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Resilient urban housing business ecosystem and the role of nature-based solutions

"Nature becomes one with the city, and city with the nature"

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Master's thesis

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Abstract:

The objective of this thesis is to study resilient urban housing business ecosystems and the role and use of nature-based solutions (NBS) in these ecosystems. Thesis aims to gather knowledge on how nature-based solutions are perceived in urban residential building and planning regime and how these solutions are valued to increase urban resilience. Thesis aims to provide knowledge on who are the actors in key role in designing, implementing, or using nature-based solutions in the case cities urban built environment and residential buildings of the business ecosystem. The benefits from nature-based solutions are presented and challenges hindering the mainstreaming of nature-based solutions as well as ways to overcome them are addressed.

This thesis is a qualitative study with an empirical research approach. The empirical part of the study consists of data collected from 11 expert interviews, and two expert workshops. Altogether the empirical data corpus consisted of 15 transcripts. The interviews were semi-structured, thematic interviews where experts from different organizations of urban planning and construction industry were interviewed. Two separate workshops were held during August of 2023 in both case cities Helsinki and Turku. Workshops consisted of researcher presentations and focus group work, and the expert participants represented versatility of the field. Study applies reflexive thematic analysis method for qualitative data analysis. It is a systematic and flexible method that is used for identifying, analysing, and reporting meaning-based multifaceted and conceptual patterns within data by generating codes and themes.

Several actor groups and key actors were identified based on the analysis. Also, an open role for a champion was recognized from the analysis. Several benefits derived from NBS and barriers for mainstreamed use were identified. Multiple solutions such as land use planning, urban governance practices including green factor, and economical incentives help to increase use of NBS in urban settings, and to answer the future of more resilient city.

Urban resilience can be increased through inclusion of NBS and the associated delivery of ecosystem services in urban areas. Urban greenery and green spaces are highly relevant for well-being of residents. A holistic approach for urban planning and residential housing building is called for with increase in implementation of NBS. City should be designed for people as well as to other species. Experts share a vision of greener and more sustainable city where nature becomes one with the city, and city with the nature. There is still need for more research on long-term review of follow-ups and next steps taken from pilot projects to answer how nature-based solutions could be transferred from experimentations for everyday use and how this knowledge could be transferred for wider audiences.

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Tiivistelmä:

Tutkielman tavoitteena on tutkia resilientin kaupunkiasumisen liiketoimintaekosysteemejä sekä luontopohjaisten ratkaisujen roolia ja käyttöä näissä ekosysteemeissä. Tarkoituksena on myös selvittää miten luontopohjaiset ratkaisut nähdään osana kaupunkien asuinrakentamista ja suunnittelua sekä koetaanko niiden lisäävän kaupungin resilienssiä. Tavoitteena on selvittää mitkä toimijat ovat avainasemassa suunniteltaessa, toteutettaessa tai hyödynnettäessä luontopohjaisia ratkaisuja kohdekaupunkien urbaanin ympäristön ja asuinkerrostalojen liiketoimintaekosysteemissä. Tutkielma esittelee luontopohjaisten ratkaisujen hyötyjä, sekä käsittelee luontopohjaisten ratkaisujen yleistymisen esteitä ja keinoja näiden haasteiden ratkaisemiseksi.

Tämä tutkielma on laadullinen tutkimus, jossa käytetään empiiristä tutkimuslähestymistapaa. Tutkimuksen empiirinen osa koostuu 11 asiantuntijahaastattelusta ja kahdesta asiantuntijatyöpajasta. Aineisto koostuu kaikkiaan 15 litteroinnista. Haastattelut olivat puolistrukturoituja teemahaastatteluja, joissa haastateltiin asiantuntijoita eri organisaatioista kaupunkisuunnittelun ja rakennusteollisuuden alalta. Kaksi työpajaa järjestettiin elokuussa 2023 kohdekaupungeissa Helsingissä ja Turussa. Työpajat koostuivat tutkijoiden esityksistä ja ryhmätyöskentelystä, ja asiantuntijat edustivat monipuolisesti eri aloja. Tutkimuksessa käytetään refleksiivistä teema-analyysiä analyysimenetelmänä. Se on systemaattinen ja joustava menetelmä, jota käytetään merkityspohjaisten moniulotteisten ja käsitteellisten kaavojen tunnistamiseen, analysointiin ja raportointiin koodeja ja teemoja muodostamalla.

