarding the degradation of green space due to high wear and tear and insufficient resources for GI maintenance and management (Randrup et al., 2021). In contexts characterized by frugality, the notion of strategic approaches combined with aligned practices would arguably be even more important.

5.6 Conclusion and outlook

This thesis addressed the horizontal, vertical and temporal alignment when managing GI within a local government context. Despite an emphasis on the necessity of cross-sectoral collaboration this study shows that the local processes fail to recognize conditions of GI development on operational level, effectively overlooking the context where they are to be implemented. This further serves to highlight the difference between what is intended on policy and tactical level and what is asked on operational level. While comprehensive plans focus on the connectivity and coherence of GI (Paper I), organizational structures create barriers to what is possible, both from a spatial and a long-term perspective (Papers II and III).

Policy is understood and legally recognized as addressing long-term perspectives. In contrast, GI management is understood as maintenance and seen to address every-day actions with a short-term perspective, which hampers its potential as a strategic process. This issue is by no means new. The discrepancies between plans and implementation could potentially be said to be as old as strategy (and policy) making themselves, with claims of the lack of alignment or connection between long-term and short-term

matters going back years. However, the findings that this is still perceived as a central challenge indicate that these realizations have not resulted in significant change.

As current global challenges are turning up the heat, both figuratively and literally, the need to reassess this issue is central. Furthermore, looking at this challenge from a landscape or nature-based perspective offers a unique approach, as long-term change is the fundamental mechanic of the living material and phenomenon we work with. It is clear that the need for increased horizontal alignment by cross-sectoral collaboration does not diminish the need for vertical alignment. On the contrary, as demands increase in numbers and become more multifaceted and complex, their implementation will require an even more close-knit strategic approach to successfully manage all expected outcomes from a long-term perspective. If a deeper understanding of the role of management is lost, the risk, and current trajectory, is that GI management continues to be replaced by maintenance. This means that the core mechanics of biotic material, i.e. dynamics and unpredictability, are at best overlooked and at worst considered a liability.

As such, the main contribution of this thesis concerns the need to re-formulate the question in research as well as in practice. The current linear understanding of managing GI in public organizations does not address the inherent adaptive complexity of the vegetation that is the foundation for GI. For GI to contribute to long term sustainability, there is a need to understand alignment of visions, planning and implementation as an adaptive and ongoing process, operating at several organisational levels, across and within several sectors.

This means engaging with implementation as a strategic and ongoing activity, both through management and maintenance of GI. This will lead us to finding new questions, to which the answers are currently lacking from current understandings and necessary to take steps closer to sustainable approaches to GI.

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Popular science summary

Urban green infrastructure (GI), including parks, forests and other green and blue spaces are an important resource for handling global sustainability challenges such as climate change, biodiversity loss, and public health decline. To tackle these challenges it is important to create visions and strategic plans, but also that the plans are realized on the ground. In the Nordic context, local governments are key actors as they own, and thus have the responsibility for planning, creating and managing, public GI. As urban green infrastructure is comprised of vegetation, it takes a long time for the intended benefits of GI to reach their full potential. This means that a long-term perspective is important when planning and managing green infrastructure. This study investigates how local governments in the Nordic countries manage GI to balance cross-sectoral demands, such as using GI for public health, and long-term objectives. By using document analysis, interviews and workshops, the study looks at policy content, collaboration between practitioners responsible for GI, and those responsible for public health, and how long term perspectives are incorporated when creating new parks.

The study shows that there are several gaps between policy intentions and practical implementation. While the studied policies mention the connection between GI and public health, it is vaguely described and do not provide sufficiently clear visions or prioritizations to support the succeeding planning stages. Cross-sectorial collaboration between urban planning and public health is on-going, but it remains limited due to resource constraints and differing priorities. A short-term focus on creating new spaces without sufficient resources for long term maintenance is restricting the potential of GI. On the operational levels, park management primarily works with static maintenance and making ends meet instead of working strategically. This leads to challenges when trying to create environments that use the dynamic nature of growing vegetation as a way to make parks that are more resilient, and able to promote public health in the long term. In conclusion, prioritization and clearer visions are needed. But it is also important that sustained resources for both for collaboration and long term management are in place. In order to make sure that all steps from policy to with practical implementation are aligned it is important GI management can work strategically and take long term perspectives into account.

Populärvetenskaplig sammanfattning

Urban grön infrastruktur (GI), såsom parker, skogar, och andra gröna och blå miljöer är en viktig resurs för att hantera globala hållbarhetsutmaningar så som klimatförändringar, förlust av biologisk mångfald och försämrad folkhälsa. För att möta utmaningarna är det viktigt med strategiska angreppsätt i visioner och planer, men också att dessa planer implementeras. I nordiska länder är kommunerna nyckelaktörer eftersom de äger och därför ansvarar för att planera, skapa och förvalta offentlig GI. Eftersom den här gröna infrastrukturen består av vegetation tar det lång tid för de avsedda fördelarna att nå sin fulla potential. Detta innebär att det är viktigt med ett långsiktigt perspektiv i både planering och förvaltning. Den här studien undersöker hur kommuner i de nordiska länderna hanterar GI för att balansera tvärsektoriella krav, exempelvis genom använda GI som en resurs för folkhälsa, och långsiktiga mål. Genom att använda dokumentanalys, intervjuer och workshops tittar studien på policyinnehåll, samverkan mellan ansvariga planerare och förvaltare av GI, och de som ansvarar för folkhälsa, samt hur långsiktiga perspektiv kan inkorporeras när nya parker skapas.

Studien visar att det finns flera glapp mellan policyintentioner och praktiskt genomförande. Även om studerade policydokument nämner sambandet mellan GI och folkhälsa, är det vagt beskrivet och ger inte tillräckligt tydliga visioner eller prioriteringar för att stödja efterföljande planeringsskeden. Tvärsektoriellt samarbete mellan planering och folkhälsa pågår, men det är fortfarande begränsat på grund av resursbegränsningar och olika prioriteringar. Ett kortsiktigt fokus på att skapa nya anläggningar utan tillräckliga resurser för långsiktigt förvaltning. På de operativa nivåerna arbetar parkförvaltningen i första hand med statiskt underhåll och att försöka få bristande budgetar att gå ihop. Detta leder till utmaningar när man skapar miljöer som använder den växande vegetationens dynamik som en strategi för att skapa parker som är mer robusta och kan främja folkhälsa på lång sikt. Sammanfattningsvis behövs tydligare visioner och prioriteringar på policynivå, men det är också viktigt att det finns resurser för både samarbete och långsiktig förvaltning. För att säkerställa att alla steg från policy till praktiskt genomförande är anpassade är det viktigt att förvaltningen av GI kan agera strategiskt och ta hänsyn till långsiktiga perspektiv.

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Appendix

The GI-HH&W pathway analytical framework

The GI-HH&W pathway analytical framework is based on a three-layered structure, each of which is explained in more detail in the following. The basis of the model is the socio-ecological framework (Lachowycz and Jones, 2013; Anderson et al. 2021) where the ecological (spatial) domain represents the properties of and functions performed by GI while the social (human) domain represents the HH&W effects delivered by the spatial factors.

Ecological domain

Within the ecological domain, two main dimensions are GI Properties and GI Functions, each with a range of categories further classifying relevant concepts.

GI properties

GI Properties describes the physical features of a green space. This can be compared to the "green space characteristics" described by WHO (2017). However, seen from a GI perspective, these properties could also describe the relation between spaces or describe the network of spaces that comprise the entire green structure in a municipality.

There has been several attempts to categorize the relevant features of a green space (Bedimo Rung et al. 2004; Lachowycz and Jones, 2013; Lee et al. 2015). Some of these features are common across several models, such as features/facilities, condition/maintenance, access/accessibility, aesthetic/ attractiveness/design, and safety (Bedimo Rung et al. 2004; Lachowycz and Jones, 2013; Lee et al. 2015).

Based on these models, GI properties were grouped into 4 categories (level 3): Type, Attribute, Character, and Management.

Type is, within a spatial planning implementation context, a central way of describing and categorizing individual elements of the GI fabric, such as a "park" or a "recreational area".

Attributes describes a space in a more objective and measurable way and includes aspects like distance, size, and content, but also access to, accessibility within spaces (including safety, which is here seen as whether a space can be visited without risk of injury or harm, and hence is a form of accessibility).

Character of a space deals with the sensory experience and expression of the

place and includes features describing quality, such as aesthetics, attractiveness, design and condition.
Management describes how a space is managed, or who has the responsibility to manage it.

GI functions
While WHO (2017) describes this dimension as green space impacts, GI Functions describe what the GI properties can perform or provide an opportunity for in terms of individual experiences or environmental processes. This can be seen as the performing aspect of ES, or nature's contribution to People, following the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services' (IPBES) revised approach (Diaz et al., 2018). From a HH&W point of view, these functions can be divided into two main categories (level 3); Experiential and Environmental.
Experiential functions relate to functions performed by GI that are experienced by a human, such as providing a space for use or an experience of nature, similar to WHO's (2017) use and function.
Environmental functions describe ecological functions that affect human health without demanding conscious interaction, similar to WHO's (2017) environmental regulation service.

Human domain

The human domain contains two dimensions: Effects on People, and HH&W Benefits (on a societal level rather than individual, each detailed by further categorizations, as described below).