Analyysin perusteella tunnistettiin useita toimijaryhmiä ja avainasemassa olevia toimijoita. Lisäksi analyysissa tunnistettiin vapaa rooli ”edistäjälle”. Myös useita hyötyjä liittyen luontopohjaisiin ratkaisuihin, ja esteitä niiden laajemmalle käytölle tunnistettiin. Monet ratkaisut, kuten maankäytön suunnittelu, kaupunkien hallintokäytännöt, kuten viherkerroin rakentamisessa, ja taloudelliset kannustimet auttavat lisäämään luontopohjaisten ratkaisujen käyttöä kaupunkiympäristöissä ja vastaamaan tulevaisuuden tarpeeseen kestävämmästä ja resilientistä kaupungista.

Kaupunkiresilienssiä voidaan parantaa lisäämällä luontopohjaisia ratkaisuja ja niihin liittyviä ekosysteemipalveluja kaupunkialueilla. Kaupunkiluonto ja viheralueet ovat erittäin tärkeitä asukkaiden hyvinvoinnille. Tarvitaan kokonaisvaltainen lähestymistapa kaupunkisuunnitteluun ja asuinrakentamiseen luontopohjaisten ratkaisujen lisäämisen ohella. Kaupungin tulisi olla suunniteltu sekä ihmisille että muille lajeille. Asiantuntijat jakavat näkemyksen vihreämmästä ja kestävämmästä kaupungista, jossa luonto sulautuu osaksi kaupunkia ja kaupunki osaksi luontoa. Edelleen kuitenkin tarvitaan lisää tietoa pitkäaikaistutkimuksista ja toteutuneiden pilottiprojektien seuraavista vaiheista, jotta voidaan selvittää, miten luontopohjaiset ratkaisut siirretään kokeiluista jokapäiväiseen käyttöön ja miten tämä tieto voitaisiin jakaa laajalle yleisölle.

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1 Introduction

Humans have drastically affected the functioning and resilience of Earth system and the biosphere, leading societies to face multiple large-scale and interlinked threats, such as human-driven climate change and biodiversity loss and reduction, resulting from overexploitation of natural resources (Steffen et al., 2015; Castaño-Rosa et al., 2022). Furthermore, rapid urbanization drives large-scale land use conversion from rural to urban areas. Urbanization has led to a development were almost 60 % of human population live in urban areas. By 2050 this is expected to increase with additional 2.5 billion people, driving even more widespread changes in the biosphere. (Folke et al., 2016; McPhearson et al., 2022.)

This myriad of crises comes with complex and interconnected direct and indirect impacts to our societies, hence, to built environment (Steffen et al., 2015; Castaño-Rosa et al., 2022). These impacts and following challenges are multiple, complex, and interdependent and alongside climate change, urbanization amplifies vulnerability and exposure to different hazards (McPhearson et al., 2022; Vigren 2024). Extreme weather events, e.g., heat waves, flooding, and droughts, as well as increased heat-island effect and pollution levels are some of the associated impacts of climate crisis with a negative effect on built environment and urban populations. Moreover, urbanization creates pressure for the environment through degradation and loss of natural areas, increase in impervious surfaces, and urban densification - challenges interlinked with biodiversity loss and reduction. As urbanization and human population densities in cities continue to increase, the built environment has to be resilient to multiple crises to assure continuing stability and habitability of urban areas. (Kabisch et al. 2016; Castaño-Rosa et al., 2022.)

There is a widely recognized urgency in the need to protect natural capital and value ecosystem services as they are fundamental to the progress towards sustainable development objectives (Raymond et al., 2017). Here, sustainable development is referred to a change in the lives of human societies that ensures the viability and subsistence of all species and the services of ecosystems (Dawe & Ryan, 2003). Comprehensive management of socio-ecological systems serves as a way to answer the aforementioned multifaceted challenges and find ways for sustaining and potentially increasing the delivery of ecosystems' services to humans and ensure urban residents' quality of life (Eggermont et al., 2015; McPhearson et al., 2022). Socio-ecological resilience means the capacity to adapt

or transform amidst change in socio-ecological systems in a way that continues to support human well-being (Folke et al., 2016). Cities can be characterized as complex social-ecological systems, where people are a part of an interactive holistic system (Scott et al., 2016).

Nature-based solutions have potential to decrease the vulnerability and enhance resilience and adaptability of ecosystems. Nature-based solutions can restore degraded ecosystems, develop climate change adaptation and mitigation as well as improve risk management and resilience (European Commission, 2015). Sustainable use of nature in solving societal challenges and in responding to changes in the environment in the long-term is in the core of nature-based solutions. Nature-based solutions have numerous benefits for people and can address multiple challenges simultaneously through provision of ecosystem services. Therefore, they can be a concrete solution in the path to more sustainable urbanization. (Eggermont et al., 2015; Kabisch et al., 2016; McPhearson et al., 2022.)

Nature-based solutions are in an essential role in urban planning to increase cities resilience in response to climate change and uncertain future urban conditions. Nature-based solutions hold big potential when adopted in buildings and their surroundings. Including this, adoption of nature-based solutions have been offered as a solution for the construction industry to improve their resilience (Bona et al., 2023). As climate change adaption and mitigation are key challenges for cities also in Finland, nature-based solutions have been presented as a possible solution to be applied in Finnish cities urban planning and construction industry.

To facilitate long lasting changes in our societies and residential housing construction practices, nature-based solutions could serve as a method when increased in urban areas to achieve these goals (Bona et al., 2023). With nature-based solutions, environmental and societal challenges can be transformed into innovation opportunities. Nature-based solutions provide incentives for business to integrate natural capital in policies and planning and maintain as well as increase biodiversity and human well-being. (Eggermont et al., 2015.) Implementation of nature-based solutions in urban context has been studied to require a collaborative approach to the planning and implementation of nature-based solutions, meaning that actors within the society, i.e. the business ecosystem, need to be offered platforms for formation and planning of green spaces. Nature-based solutions in urban context requires cooperation of different public and private actors. (Bona et al., 2023.)

The grand challenges of climate change, biodiversity loss and urbanization make collaboration between different communities and actors of expertise within societies necessary. Ecosystem thinking offers an opportunity to connect various actors together and the concept of business ecosystem explains the networks of different actors and processes. (Vigren, 2024.) In urban construction multitude of different actors and stakeholders come together, such as architects, designers, engineers and contractors, and individuals, communities and societies are affected by construction projects (Murtagh et al., 2020). Thus, the insights of the residential housing business ecosystem are in place to research their views on resilience and use of nature-based solutions. However, there are still some uncertainties regarding how nature-based solutions are perceived within the construction and urban planning industry and what could be done in order to increase solutions use in urban context. It is important to understand how the actors themselves view the use and implementation of nature-based solutions in urban areas.

This thesis is structured as follows. Chapter 2 presents the aim of the study and the research questions. In chapter 3 the analytical framework and key concepts for the thesis are described to shed light for the thematic background of thesis' topic. Chapter 4 consists of the description of how the study was conducted, i.e., the research methodology and collection of empirical data. Here reliability and validity of the study are also discussed further. The analysis results are presented in chapter 5 and followed with discussion in relation to previous literature in chapter 6, linked to the set research questions. Lastly in chapter 7, the thesis is summarized in the conclusions and suggestions for future research are provided.

2 Aim of the study and research questions

The objective of this thesis is to study resilient urban housing business ecosystems and the role and use of nature-based solutions in these ecosystems. The focus is especially on the Finnish cities of Helsinki and Turku which have been identified as frontrunner cities in Finland using nature-based solutions to increase cities resilience for climate change induced risks and changes in urban environments.

This thesis aims to shed light on how nature-based solutions are perceived in urban residential building and planning regime and how these solutions are valued as a means to increase urban resilience. Moreover, the thesis aims to provide knowledge on who are the actors in key role in designing, implementing, or using nature-based solutions in the case cities urban built environment and residential buildings of identified business ecosystem. Including this, thesis aims to identify hindrances and related challenges for more widespread use and implementation of nature-based solutions in urban environments. The types of challenges and roadblocks hindering the mainstreaming of the NBS opposed to opportunities and possibilities for wider use and ways to remove these barriers for mainstreaming are addressed. Thesis will also examine the perceived future of nature-based solutions in cities for creating a more sustainable and resilient urban built environment based on the expert actors' views.

The following research questions (RQ) were formed to answer these objectives:

RQ 1: Who are the key actors in business ecosystem in applying nature-based solutions in the residential housing regime in the case cities of Helsinki and Turku?

RQ 2: What kind of benefits and challenges there are around mainstreaming nature-based solutions in urban environments?

RQ 3: What kind of solutions can be found for increasing use of NBS in urban environments and how is the future of NBS perceived in cities?

3 Analytical framework and key concepts

In this section the analytical framework and key concepts for the thesis are presented. First, nature-based solutions are described. Secondly, the concept of business ecosystem is introduced. These chapters are then drawn together and the connections between nature-based solutions (NBS), business ecosystems (BE) and their relation to sustainability and resilience in urban areas are examined.