Effects on humans
Effects on humans can be described as the specific service provided, i.e. the specific impact a GI function has on humans, bridging the spatial and the human domain. This concept is described as "Pathways to health" by WHO (2017). This framework is defined as consisting of 4 categories (level 3): Individual Services, Community Services, Environmental Services and Equality and Equity.
Individual Services are, for example, reduced stress and increased physical activity, which are individual affect (Hartig et al. 2014; WHO, 2017).
Community Services are referring to those effects that require interaction with others, such as social contacts and social cohesion (Hartig et al. 2014;

WHO, 2017). Similarly, better air quality or buffered temperatures are services provided by the environment.
The distribution of the GI functions affects Equality and Equity for inhabitants and therefore interactional and distributional justice (Rigolon et al. 2019). Although environmental justice can be considered to be engrained in all categories, as suggested by Rigolon et al. (2019), the purpose of assigning a separate category is to clarify whether these aspects are specifically mentioned.

HH&W outcomes
HH&W benefits can be described as the health outcomes on humans. WHO has defined health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (WHO, n.d., para. 1), entailing three main categories to take into consideration (level 3): Physical Health, Mental Health, and Social Well-Being.
Physical Health and Mental Health refer to factors affecting physical well-being and emotional and psychological well-being respectively, and Social Well-Being specifies the individual's experience of their own life, for example, in terms of quality of life.

Adaptation of the framework
While the overarching dimensions were kept, the headlines were shifted to a more precise description. Beyond clarification through detailed definitions for the categories in the framework, two main adaptations were done from the WHO model. First, the category 'Setting Features' was removed, and second, the category 'Equity and Equality' was moved from the HH&W Outcomes to Effects on Humans. The WHO framework details the category "setting features", detailing land prices and living environment. The category was partly omitted (land price) and partly integrated into the dimension looking at effects on humans (living environment) in this framework. We argue that while land prices may indirectly have impacts on human health, taking this into account as a direct connection would lead to potential conflicts with notions of Equity and Equality, and therefore we chose to omit it from the analysis. Second the category 'Equity and Equality' (called Health inequity in the WHO model) was moved from the HH&W Outcomes to Effects on Humans because this was understood as a factor that would impact health outcomes, rather than being a health outcome in itself.

Applicability of the framework

The GI-HH&W pathway framework represents a complex reality, and it is understood that the categories described within each dimension all interrelate and affect each other. This becomes even more evident when it comes to GI Functions and Effects on Humans related to GI. It is not always obvious if a specific concept is considered a function or an effect of a function. This issue is also mentioned by De Groot et al. (2010), who suggest that even though the overall structure of the pathway or cascade type model is generally accepted, there is still debate on the distinction between "function", "service" and "benefit". In this framework, a distinction has been made where GI Function describes the performative aspect of a space, and the Effect on Humans is defined as what affects humans as described by Shanahan et al. (2015), but it is recognized that the interconnections of ES are intertwined in a much more complex mesh.

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Descriptions of the relationship between human health and green infrastructure in six Nordic comprehensive plans

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ABSTRACT

The link between green infrastructure (GI) and human health and well-being (HH&W) is well-established. While land use planning is fundamental for delivering increased and equitable HH&W outcomes, whether and to what extent this is implemented in planning practice is largely unknown.

This study performed a content analysis of six Nordic comprehensive plans regarding terms, connections, and goals used to describe the GI-HH&W relationship in order to identify the conditions set for developing health-promoting GI in strategic planning interventions.

The results revealed common, varied, and nuanced terminology describing GI in all six plans, while health outcomes were non-specifically described and less consistently referred to. Similarly, connections between and goals related to GI and HH&W outcomes were rarely mentioned and expressed only in general terms. This lack of nuance may lead to uncertainty concerning (i) land claims required and (ii) how to configure allocated land in order to promote HH&W via GI. Overall, current descriptions fail to acknowledge that health outcomes vary with properties of GI, and may thus fail to provide sufficient arguments to withstand other land use interests. From a strategic planning perspective, the general description of the GI-HH&W relationship may create additional uncertainties for prioritization in subsequent planning phases.

1. Introduction

The relationship between natural environments and human health and well-being (HH&W) is well-documented (Bratman et al., 2019; Hartig et al., 2014; Markevych et al., 2017; van den Bosch & Ode Sang, 2017; WHO Regional Office for Europe, 2016). The World Health Organization recently presented a strategy calling for a transformation in how the environment is managed with respect to HH&W (WHO, 2020), highlighting a need for making HH&W a strategic objective in cross-sector action, stating land use planning as a key sector. Effective land use planning can be considered fundamental for delivering increased and equitable HH&W outcomes (Besser & Lovasi, 2023; Sallis et al., 2016), as benefits from green space need to be actively planned for (Amano et al., 2018; Kabisch et al., 2023).

Studies on the effects of natural environments on health outcomes are rapidly emerging, detailing e.g., specific HH&W outcomes derived from concepts such as "nature". However, less focus has been placed on providing evidence from a planning perspective, e.g., addressing specific needs of different age groups (Douglas et al., 2017), or through specific types of nature, e.g., 'green infrastructure' (GI) (Nieuwenhuijsen, 2021). GI is defined as a "*strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services*" (EC, 2013, p. 3). A well-documented relationship between ecosystem services (ESS) and human well-being presents a strong argument for combining these in planning approaches (van den Bosch & Ode Sang, 2017). Strategic planning and management of GI includes integrated, connective, and cohesive networks of green spaces viewed in a combined socio-ecological perspective (EC, 2013; Jansson et al., 2020; Mell, 2009), thus offering opportunities to integrate HH&W (Tzoulas et al., 2007). Therefore GI planning is critical for prioritizing health aspects, e.g., related to differentiated uses (Lee et al., 2015) or equity (Gradinaru et al., 2023). As part of the now renowned prolific Green Surge project on sustainable GI development, Davies and Lafortezza (2017) studied whether health was mentioned in collected European GI plans, revealing a high prevalence of the concept. However, they did not further analyze the extent to

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which health was presented or the aspects of health discussed.

In a European context, national and local governments are perceived to have the main responsibility for *developing* GI policies (Slätmo et al., 2019), while *implementation* of strategies for public accessible spaces in urban areas most often lies at the local government level (Carmona et al., 2004; Randrup & Persson, 2009). Within European planning practice, different cultures can be identified, e.g., the "The Nordic planning family" is characterized by a "comprehensive integrated" approach (Davies & Lafortezza, 2017, p 95). In the Nordic context, the comprehensive plan, sometimes referred to as the masterplan or municipal plan, is the overarching spatial planning instrument on local level, specifying and prioritizing land use, including GI preservation and development, to reflect political long-term ambitions (Borges et al., 2017). The plan consists of a map specifying land use and a written plan description, also referred to as a community section, containing visions, goals, and information to steer the municipality's strategic development. This comprehensive plan acts as the main guide and basis for land use, guiding the legally binding 'detail plans' that regulate individual areas, as well as pointing out focus themes and prioritizations in further steps in strategic planning (e.g., green plans or other strategic documents with a thematic focus) (Randrup & Jansson, 2020). Comprehensive plans are mandatory in all the Nordic countries, but there are differences in whether they are legally binding or only guiding. While guidance on primary focus areas for comprehensive plans is provided by national planning legislation in all Nordic countries, municipal autonomy is strong (Borges et al., 2017), so is up to each municipality to interpret and implement aspects such as HH&W within its plans. The Nordic countries show general similarities in GI planning discourses (Nordh & Olafsson, 2021) and public health promotion responsibilities on local government level (Helgesen, 2014). However, knowledge is lacking on whether and how the pathways between GI and HH&W are described in local government spatial planning practice and how the GI-HH&W relationship is integrated into municipal comprehensive plans, leaving the question of planning conditions for practical implementation of the coveted health-promoting GI unanswered.

1.1. Aim and research questions

The aim of this study was to identify the conditions in Nordic land use planning for further strategic interventions to create health-promoting green infrastructure. This was done by assessing how the relationship between human health and wellbeing and green infrastructure is addressed in comprehensive plans drawn up by Nordic municipalities.

This research question (RQ) was broken down into three sub-questions (a–c):

RQ: How is the GI-HH&W relationship described in Nordic comprehensive plans?

a) How is relevant terminology used to describe GI and HH&W?

b) How are the concepts of GI and HH&W connected?

c) Which goals are mentioned as regards the GI-HH&W relationship?

2. Analytical framework

2.1. A model describing the GI-HH&W relationship

In 2017, the WHO Regional Office for Europe presented a "*Causal model of the impacts of urban green spaces on health and well-being*" aimed at practitioners in planning, design, and management, decision makers, and civil organizations on local level (WHO Regional Office for Europe, 2017). The model, based on Roué-Le Gall (2015, cit. Milvoy & Roué-Le Gall, 2015), places the "green space-health" relationship in a framework that comprehensively describes GI-HH&W interconnections, largely building on work by e.g., Hartig et al. (2014). In this study, that model was adapted for a content analysis of planning documents.

2.2. Analytical framework for GI-HH&W pathways

The original WHO framework provides examples in the categories described, while the adapted model was reworked to provide defining descriptions (see Appendix to this paper) of the categories to guide content analysis, as well as a revision of the headings for each category and dimension. In a further development, the adapted WHO framework included a structural layering of the dimensions presented. The resulting analytical framework for GI-HH&W pathways is based on a three-layered structure (see Fig. 1 and Appendix). The basis is the socio-ecological framework described by e.g., Andersson et al. (2021) and Lachowycz and Jones (2013), where the ecological domain represents properties and functions performed by GI and the human domain represents HH&W effects and outcomes delivered by the ecological domain.

2.2.1. Ecological domain

The ecological domain is divided into two main dimensions; *GI Properties* and *GI Functions*.

GI Properties describe the physical features or characteristics of a green space and the relationship between individual spaces or overall GI within a municipality. There have been several attempts to categorize relevant features of green space (e.g., Bedimo-Rung et al., 2005; Lee et al., 2015; Lachowycz & Jones, 2013). Some features are included in several models, such as features/facilities, condition/maintenance, access/accessibility, esthetic/attractiveness/design, and safety (Bedimo-Rung et al., 2005; Lee et al., 2015; Lachowycz & Jones, 2013). In our model, *GI Properties* are divided into four categories: **Type, Attribute, Character,** and **Management**. From a HH&W point of view, *GI Functions* describe what *GI Properties* can perform or provide an opportunity for, in terms of individual experiences or environmental processes, resulting in two categories: **Experiential** and **Environmental**.

2.2.2. Human domain

The human domain comprises two dimensions: *Effects on Humans* and *HH&W Outcomes*. *Effects on Humans* can be described as the specific service provided, i.e., the impact of a *GI Function* on humans. These effects can be divided into four categories: **Individual services, Community Services, Environmental services,** and **Equality and equity.** The distribution of *GI Functions* affects **Equality and equity** for inhabitants, and therefore interactional and distributional justice. Although environmental justice can be considered to be engrained in all categories (Rigolon et al., 2019), the purpose of assigning a separate category in our model is to clarify whether these aspects are specifically mentioned in planning documents. The *HH&W outcomes* are categorized based on WHO's definition of health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." (WHO, n.d), so three main categories are taken into consideration: **Physical health, Mental health,** and **Social well-being.** Table A1 in the Appendix lists the sources used to support the different categories.

2.2.3. Applicability of the framework

The original WHO framework aims to convey the overarching causality of the impacts of green spaces on health and well-being to be considered by policymakers and practitioners. Our adapted analytical framework assesses whether and how the relationship between GI and HH&W is presented in comprehensive plans. However, in both its forms the analytical framework represents a complex reality where the categories described within each dimension all interrelate and affect each other (Fig. 1). This is particularly evident for *GI Functions* and *Effects on Humans*, where it is not always obvious whether a specific concept is a function or an effect of a function. This issue is raised by Groot et al. (2010), who note that even though the overall structure of the WHO framework is generally accepted, there is still debate on the distinction between "function", "service", and "benefit". The distinction made in the present study was that *GI Functions* describe the performative aspects

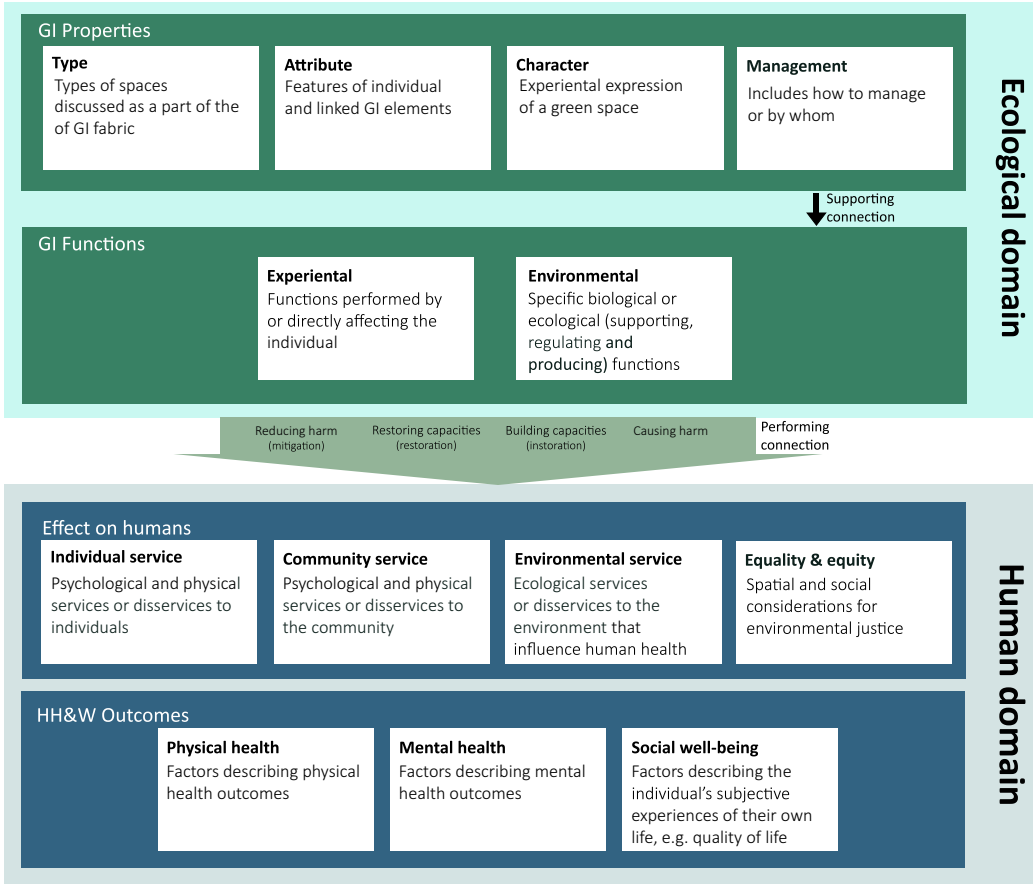

Fig. 1. Analytical framework for green infrastructure-human health & well-being pathways (adapted from WHO Regional Office for Europe, 2017). See Table A1 in Appendix for references on each category in the diagram. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

of a space, while *Effects on Humans* describe issues affecting humans (e.g., Shanahan et al., 2015), although recognizing that this oversimplifies the interconnections of ESS.

Table 1
Number of inhabitants (Inh.), urbanization, geographical location, and area of the six selected municipalities.

	Täby, Sweden	Espoo, Finland	Stavanger Norway	Aarhus, Denmark	Ii, Finland	Vilhelmina, Sweden
Inh (2021)	73 307[a]	293576[b]	142985[c]	352 31[e]	9848[b]	6667[a]
Urbanization	Town	City	City[f]	City	Rural	Rural
Geographical setting	Capital area	Capital area	Second-tier city	Second-tier city	Rural	Rural
Area tot. km^2	71[a]	528[c]	262[d]	468[c]	2873[c]	8740[a]
Area land km^2	60[a]	312[c]	256[d]	–	1614[c]	8047[a]

[a] SCB (2021).
[b] Statistics Finland (2021).
[c] Lantmäteriverket (2021).
[d] SSB (2021).
[e] DST (2021)
[f] Before merger with two rural municipalities.

3. Method

3.1. Selections of municipalities and comprehensive plans

Denmark, Norway, Finland, and Sweden are the four largest countries in the Nordic region, with a total population of just over 27 million (2022) distributed across 1053 municipalities (98 in Denmark, 356 in Norway, 305 in Finland, 290 in Sweden). Comprehensive plans from six municipalities in the four countries were selected and analyzed (Tables 1 and 2), as a collective case study representing a convenience sample (Stake, 2008). The selected cases reflected a spectrum from remote rural settlements ($N = 2$) to second-tier city municipalities (Cardoso & Meijers, 2016) (N = 2), and municipalities in capital regions (N = 2), geographically spread across the Nordic region (Fig. 2). The samples all belong to the same family in European planning practice (Davies & Lafortezza, 2017). They also represent a range of settings and variations in urbanization, comprising three cities (>50 % of the population living in high-density clusters), one town and its suburbs (<50 % living in high-density clusters and <50 % living in rural areas), and two rural municipalities (>50 % of the population living in rural areas) (Grunfelder et al., 2018). While differing in size and scope of urbanization, the selected municipalities are all partners in the NORDGREEN research project in which this study was conducted. Therefore, the municipalities are all highly motivated to increase practical implementation of research-based knowledge on how to integrate health aspects into GI planning. As such, the municipalities represent potential examples of best practice and can yield preliminary insights into the very context-dependent situations they represent (Flyvbjerg, 2006), providing an understanding of how the complex issue of the GI-HH&W relationship is addressed in Nordic planning practice.

For each municipality, the current comprehensive plan was identified (Table 2). In Finnish municipalities, legislation permits geographically defined plans for parts of the city. In those cases, the most recent plan covering a significant part of the city was chosen. All comprehensive plans were linked to a map outlining the vision for land use in the municipality, but these maps were not included in the analysis since the main focus was on GI-HH&W relationships. Thematic maps visualizing the plan content (showing e.g., GI, recreational connections, etc.) were assessed.