3.1 Nature-based solutions

Nature-based solutions are "actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016, p. 2). The European Commission (2015) defines nature-based solutions as nature inspired and supported solutions that aim to aid societies sustainably address different environmental, social and economic challenges. In summary, nature-based solutions can help societies to improve local ecological and social sustainability and guarantee long-term productivity by making use of nature and looking for design and process knowledge provided by it (Maes & Jacobs, 2015; Eisenberg & Polcher, 2019).

NBS is an innovative and systemic cost-effective concept, that utilize concrete implementation actions as solutions for the risks and pressures of changing climate, urbanization, biodiversity loss, and consequential societal challenges (Kabish et al. 2016; European Commission, 2021). Nature-based solutions provide simultaneous environmental, social, and economic benefits and help build resilience as they "bring more, and more diverse, nature and natural features and processes into cities, landscapes, and seascapes, through locally adapted, resource efficient and systemic interventions" (European Commission, 2021, p. 17). Hence, NBS can mitigate human impact on urban landscapes and serve as a bridge between human activities and ecosystem processes (Scott et al., 2016).

As Eggermont et al. (2015) state, there is a strong connection between nature-based solutions and for instance ecosystems-based approaches and concept of blue-green infrastructure. Raymond et al. (2017) argue that these approaches, including ecosystem services approach, are brought together by nature-based solutions. Nature-based solutions focus on the benefits to people and the environment itself, whereas ecosystem services

valuation is often based on the immediate benefits to human well-being and economy (Eggermont et al., 2015; Cohen-Shacham et al., 2016). Here it is highlighted that ecosystem services approach forms a basis for the nature-based solutions and NBS are defined as operationalizing ecosystem services, i.e., NBS provide several beneficial ecosystem services. In the core is appropriate and sustainable production of ecosystem services to solve societal challenges. (Vikström et al., 2019; Bona et al., 2023.)

Nature-based solutions can be characterized to fall into three different types that deliver different amount of ecosystem services with varying level of engineering of ecosystems, illustrated in Figure 1. This typology displays that the focus is not only on protection of nature but strongly on the multiple benefits nature-based solutions provide for managing societal challenges (Vikström et al., 2019).

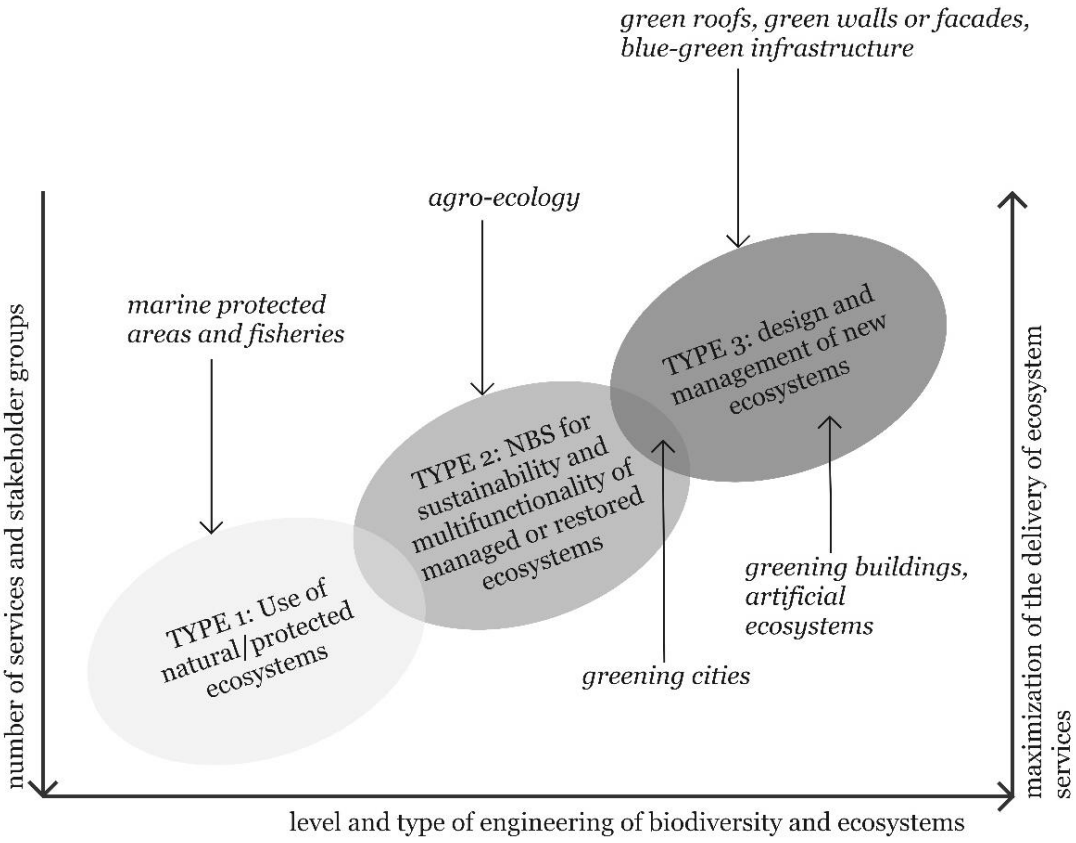


Figure 1. Three types of nature-based solutions, that differentiate between the level and type of engineering of ecosystems, the number of beneficiary stakeholder groups and provided ecosystem services (mod. Eggermont et al., 2015; Cohen-Shacham et al., 2016).

Type 1 includes creative use of existing ecosystems, whereas Type 2 nature-based solutions create new diverse ecosystems through adapting and restoring degraded ones. Type 1 solutions involve making better use of existing natural or protected ecosystems with no or minimal intervention where the objective is to maintain or improve the delivery of ecosystem services in- and outside of the area in question. Type 2 of NBS is focused on the developing sustainable management of extensively or intensively managed ecosystems and landscapes to improve the delivery of selected ecosystems services compared to more conventional intervention methods. Lastly, Type 3 solutions bring elements of ecosystem into the built environment, and create completely new, often artificial ecosystems. Type 3 solutions involve creating completely new ecosystems or intervention management of existing ecosystems. (Eggermont et al., 2015.)

Type 3 nature-based solutions are linked to examples that include green roofs, green walls, or facades as well as blue-green infrastructure and animal-aided design. In the juxtaposition of Type 2 and Type 3 solutions is the overall greening of cities, whereas Type 3 solutions goal is most often greening of buildings or other singular urban areas and plots. (Eggermont et al., 2015; Vikström et al., 2019.) In other words, the solutions used in urban environments are mostly either Type 2 or Type 3 solutions.

In the built environment nature-based solutions can be implemented in three levels: green building materials, i.e., raw natural materials; green building systems or systems for greening of the buildings that include integration of green and living components into structures such as green roods, living walls and façade greenery; and green building and urban sites meaning the land areas adjacent to the building that have a blue-green role in cities that emphasize the value of open and water-sensitive urban design (Bona et al., 2023). Including this, NBS can be characterized by the scale they are implemented in urban areas. Bona et al. (2023) describe three scales of nature-based solutions and actions in urban areas. This apportionment and respective NBS actions are presented in Table 1.

Table 1. Nature-based solutions interventions and actions in urban areas applied in different scales (mod. Bona et al. 2023).

Scale	NBS actions and interventions
Micro scale: building or plot	Pervious pavement
	Urban meadow
	Private garden
	Regreened spaces between buildings
	Shelter for auxiliary fauna
	Green facades and vertical gardens
	Sustainable urban drainage systems
	Green roof and meadow
	Combined solutions – green roof with renewable energy
	Rooftop farming and in-height orchards
Meso scale: District or neighbourhood	Pervious pavement
	Comfortable urban places
	Urban microclimates, e.g., public fountains and lakes
	Green wharf
	Spontaneous flora
	Street trees
	Community garden
	Allotment gardens
	Urban parks
	Permeable riverbanks and waterbodies
	Renaturing of abandoned areas and opportunity plots
Macro scale: City and beyond	Urban farming
	Constructed wetlands
	Green street networks
	Urban forests
	Ecological corridors
	Urban planning, incl. green factor
	Renaturing of rivers and streams
	Controlled flood plains

Nature-based solutions enhance the resilience of socio-ecological systems in the face of global changes and extreme or unexpected events. Applying nature-based solutions in cities is a comprehensive approach for managing complex and dynamic socio-ecological systems to sustainable use and increase the delivery of ecosystem services. (Eggermont et al., 2015.) Nature-based solutions are solutions for adaptation and resilience in urban areas, as they have significant potential to decrease vulnerability and enhance resilience of cities (Kabish et al. 2016).

Sustainable urban development is connected to the rebalanced relationship between nature and society where development provides long-term social, economic, and

environmental benefits to urban areas. Nature inspired and supported nature-based solutions can answer the various societal challenges that in urban areas can be associated with climate resilience, human health, and well-being. By utilizing urban NBS, these social, ecological, and ecological sustainability challenges can be simultaneously addressed. (Raymond et al., 2017; van der Jagt et al., 2020.)