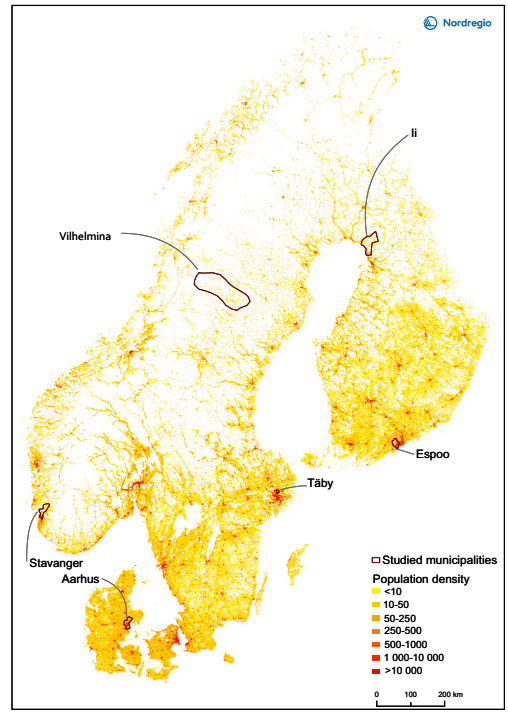

Fig. 2. Spatial distribution and overall population density (or urbanity) of the six selected Nordic municipalities. Image: Oskar Penje, Nordregio.

3.2. Data collection

Document content analysis was used as the main method to investigate whether and how HH&W aspects are connected to GI in Nordic

Table 2
Comprehensive plans analyzed for the six selected Nordic cities (abbreviations in brackets).

	Täby (TÄB)	Espoo (ESP)	Stavanger (STA)	Aarhus (AAR)	Ii (II)	Vilhelmina (VIL)
Title of plan	Det nya Täby Översiktsplan 2010–2030	Espoon eteläosien yleiskaava 2030	1. Kommuneplanens samfunnsdel 2020–2034 2. Planbeskrivelse 2019–2034 3. Bestemmelser og retningslinjer araealdel 2019–2034[a]	Aarhus Kommune-plan	Iin keskustaajaman osayleiskaava	Vilhelmina kommun Vualtjeren Tjïelte med sikte på 2030[b]
Plan approval year	2010	2008	2019–2020	2017	2016	2018
No. of pages (excl. appendices)	88	101	25, 115, 42	172	71	92
Legal status	Visionary and advisory, not legally biding	The map and complementary descriptions are legally binding	Visionary and advisory. A specific part (no 3.) is legally binding	Visionary and advisory, not legally biding	The map and complementary descriptions are legally binding	Visionary and advisory, not legally binding
Geographical coverage	The entire municipality	The south part, approx. half of the city	The entire municipality	The entire municipality	The central part of the city, excl. rural areas and small settlements	The entire municipality
Reference	(Täby Municipality, 2010)	(Espoo Municipality, 2008)	1. (Stavanger Municipality, 2020), 2. (Stavanger Municipality, 2019a), 3. (Stavanger Municipality, 2019b)	(Aarhus Municipality, 2017)	(Ii Municipality, 2016)	(Vilhelmina Municipality, 2018)

[a] The plan comprises three parts with different purposes. Due to an ongoing municipal merger, the plan was under revision during data collection, with one part from the new municipality (2020) and the other two from the old (2019a, 2019b).
[b] "Green comprehensive plan" was produced as a part of a research project (Bjärstig et al., 2018).

comprehensive planning. As the purpose of a comprehensive plan is to guide and steer land use and long-term development, the topics covered by the plans can be expected to reflect political intentions and therefore guide decision-making in subsequent planning steps (Norton, 2008).

Data collection comprised two main components, inspired by Cortinovis and Geneletti (2018), drawing on Baker et al. (2012). These were (i) the information base, i.e., background or general information used to support planning decisions, and (ii) the visions and goals stating the "long-term vision of the plan and the targets (either qualitative or quantitative)" (Cortinovis & Geneletti, 2018, p. 299), meaning statements describing the ambitions of the general and specific objectives of the plan. To complement the goals, strongly worded polices (i.e., containing words such as "must" or "shall") were included. Polices serve as "a general guide to decisions about development and assure that plan goals are achieved" (Berke et al., 2012, p. 140). As comprehensive plans are the overarching planning document on municipal level, few direct actions or implementation steps were expected to be found. Therefore these concepts were omitted from the collection procedure, despite being used in other studies (see e.g., Cortinovis & Geneletti, 2018; Heidrich et al., 2013). The focus was on content relating to the GI-HH&W relationship, rather than assessing the quality of the plan. A protocol inspired by Woodruff and BenDor (2016) was created to guide data collection to answer RQ. See Appendix B for the protocol.

First, the main author and one co-author independently read and coded two of the plans (STA, TÄB), followed by a systematic comparison of selected codes, similarly to Baker et al. (2012). The comparison confirmed that the selection criteria were sufficiently clear, with only minor adjustments needed in interpretation of selected codes. The remaining four plans were read and coded by the main author to ensure consistency (see also e.g., Baker et al., 2012). All six comprehensive plans were re-read twice or more by the main author, and key sections, sentences, or terms that corresponded to any of the data collection criteria were marked and copied to a spreadsheet.

The Scandinavian languages (Swedish, Danish, and Norwegian) are sufficiently similar to be read and understood in written form by all the authors. The Finnish language, a member of the Uralic family, was not directly comprehensible. Therefore, all plans were read in their original language except the Finnish plans (ESP, II), which were translated to English using an automatic online translation service that maintained the layout of the original document, enabling side-by-side comparisons. When the English text was checked, nonsensical translations were compared with the original document. The two translated plans were also read by a native Finnish speaker, in order to confirm the quality of the translations, re-translate specific sections, and ensure no relevant meaning was missed from the Finnish original text.

3.3. Coding and analysis

Our adapted framework provides a means to categorize the content of plans, here in order to answer the overarching RQ. Similarly to Nordh and Olafsson (2021), the presence of specific notions or contexts was addressed on terminology level, meaning that the presence of a specific term indicated that information or goals on that topic were addressed in the plan. For the three sub-RQs (a–c), the texts were coded and categorized related to terminology used, first into the overall domains Ecological and Human, and then into the four dimensions Properties, Functions, Effects, and Outcomes (RQa). From the categories, links were made to show how the different categories on GI and HH&W were interlinked (RQb). Finally, sentences or text sections describing specific goals relating to the GI-HH&W relationship were identified (RQc).

3.3.1. Terminology used in the GI and HH&W nexus

The terminology used within the plans was categorized in two steps:

(i) After re-reading the collected sections, sentences, and terms, the individual terms were coded in a directed qualitative content analysis approach inspired by Hsieh and Shannon (2005), using the categories of the analytical framework in a deductive approach. Terminology deemed relevant within one of the categories in the four dimensions was grouped accordingly. Here, mentions of health that did not relate to any aspect of GI, or its functions and effects (as described by the theoretical framework), were not included (e.g., land allocated to building a hospital was not included).

Terms that did not fit any specific category but were still considered relevant for the overall dimension were included in a "general" category. This was specifically the case in relation to HH&W outcome-related terms such as "health" and "well-being", where it was commonly not specified whether the term referred to physical, mental, or social health. (ii) When all terms were grouped, some categories had far more unique terms than others. In order to reflect this disparity and create meaning in description of terms, these categories were further divided into sub-categories. For example, in the sentence "*Proximity to parks and green areas is of paramount importance so that they can be easily used for the benefit of health and quality of life*", relevant terms (bold) were categorized according to the brackets:

"**Proximity** [GI Property – Attribute – Distance] to **parks** [GI Property – Type – GI] and **green areas** [GI Property – Type – GI] is of paramount importance so that they can be **easily used** [GI Function – Experiential - General] for **the benefit of health** [H&W Outcome – General] and **quality of life** [H&W Outcome – Social well-being]".

3.3.1.1. Classifying the terms. The category **General health** instead consisted of relatively general terms, such as "health", "public health", "physical health", and "quality of life". Therefore, this was added as a new category, instead of referring to the domain as a whole.

In some instances "green" was not stated specifically, but rather described as "outdoor". In those instances the context was reviewed, e.g., in comparison to the term "outdoor recreation", a Nordic term specifically meaning being in nature or green space (Nordh et al., 2017).

Physical aspects of safety discussed in the plans were classified as a form of accessibility, but perceived safety was classified as an effect on the individual.

The term sustainability was used and differentiated into social, economic, and ecological in all plans, but only VIL detailed specifically what was meant by these terms, where social sustainability was equated with public health. Therefore, the term sustainability was not categorized except in the VIL plan.

3.3.2. Links between GI & HH&W

With all terms categorized in categories and sub-categories, the collected data was read through again and links between categories that were rhetorically connected were identified. All links found between the four dimensions were noted, even when they only connected within the same domain. Terms within the same dimension were not linked. This approach allowed a link to be created if a plan mentioned e.g., the connection between a *GI Property* and a *GI Function* in one section, and a connection between the same *GI Function* and *HH&W Outcome* in another, whereas a link between e.g., a Type and Character was not included. Links formulated as goals (see next heading) were classified as both links and goals. For example, for the sentence exampled above, lines were drawn in accordance to Fig. 3.

All links were transferred to a visual diagram representing each plan, with the links between the different categories numbered and assigned a line thickness reflecting the number of connections (Table 3).