Nature-based solutions can also be characterized as technological innovation, e.g., green roof technology, or an innovation aiming to conjoin ecological principles and the traditional urban planning and development (van der Jagt et al., 2020). In urban planning policies, NBS operationalizes the ecosystem services approach for more holistic systems one that in addition to protection also enhances, restores, creates, and designs new multifunctional and connected ecological networks. NBS can be multifunctional on multiple levels in urban environments, such as city-wide ecological networks, and urban fluvial park or roadside bioswales designed to retain stormwaters. Green facades and roofs integrate the living system of nature-based solutions with built environment. (Scott et al., 2016.)

Multiple co-benefits such as improved place attractiveness, increase in quality of life and physical and mental health as well as both adapting to and mitigating climate change, and conserving biodiversity, can be associated with implementation of nature-based solutions (Raymond et al., 2017). This multifunctionality of nature-based solutions creates multiple simultaneous benefits, and in this way makes NBS able to resolve complex challenges for urban sustainability (van der Jagt et al., 2020).

3.2 Business ecosystem

Moore (1996, p. 19) defines business ecosystem as “an economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world”. Business ecosystem is a complex, adaptive socioeconomic system where its population - that is the previously mentioned organizations and individual actors, develops through coevolution with the environment. This coevolution results in self-organization, emergence, and adaptation to the environment as these systems embody the values of their customers, and suppliers, as well as those of the society. These factors aid the business ecosystem to acquire adaptability to environmental changes and to maintain sustainability, making business ecosystems robust and capable to change. (Moore, 1996; Peltoniemi & Vuori, 2005; Nuseibah & Wolff, 2015).

As presented in the Figure 2, businesses are interconnected with the society. Thus, businesses performance is dependent on the outside factors (Iansiti & Levien, 2004). Economy is nested within the society, which in turn is nested within the ambient environment (Giddings, Hopwood & O'Brien, 2002). The environment serves as a source of both economy and society and supports the human well-being constituent of the other two (Dawe & Ryan, 2003). This follows the model of strong sustainability, where these three elements – business, or economy, society, and environment - are interconnected with each other.

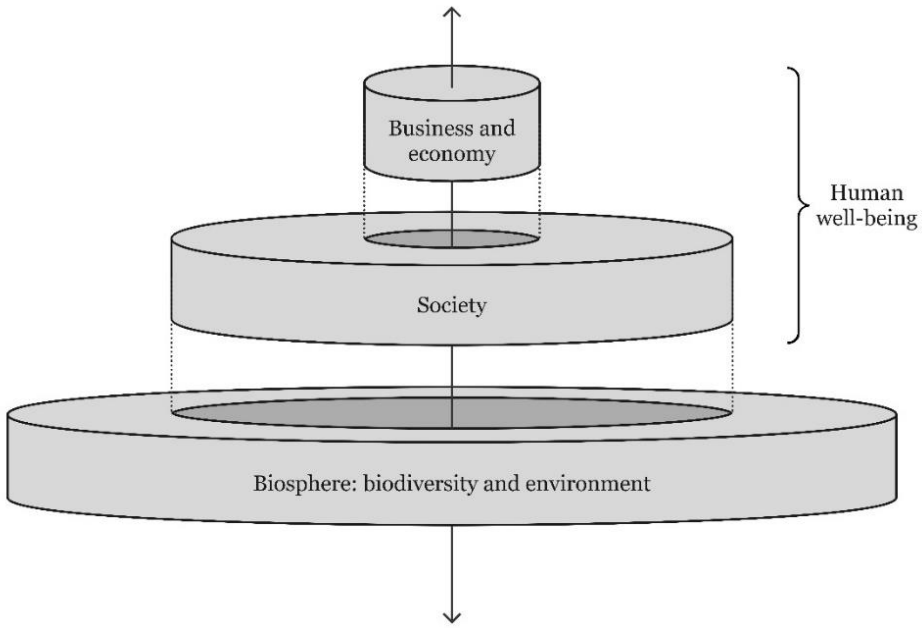


Figure 2. Interconnectedness of the business and economy, society, and biosphere. Human well-being is constituent of the society and the business and built upon the environment and biodiversity around us. (Mod. Moore, 1996; Giddings, Hopwood & O'Brien, 2002; Folke et al., 2016.)