3.3.3. GI & HH&W-related goals

Sentences or sections formulated as visions, goals, or strongly worded policies (i.e., containing words such as "must" or "shall") were marked in each plan. As found by Nordh and Olafsson (2021), the visions and goals were not always described in a specific section, but were integrated in running text in the document. Depending on their national regulations, the studied plans mentioned national and regional goals to

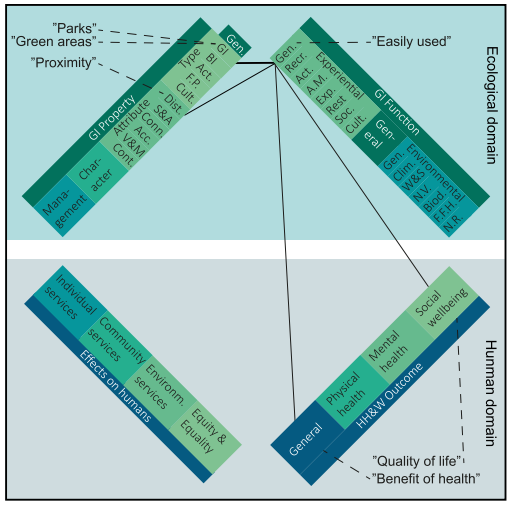

Fig. 3. Created links between identified categories in the sentence "Proximity to parks and green areas is of paramount importance so that they can be easily used for the benefit of health and quality of life". A bolder line indicates more links between unique terms. Abbreviations explained in Table 4. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 3
Number of unique terms per dimension (bold) and sum of terms per category (italics) in each plan (for city abbreviations, see Table 2).

Dimension/city	TÄB	ESP	STA	AAR	II	VIL
GI properties	**118**	**148**	**108**	**148**	**103**	**156**
General[a]	2	3	8	2	4	2
Type	*54*	*83*	*37*	*65*	*55*	*84*
Attribute	*46*	*40*	*48*	*61*	*22*	*46*
Character	*11*	*17*	*8*	*9*	*17*	*7*
Management	*5*	*5*	*7*	*11*	*5*	*17*
GI functions	**55**	**57**	**43**	**71**	**33**	**111**
General[b]	*0*	*2*	*0*	*0*	*0*	*3*
Experiential	*34*	*25*	*14*	*40*	*16*	*58*
Environmental	*21*	*30*	*29*	*31*	*17*	*50*
Effects on humans	**25**	**30**	**14**	**34**	**12**	**72**
Individual service	*9*	*10*	*4*	*8*	*8*	*15*
Community service	*3*	*0*	*1*	*16*	*2*	*14*
Environmental service	*12*	*17*	*5*	*8*	*2*	*35*
Equality & equity	*1*	*3*	*4*	*2*	*0*	*6*
HH&W outcomes	**4**	**7**	**5**	**5**	**4**	**7**
General "health"	*2*	*5*	*4*	*2*	*2*	*4*
Physical health	*0*	*0*	*0*	*0*	*0*	*1*
Mental health	*0*	*1*	*0*	*0*	*0*	*1*
Social well-being	*2*	*1*	*1*	*3*	*2*	*1*
Total	**202**	**242**	**170**	**258**	**152**	**346**

[a] General types including where GI is a part (e.g., "surroundings", "outdoor environments").
[b] General function terms (e.g., "Ecosystem services", "Societal functions").

varying degrees. Goals from other planning levels that were explicitly mentioned in the plans were coded. This was based on the reasoning that explicit mention of these goals implied that they were also considered as goals in the respective plan. The terms within the visons, goals, and policies were then grouped into the predefined categories in the framework, similarly to the process of categorizing the terms.

4. Results and discussion

4.1. Terminology used in the GI-HH&W nexus

Despite structural differences between the six comprehensive plans analyzed, a generally clear pattern emerged of the distribution of unique terms presented. Table 3 shows the number of terms within each dimension and category in the six plans. The production date of the plans spanned a period of >10 years (2008–2020), but no clear pattern was discerned between year of production and terms used.

In the relative relations between the dimensions within each city, there were obvious similarities. The ecological domain (specifically *GI Properties*) was described with far greater variation in number of terms than the human domain (specifically *HH&W Outcomes*). The categories used in each plan are summarized in Table 3.

Due to the large number of unique words in the *GI Properties* categories **Type** and **Attribute** and in the *GI Functions* categories **Experiential** and **Environmental**, these were further grouped into subcategories. Table 3 details the sub-categories and their presence in each of the plans.

In the **Type** category, all six plans mentioned terms describing: *green space*, *blue space*, *formally protected* GI, and *Cultural areas*. There were also some similarities in the terms describing **Attributes** of a space. All mentioned *distance*; *connectivity*-related terms, *accessibility*, and *variation and multifunctionality*, *size and amount*-related terms. Due to the large number of unique words in the *GI Functions* categories **Experiential** and **Environmental**, they were further grouped into themes. In the **Experiential** category, eight themes emerged in the analysis: *general* (umbrella terms); *recreation*; *activity* (physical or outdoors); *active mobility*; *experience* (nature or outdoors); *rest*; *social*; and *cultural*.

In the **Environmental** category, six themes emerged: *General* (theoretical terms); *climate; water & stormwater; nature values; biodiversity; flora, fauna, habitats;* and *nature as a resource*. These sub-categories were mentioned in all plans with the exception of *nature as a resource*, which was mentioned only in two plans (II, VIL) referring to provisioning ESS such as production of timber, fish, and berries.

In general, there were few differences between the municipalities in terms of aspects addressed within the ecological domain, even on subcategory level. This only served to strengthen the contrast with health-related terminology, where only two of the six plans were found to differentiate between physical and mental health. While effects were mentioned in some way in all plans, there were large differences in the extent and in the categories considered.

4.2. Links between GI & HH&W

All six plans recognized the connection between the ecological domain with the human domain in some form, but primarily on a very general level. Fig. 4 shows a city-specific overview of the connections between the four dimensions through their categories. While there were large differences between the total number of links in the plans (Fig. 4), the number of links connecting the ecological and human domain did not differ as widely.

While most sub-categories were covered in the plans, as indicated in Table 4, many concepts were mentioned without any connection to the other dimensions handled within our adapted framework (Fig. 4). The connections between the categories differed among the plans, but shared some general traits. There was a strong focus on the connection between the categories **Type** and **Experiential functions**, where variations in GI and BI typologies were stated to provide general functions such as *recreation* or *use*. However, this was rarely connected to any further effects or health outcomes, while e.g., sub-categories such as *activity* or *active mobility* were more often described as connected to health outcomes (Fig. 4). In this context, *rest*, *social values*, and *cultural values* were less mentioned in general and almost never connected to either effect or health outcomes, such as in this example from Espoo:

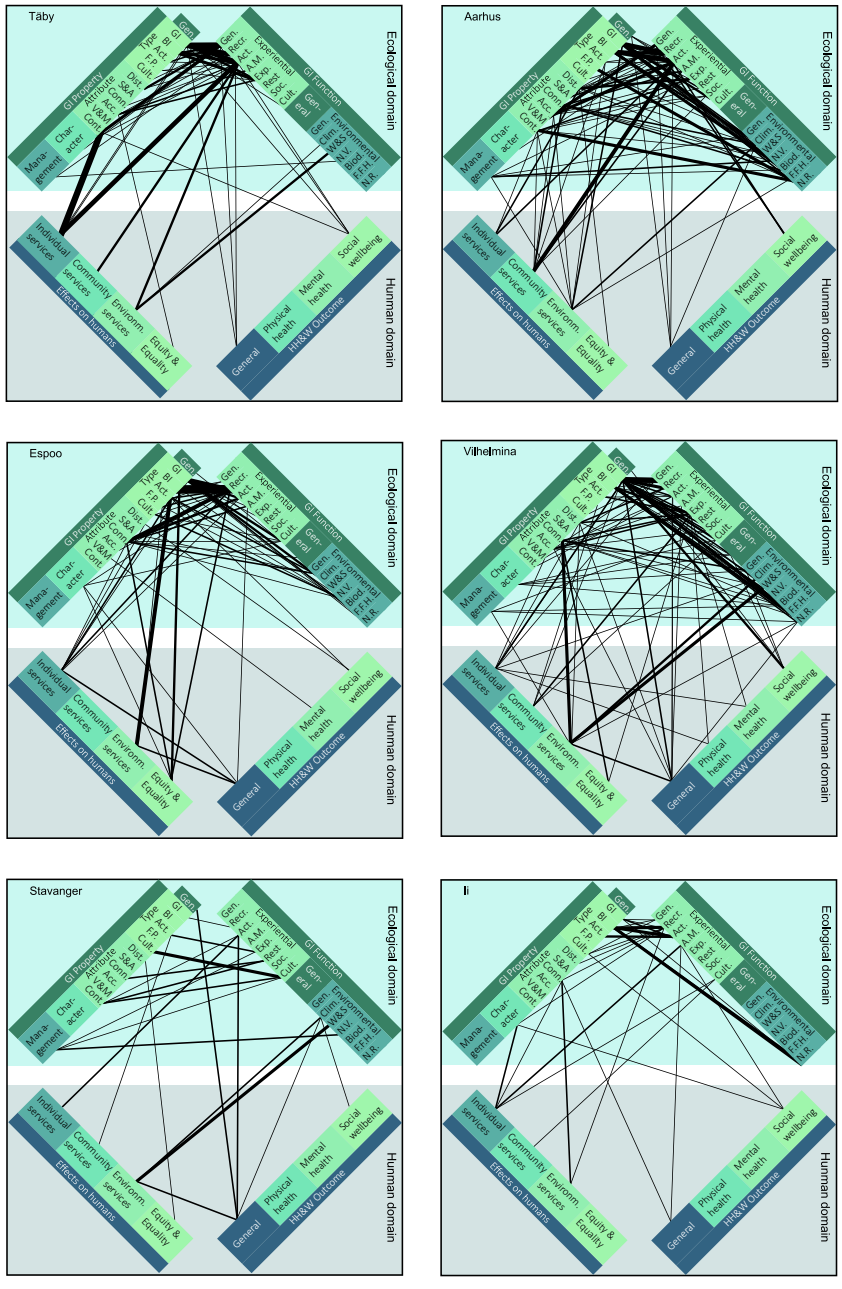

Fig. 4. Overview of connections in city plans between dimensions and categories in the analytical framework for GI-HH&W pathways. Bolder lines indicate more links between unique terms. Abbreviations of subcategories explained in Table 4.

Table 4
Overview of categories mentioned as information and included in goals in the six plans (see section 'GI and HH&W-related goals'; for city abbreviations, see Table 2). Any "X" indicates mention of the terminology, a bold "X" indicates it is mentioned in a vision or a goal, and "–" indicates no mention in the plan. Category abbreviations in brackets.

	Terminology/city	TÄB	ESP	STA	AAR	II	VIL
GI properties	Type						
	GI	**X**	**X**	**X**	**X**	X	**X**
	BI	X	**X**	X	X	**X**	**X**
	Activity (Act.)	X	X	X	X	**X**	X
	Formal protection (F.P.)	X	X	X	X	X	X
	Culture (Cult.)	X	X	X	X	X	X
	Attribute						
	Distance (Dis.)	**X**	X	**X**	**X**	X	**X**
	Size & amount (S&A)	**X**	X	**X**	**X**	**X**	–
	Connectivity (Conn.)	X	**X**	**X**	**X**	**X**	X
	Accessibility (Acc.)	X	**X**	**X**	**X**	**X**	**X**
	Variation&multifunction (V&M)	X	X	X	**X**	X	X
	Content (Cont.)	**X**	**X**	**X**	X	X	X
	Character	X	X	X	**X**	X	X
	Management	X	X	X	X	**X**	X
GI functions	Experiential						
	General(overall) (Gen.)	X	X	X	**X**	X	**X**
	Recreation (Recr.)	**X**	**X**	**X**	X	**X**	**X**
	Activity (Act.)	X	X	**X**	**X**	X	**X**
	Active mobility (A.M.)	X	X	–[a]	X	X	X
	Experience (Exp.)	X	X	X	X	–	**X**
	Rest	–	X	**X**	X	–	X
	Social (Soc.)	X	–	–	X	–	X
	Cultural (Cult.)	X	X	X	–	X	X
	Environmental						
	General(theoretical) (Gen.)	X	X	–	X	X	**X**
	Climate (Clim.)	X	–	X	X	–	X
	Water & stormwater (W&S)	X	X	**X**	X	X	**X**
	Nature values (N.V.)	X	X	X	**X**	X	**X**
	Biodiversity (Biod.)	X	X	X	X	X	**X**
	Flora, fauna, habitats (F.F.H)	X	X	X	X	X	**X**
	Nature as resource (N.R.)	–	–	–	–	X	**X**
Effects on humans	Individual service	X	X	X	X	X	X
	Community service	X	X	X	**X**	X	X
	Environment service	X	**X**	X	**X**	X	X
	Equality & equity	–	**X**	**X**	**X**	–	**X**
Health outcomes	General health	**X**	X	**X**	**X**	X	**X**
	Physical health	X	–	–	–	–	X
	Mental health	–	X	–	–	–	X
	Social well-being	**X**	**X**	X	**X**	X	X

[a] The main vision of the STA plan is "Short-travel everyday life", but not explicitly relating to GI.

Pedestrian and bicycle paths as well as outdoor routes also serve as important sports venues and recreational destinations which increase residents' exercise, and thus also contribute to improving public health (Espoo municipality, 2008, p. 82).

Most plans connected **Type** and **Environmental services**, describing the effects of *GI properties* on the environment. However, this was rarely combined with how it affected *HH&W outcomes*. Consequently, while the explicit focus was not on health outcomes, many arguments presented in the plans were inherently connected to health aspects.

In a few cases, the plan explicitly connected **Types** of spaces with **Health outcomes** through an activity, shown here in the Vilhelmina plan:

Investments in green infrastructure and increased accessibility have a positive impact on both physical and mental health by encouraging physical activities and nature experiences (Vilhelmina municipality, 2018, p. 87).

There was little focus on relating the size and amount of green space to their potential use, while aspects such as distance, connectivity, and accessibility were frequently mentioned regarding their importance for health, specifically in relation to walking and cycling, as exemplified by II:

Promoting bicycling and pedestrian traffic and the network and routes of recreational areas have positive health effects. They increase the attractiveness of everyday exercise and recreational opportunities (Ii Municipality, 2016, p. 67).

Only two of the plans, Täby and Espoo, mentioned the quality of a green space in relation to health outcomes. As with isolated mentions of quality in the other plans, this was not followed by a deeper explanation of what the concept of quality means in this context. In the Täby case, the mention of quality was as a basis for the use of a green space:

Proximity to parks and green areas is of paramount importance in order for them to be easily used for the benefit of health and quality of life. The content and quality of green areas determine how they can be used (Täby municipality, 2010 p. 17).

In the Espoo plan, quality (of the living environment) was described as being partly determined by the health outcomes it produces:

The quality factors of the living environment are health and comfort (Espoo municipality, 2008, p. 86).

In conclusion, the GI-HH&W relationship was described in all plans with a strong focus on the connection between types of spaces and their potential use for experiential GI functions, but with relatively few connections to health outcomes, with VIL being the exception.

4.3. GI and HH&W-related goals

As mentioned in the Methods section, the visions and goals identified were scattered throughout the plans. They were not always clearly stated and often integrated in the running text. Strongly worded policies were more common and used interchangeably with goals, and were therefore included in the results.

All six plans mentioned goals or policies related to the GI-HH&W relationship, but not all were equally clear. The number of statements defined as goals in the individual plans ranged between three and nine (see Table 4 for goal contents by category for each plan). The goals differed in their focus and were in general poorly linked to any specific type of environment.

The goals generally used generic terms such as "the city", "urban structure", or "surroundings", which should be provided to "promote health", "increase quality of life", or "prevent disease". Only TÄB clearly connected HH&W to a specific GI in its goals, by describing "the green half" of the municipality.

All plans mentioned a **Type** of GI or BI, but often in very general terms:

Our future Täby is a green city close to nature that is vibrant around the clock. Half of Täby is green (Täby municipality, 2010, p. 1).

All plans considered easy access to, within, and between areas to be important. Goals or policies indicating the character or content of GI were almost non-existent in the plans, with the exception of AAR (and STA's detailed regulations):

Based on wise use and layout of our land resource, we must try to create added value - more life, more nature, better transport, greater health, and so on (Aarhus municipality, 2017, p. 15).

For **Experiential** functions, similarly general terms such as "use", and "recreation" were mentioned in all plans to frame their vision, goals, and policies to detail how the generally described spaces should be used. AAR and II went one step further by detailing specific activities, while VIL also described experiences and cultural values:

Outdoor recreation, sports, and exercise shall contribute to the health and quality of life of Aarhusians. The leisure offers must be located scattered in Aarhus Municipality to ensure Aarhusians and visitors the greatest possible accessibility (Aarhus municipality, 2017, p. 47).

Only STA explicitly mentioned rest.

The mentions of **Equality and equity** mainly consisted of notions of equality, where the plans stated this in relatively general terms, e.g., "all citizens" (AAR) or:

Land use shall pay particular attention to the safety and comfort of the resulting physical environment and to the conditions for socially balanced demographic development (Espoo municipality, 2008, p. 102).

VIL clearly stated this in relation to health outcomes:

Good health for all on equal terms is an obvious endeavor in the municipality's work (Vilhelmina municipality, 2018, p. 21).

Only STA explicitly mentioned policies addressing health differentials:

Stavanger wants active residents who thrive in the best possible way throughout life. Therefore, we must: reduce social inequality and differences in living conditions through measures aimed at low-income families […] and facilitate environments and activities that promote health and prevent disease (Stavanger municipality, 2020 p. 15).

Very few specific, measurable quantitative regulations or guidelines were mentioned. STA specified 500 m to green space access and specified size and distance to different types of playgrounds, while AAR stated that forest area should increase to 8000 ha by 2030. STA was the only plan with a part devoted to mandatory specifications for e.g., size, content, and noise level in playgrounds.

Five of the six plans (not including II) mentioned **Health outcomes** in the goals or policies. Similarly to the described terms, the health outcomes were general, both when detailing the spatial aspects: "*The urban structure must safeguard the quality of life, safety, environmental comfort and competitiveness of current and future residents.*" (Espoo municipality, 2008, p. 101), or in terms of general health or in quality of life: "*Develop the green half of the city to promote citizens' quality of life, health, and recreation – in dialogue with the citizens.*" (Täby municipality, 2010, p. 17).

How is the GI - HH&W relationship described in Nordic comprehensive plans?

Based on the three sub-RQs, a pattern emerged in the general way in which the GI-HH&W relationship was described in the six plans. The prevailing use of GI terms was similar in all plans, revealing a common GI discourse, as also found by Nordh and Olafsson (2021). While the descriptions of terms relating to properties of GI were nuanced, visions describing outcomes were relatively scarce. Most *Effects on Humans* were described as risks or avoidance of risks connected to the environment or the individual. This reflects the fact that planning legislation requires the plan to avoid harm, rather than promoting health, whereas public health should be part of urban planning, describing intended health benefits (Lee et al., 2015).