Business ecosystem can be understood to represent a platform, a community or a network as Weber and Hine describe (2015). Moreover, business ecosystems can be described as communities that create innovations and value by utilizing complementary inputs brought by its members, i.e., its actors. As a complex structure business ecosystem is constructed of many actors, such as government, other businesses, and environmental conditions, that function in an interconnected network. This network is presented in Figure 3, where various categories of the business ecosystem and the multiple actors are visible. The three actor categories include core business and the key actors, extended enterprise and enlarged business, as well as the umbrella concept of business ecosystem. Between these categories and multiple actors is constant communication and interaction, creating a networked collaboration economy. (Nuseibah & Wolff, 2015.)

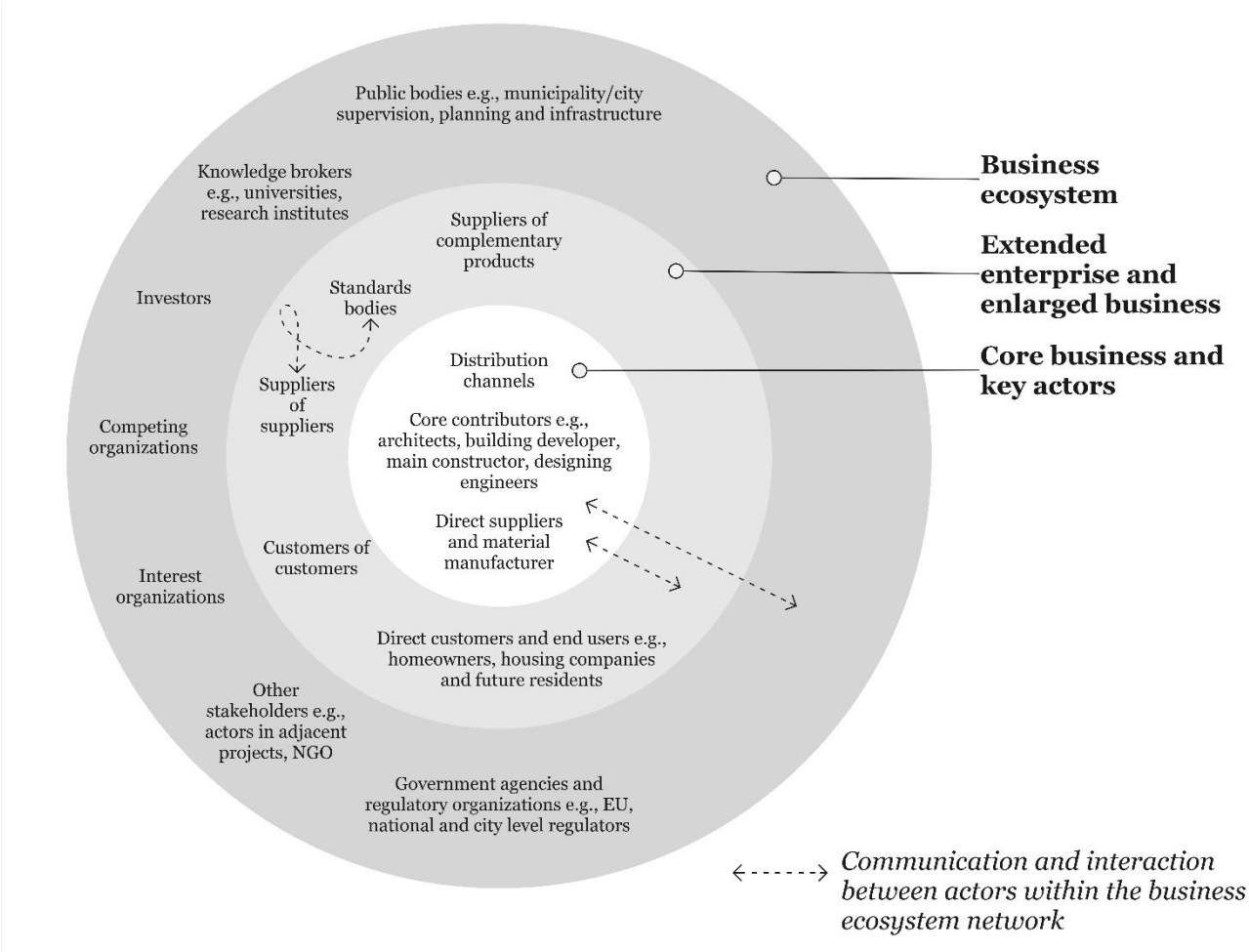


Figure 3. Business ecosystem and three main actor categories. The actors interact with each other within and across different categories or levels of the BE. (Mod. Moore, 1996; Heikkilä & Kuivaniemi, 2012; Nuseibah & Wolff, 2015; Viholainen et al., 2021; Toppinen et al., 2022; Lähtinen et al., 2023; Viljanen et al., 2023.)