When describing *Health Outcomes*, the plans were similar in terminology and nuance, but only in terms of the very general focus, to a point where the intended subcategorization of physical health and mental health proved too specific. This confirms findings by Reyes-Riveros et al. (2021) that planning strategies rarely address health benefits. However, most of the plans mentioned many aspects that are potentially relevant for the GI-HH&W relationship, but rarely explicitly stated as such, meaning that this might be a question of framing rather than actual content.

The study by Nordh and Olafsson (2021) grouped the concepts of health and recreation together and found widespread occurrence. In the present study, however, our analytical framework differentiated the two as a function provided by GI and the health outcome experienced by an individual. Recreation is a term that warrants specific attention, since it was frequently used as an overarching term in all six plans, as also found by Cortinovis and Geneletti (2018). While the term conveniently covers a range of different concepts, these cannot always be provided by the same space, e.g., a combination of organized physical activity and rest, or social gatherings and solitary relaxation. Thus, the term does not indicate the types of GI that are required. From an economic point of view, a shift from focusing on recreation to actual health outcomes could promote re-evaluation of land uses, where brownfield sites or undeveloped areas could be viewed as potential resources for health promotion and ESS, instead of the economic benefits gained from housing developments (Scott et al., 2016).

In other studies, green space policy frameworks have been found to focus on broad targets, e.g., distance from residence to green space and minimum sizes of parks, as opposed to design and content, or intended health benefits of the space (Moseley et al., 2013; Davies & Lafortezza, 2017). Our findings confirmed this on a very general level. Most of the six plans studied instead mentioned visions, but with attributes such as distance and accessibility far more commonly described than expected HH&W outcomes. However, while mentioning distance can be viewed as a baseline in the plans, some studies have shown that proximity to GI alone may not improve well-being, indicating a more complex relationship involving other factors (Brindley et al., 2019; Mears et al., 2019). Thus, connectivity and accessibility-related goals were more commonly described in the plans, focusing on a network of green spaces and easy access to these. Perceived access has been described by some as more important than geographical proximity (Lachowycz & Jones, 2013), but there was no indication in the plans of how this access should be manifested.

While general descriptions of access, connectivity, and distance were frequent, the character of spaces was in general less commonly specified. All plans mentioned "quality", but the term was not clearly defined or expanded upon in any plan. As examplified by the Täby and Espoo quotes addressing quality, the use of the term varied significantly and provided little guidance for planning. Quality is a concept that is inherently complex and can be understood in different ways (Fors et al., 2018), but each definition will inevitably include some values and exclude others (Lindholst et al., 2015). As quality of spaces have been stated to have larger impact on health outcomes than quantity (de Vries et al., 2013), a more clear indication of what is desirable in terms of quality would be relevant to truly support decisionmaking and prioritization in subsequent planning phases.

Only one plan (STA) provided a detailed recommendation regarding

content of GI, stating that places for rest must be installed along hiking trails according to the principle of universal design. Providing details of how spaces should be differentiated in order to support different HH&W outcomes was emphasized by Douglas et al. (2017), while Lee et al. (2015, p. 134) pointed out that "*a blunderbuss approach to development of urban green spaces may not translate into the desired health outcomes*". The overarching character of the comprehensive plans cannot be expected to provide extensive detailed guidelines on content, but most goals found were general to the point of providing little potential guidance for future decision-making.

The only plan explicitly mentioning both ESS and GI was VIL. This municipality is very large in area and has a relatively low level of urbanization, which explains a lack of focus on urban GI elements. The plan was produced as part of the project *Green planning: Vilhelmina as a testbed for innovative land use planning in the mountain region*, with the target of creating a green comprehensive plan focusing on participatory processes. This could explain the variety and number of terms describing both GI functions and effects on humans.

Protection and preservation of sensitive green spaces (here categorized as relating to Management), were mentioned by all plans, in line with recent findings for GI plans in Denmark, Norway, and Sweden (Nordh & Olafsson, 2021). Another common focus was disturbance of wildlife or sensitive nature areas and potential conflicts with recreational pressures in some form, which all plans mentioned and stated that recreational needs must come second.

Regarding equality and equity, only one plan (STA) specifically mentioned concepts relating to equity in describing health distribution within the population, while other mentions were of a more general character, e.g., "social balance" or "equal access for all citizens". As such, the plans generally had a focus on equality and did not address the potential impact of planning on e.g., vulnerable groups, reflecting findings by e.g., Gradinaru et al. (2023) on the superficial way in which equity is related to GI in strategic urban plans in Romania.

4.4. Implications for practice

This study analyzed six comprehensive plans from four Nordic countries to identify potential theory-practice gaps (e.g., Cooke et al., 2021). The results revealed connections between elements of GI and HH&W in the comprehensive plans, but the pathways were not strong in any of the plans. While it is important to communicate the overall message that green spaces or GI are important features for HH&W promotion, the lack of nuance in the use of terms and the lack of explicit goals create uncertainty about land claims and how allocated land should be configured to promote HH&W. Some aspects may be considered in subsequent strategic plans but, as mentioned, in the Nordic context these often have a thematic focus such as "mobility", "environment", or "green space", whereas it is the task of the comprehensive plans to prioritize between different types of land use, and thus themes or interests. As the "highest-level" planning document in the municipalities, the comprehensive plan sets the direction for the municipality's future development, meaning that a public health focus might be warranted. An intentional vision in this regard was only presented in the VIL plan, which had a common theme concerning ESS and GI from a landscape perspective, an approach that permeated the entire plan.

From a strategic planning perspective, the general nature of the plans could result in additional uncertainties in subsequent planning phases. Visions and goals that connect GI and HH&W in a clear way would be more productive in achieving clearer targets and entailing strategies that are more feasible for monitoring and evaluation. The method used in this study took the plans at "face value", i.e., investigated what was clearly stated rather than what might be implied. This might pose a risk of excluding implied arguments that were not clearly stated, e.g., the intended positive health aspects might have been unstated or taken for granted when mentioning e.g., recreation. However, since the plans are "communicative policy acts" (Norton, 2008), failure to include explicit arguments could pose a risk of issues being overlooked or ignored by decision-makers.

An undifferentiated approach to describing GI-HH&W pathways fails to acknowledge that health outcomes will vary with the properties and functions provided by GI and for different users (Bedimo-Rung et al., 2005; Hartig et al., 2014), and might not be sufficient to withstand other strong land use interests. The studied plans mentioned a range of concepts relating to the GI-health nexus, but did not frame them as such. This indicates that with a more targeted approach linking a broader set of terms, there is ample opportunity to connect *GI properties* more clearly to *HH&W outcomes*.

In relation to wicked challenges such as densification and climate change adaptation, increasing levels of multifunctionality are required from specifically urban GI. Multifunctionality is an important principle in urban GI planning (Pauleit et al., 2011), but an undifferentiated approach to the concept poses a risk that a given space, or a structure of small, fragmented spaces, will be expected to fulfil any and all needs expressed by residents, failing to account for the fact that not all types of functions can co-exist. This is particularly relevant in relation to aspects such as stress, where the qualities 'serene' and 'natural" are rated as most sought after (Grahn & Stigsdotter, 2010; Sang et al., 2016), and e.g., rest and social activities are difficult to combine in the same space (Stoltz & Grahn, 2021).

If the need for differentiated spaces, and particularly large green areas, is not stated clearly at land-use level, this risks being manifested on place-based level as more programmed spaces in order to accommodate multifunctionality that serves more citizens and copes with increased wear and tear (Randrup et al., 2021). Randrup et al. (2021) also found that central spaces are becoming less green and more programmed, while peripheral areas are becoming more nature-like as a result of decreasing maintenance intervals to divert a restricted maintenance budget to central areas. In effect, this creates a potentially uneven distribution of possible health outcomes where rest and tranquility might be difficult to find in central urbanized areas, while peripheral areas might be considered less attractive and accessible owing to perceived lower safety because of lower maintenance levels, as described by Nam and Dempsey (2019). There is then a risk of an undifferentiated approach to describing GI-HH&W pathways leading to distributional injustice. The question of health distribution is increasingly becoming an issue of health equity. A "smart data" approach now allows for more detailed comparison of residents' health in different areas of a city, paving the way for a more tailored approach to targeted health benefits for different spaces and promoting environmental justice.

Most health benefits likely come from the use of green space rather than its presence (Lee et al., 2015), but it is equally important to recognize that some health outcomes are affected by the mere presence of green spaces (described in this study as environmental services). A holistic view of GI is needed in order to emphasize synergies and interrelations between environmental effects such as increased biodiversity, which in turn might affect humans. The indirect effects of important aspects such as air quality and noise reduction also need to be understood in terms of functions performed by green spaces, rather than just the notion of their presence, in order to nuance the situation of presence/no presence and acknowledge that the distribution and configuration of these spaces affect the functions provided.

With the introduction of environmental demands on municipal level, comprehensive plans have become increasingly precise as regards environmental values (Nilsson, 2017). All plans analyzed here had established processes for environmental assessments on outcomes of the plan. Current legislation and national policy focus on avoiding harm, rather than promoting health, but Davies and Lafortezza (2017) suggest that health outcomes should be included in a strategic environmental assessment process. Similarly, introducing public health strategies on municipal level could mean that health promotion issues are addressed in a more strategic manner.

Limitations and suggested further research A limitation of the study was the small number of municipal plans reviewed. However, the six selected municipalities included represent different contexts in terms of urbanization and geography and the detailed analysis can be seen as a strength in understanding the subject matter (Flyvbjerg, 2006). The study was intended to give an indication of the current state of health and GI in Nordic planning practice, but the sample size was not large enough to enable definite recommendations for Nordic planning in general. However, the results, specifically on use of similar terms and the general vagueness of related goals, are sufficiently clear enough to provide a strong indication of how Nordic municipal comprehensive plans describe the relationship between GI and HH&W. Inclusion of different Nordic nations increased the complexity of policy contexts, and therefore the use of potential recommendations, but plans from municipalities with same country did not show great similarities, indicating that municipal autonomy may partly overrule national differences.

Further studies involving greater numbers of plans are needed to verify these conclusions. Using the adapted framework developed in this study, a diverse set of municipal comprehensive plans could be analyzed to confirm the findings on an instrumental level. This could be complemented with studies on plan quality, although on a professional planning and management level studies are perhaps needed on how the GI-HH&W pathways described in the plans are used in practice. This could be done through interviews with central actors, planners, managers, and health officers in participating municipalities. The results would reveal the relationships between planning incentives and practice and indicate how planning documents could be better formulated and presented for a stronger impact in creating GI for the benefit of HH&W.

5. Conclusions

Analysis of terminology used, connections made, and stated goals relating to GI-HH&W pathways in comprehensive plans for six Nordic cities showed that: (i) terminology relating to the ecological domain (*GI Properties*, *GI Functions*) was nuanced and largely consistent; (ii) terms relating to the human domain (*Effects on Humans*, *HH&W Outcome*) were rarely mentioned and broadly described; and (iii) an array of aspects relating to GI properties and the functions they provide were described, but connections to GI-HH&W pathways were sparse and described only in general terms.

This incomplete handling of GI-HH&W pathways in contemporary comprehensive plans risks creating an inability to withstand other land use interests, especially where economic benefits are apparent.

While the plans contained an abundance of information relating to aspects that are relevant for HH&W outcomes, these were not clearly stated as such. This suggests that in future comprehensive plans, the focus on HH&W outcomes could be strengthened by reframing to connect to a HH&W perspective, rather than primarily focusing on activities providing health benefits, such as recreation. A stronger HH&W focus would also require more nuanced descriptions of expected health outcomes beyond e.g., "mental health" or "quality of life", in order to create a more differentiated vision of pathways to public health and of specific properties needed to sustain health-promoting activities and expected health outcomes.

CRediT authorship contribution statement

Anna Sunding: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. **Thomas B. Randrup:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Helena Nordh:** Formal analysis, Funding acquisition, Methodology, Validation, Writing – review & editing. **Åsa Ode Sang:** Formal analysis, Methodology, Supervision, Validation, Writing – review & editing. **Kjell Nilsson:** Funding acquisition, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A

Table A1
Description of categories, and examples of reviews and articles relating each of the categories to the GI-HH&W relationship shown in Fig. 1.

	Category description	Reference
GI properties		
Type	Types of spaces discussed as a part of the of GI fabric, including GI, BI, activity-related spaces, formal protected space, cultural spaces	Chen et al., 2021; Nguyen et al., 2021; Hunter et al., 2019; Nieuwenhuijsen et al., 2017
Attribute	Features of individual and linked GI elements, including size, access, accessibility, connectivity, content	Nguyen et al., 2021; Felappi et al., 2020; Hunter et al., 2019 Nieuwenhuijsen et al., 2017; McCormack et al., 2010
Character	The experiential expressions of spaces, focusing on expressed or intended character rather that perceived character. Includes aesthetics, style, conditions or levels of maintenance, quality	Nguyen et al., 2021; Nieuwenhuijsen et al., 2017; McCormack et al., 2010
Management	How to manage a space, or who has the responsibility for managing it	Felappi et al., 2020; Nam & Dempsey, 2019
GI functions		
Experiential	Functions with opportunity to directly affect the individual experiencing a green space, including psychological and physical experiences, learning and inspiration	Chen et al., 2021; Nguyen et al., 2021; Hunter et al., 2019; Coutts & Hahn, 2015; Hartig et al., 2014

(*continued on next page*)

Table A1 (*continued*)

	Category description	Reference
Environmental	Specific biological or ecological (supporting, regulating and producing) functions, including climate, water and storm water regulation, temperature regulation, general values, utilizing nature's resources	Nieuwenhuijsen et al., 2017; Coutts & Hahn, 2015: Hartig et al., 2014
Effects on humans		
Individual service	Psychological and physical services or disservices to individuals provided by GI, e.g., an active lifestyle, perceived safety, prevention of adverse health effects, feeling comfortable, de-stressing	Nguyen, Astell-Burt, Rahimi-Ardabili and Feng, 2021; Hunter et al., 2019 Nieuwenhuijsen et al., 2017; van den Bosch & Ode Sang, 2017; Hartig et al., 2014; McCormack et al., 2010
Community service	Psychological and physical services or disservices to the community provided by GI, e.g., social contact, commitment to home municipality, breaking down social barriers, conflict between residents or user groups	Chen et al., 2021; Nguyen et al., 2021; Nieuwenhuijsen et al., 2017; Coutts & Hahn, 2015
Environmental service	Includes services or disservices to green spaces that has an effect on human health, e.g., better air quality, water quality, reduced noise, pollutants, mitigated flood risks and damage	Chen et al., 2021; Nguyen et al., 2021; Nieuwenhuijsen et al., 2017; van den Bosch & Ode Sang, 2017; Hartig et al., 2014
Equality & equity	Spatial and social considerations for environmental justice, including mentions of health distribution and social balance, different groups of inhabitants	Hunter et al., 2019 (claiming insufficient studies); Rigolon et al., 2021
HH&W outcomes		
Physical health	Descriptions of physical health outcomes, including e.g., allergies, cardiovascular effects, obesity, injuries	Nguyen et al., 2021; Rigolon et al., 2021; Hunter et al., 2019; Nieuwenhuijsen et al., 2017; van den Bosch & Ode Sang, 2017; Coutts & Hahn, 2015
Mental health	Descriptions of mental health outcomes, including e.g., depression, cognitive functions	Nguyen et al., 2021; Chen et al., 2021; Hunter et al., 2019; Felappi et al., 2020; Nieuwenhuijsen et al., 2017; Coutts & Hahn, 2015; Hartig et al., 2014
Social well-being	The individual's subjective experiences of their own life, e.g., quality of life, life satisfaction	Nguyen et al., 2021; Hunter et al., 2019

Appendix B. Instructions for data collection (Protocol)

Data collection focuses on two main types of data: 1) The information provided in relation to green space and health matters and 2) the goals provided in relation to green space and health matters.

The data collection process involves searching for answers to the posed questions using the *Analytical framework for GI-HH&W pathways(shown in a separate file)*, as well as potential "new" terms or typologies not originally mentioned in the framework.

The masterplans are read through in their entirety. Key sections or sentences are marked and transferred to an analysis matrix containing each city and all questions & sub-questions.

The analytical framework for GI-HH&W pathways

The analytical framework for GI-HH&W pathways consists of four main Dimensions;

Categories represent subgroups of the dimensions and are the main focus in the data collection.

GI Properties (Type, Attribute, Character, and Management).

GI function (Experiential and Environmental).

Effect on humans (Individual service, Community service, Environmental service, Equality and Equity).

HH&W Outcome (Physical health, mental health, social well-being).

The categories are not conclusive/final in the data collection phase. Thus, they should be considered as "concrete examples" of the different dimensions in order to facilitate data collection. This means that terms or typologies that do not fit any category but are still considered as relevant for the overall step should be included. Similarly, general terms such as "health" and "well-being" should be included even though they fit more than one category.

Direct and indirect pathways between dimensions

A GI Property mentioned as supporting a GI Function is not a direct link to Human-related factors. However, if the mentioned GI Function is in turn stated to have an Effect or Health outcome, the GI Property can be considered to indirectly support these factors. It should therefore be included in data collection.

Information on maps

Map-based information could become relevant in relation to e.g., RQc, relating to spatial components. If e.g., walking paths are stated to be beneficial for health, a map that points out developments of a walking path network should be noted, with a reference to any reasoning supporting the specific spatial placement.

Questions guiding data collection

How is relevant terminology used to describe GI and HH&W?

Look for information containing terms which can be located into categories (see the framework).

Are there specific goals in related to Green Space?

Look for specific goals or strongly worded policies on decision making, or strategic planning, design or management relating to the GI-HH&W nexus.

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This thesis explores how Nordic local governments manage green infrastructure (GI) across organizational levels in the context of cross-sectoral demands and long-term perspectives. The findings show that despite the need to embrace more nature based approaches, current linear views of managing GI in public organizations do not sufficiently address the inherent adaptive complexity of GI. This suggests a need to align intentions and implementation as a strategic, adaptive and ongoing process to secure the long term sustainability of GI.

Anna Sunding received her postgraduate education at the Department of Landscape Architecture, Planning and Management, and her undergraduate degree in Landscape Architecture at SLU, Alnarp.

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