These different actors and organization of the business ecosystem are characterized to fall into three roles: dominators, keystones, and niche players. Dominators pursue to maximize their own profits and extract value with minimal effort from the ecosystem they operate in. These actors tend to function nonreciprocally. Keystone actors are enablers who facilitate collaboration between other actors and support collective innovation within the business ecosystem. This role has a big impact and is in a crucial role in the whole system as keystones create value and share it by connecting participants of the network together. Niches create value and innovations to the whole ecosystem and usually represent the majority of the actors in an ecosystem. (Iansiti & Levien, 2004; Peltoniemi & Vuori, 2005; Nuseibah & Wolff, 2015.)

The connections and interrelationships between actors are the core focus of the business ecosystems. Businesses and organizations are depended on the capabilities and resources

of their ecosystem, which provides them relationships, interactions, and resources within the ecosystem. (Weber & Hine, 2015.) Integration and collaboration between the actors in the business ecosystem is crucial for value creation and sharing it through different platforms (Nuseibah & Wolff, 2015). To emphasize this, Vigren (2024) points out that innovation ecosystem concept overlaps significantly with the business ecosystem. Adner (2006, no page number) defines innovation ecosystems as "collaborative arrangement through which firms combine their individual offerings into a coherent, customer-facing solution". Möller & Halinen (2017) argue that business ecosystem describes innovations and business coalitions collaborative forms.

In an alternative approach to nature-based solutions, Van der Jagt et al. (2020) bring forth a range of actors in a Nature-based Innovation System (NBIS), in which sustainability transition is linked with the urban nature-based solutions. NBIS framework includes the institutions, networks, and actors that are recognized to initiate, advance and diffuse nature-based solutions. In conclusion, the business ecosystem concepts emphasize value creation on network-level - the participant network of business ecosystem and actions within this context comprise value creation (Pulkka et al., 2016; Viholainen et al., 2021).

3.3 Locating nature-based solutions into the business ecosystem

Nature-based solutions concept is merged in the systemic approach to offer solutions for multiple challenges that urban environments and societies face. Implementing nature-based solutions requires simultaneous addressing of political, economic, and scientific challenges by several actor groups (Raymond et al., 2017). NBS advocates participatory approaches for co-designing, co-creation, and co-management of nature-based solutions to find solutions that aim to meet the needs of a wide range of stakeholders (Eisenberg & Polcher, 2019).

Multidisciplinary work and operating beyond 'silos' and engaging with all the sectors and relevant stakeholders is involved in the concept (European Commission, 2015). Including this, seamless long-term collaboration between different industries, administrative sectors, and planning levels and common will are essential in order to increase the implementation of NBS. More close-knit project collaboration between different sectors and cross sectorial project organization encourages disassembling of sectorial silos. Engaging decision makers to implement NBS and involving residents are also key factors. (Vikström et al., 2019.)

With business ecosystem thinking the system-level effect of collaboration as well as complementarities and interdependence between various actors can be identified and analysed. For instance, BE concept has been used to study interdependence and dynamism between construction project actors and examine and understand value creation in networks of construction industry and it has demonstrated to have a positive impact on value creation in construction business industry. (Pulkka et al., 2016; Viholainen et al., 2021.)

Ecosystem thinking has great potential to bridge expertise communities, for instance construction management, urban development researchers and cities urban planners (Vigren, 2024). In this sense, city officials have the crucial leadership role to ensure that NBS actions align with different urban planning strategies and governance processes such as climate change and urban regeneration strategies (Raymond et al., 2017).

4 Research methodology and data collection

This thesis is a qualitative study with an empirical research approach, emphasizing methodological flexibility. Qualitative research was selected as an appropriate method to answer the research questions due to the method's flexibility and focus on the meanings and outcomes of the studied subject and phenomena (Silverman, 2014). Thesis is done as a part of the Resilient housing building and housing solutions from Finnish Front runner Firms – Pathways for Global Exports (FoREfront) research project conducted by Natural Resources Institute Finland and University of Helsinki (see Forefront, n.d.).

In this chapter the context of the study is presented including brief introduction for the case cities of Helsinki and Turku that act as an expert backdrop for the study. Next the data collection methods are presented and continued with description of the data analysis. The empirical part of the study consists of data collected from 11 expert interviews, and two expert workshops organized by the FoREfront research project. Altogether the empirical data corpus consisted of 15 transcripts. The gathered data was organized into a single data corpus and no distinction was made between transcripts gathered from workshops or themes during the coding process as they were coded with a concise manner. Lastly, reliability and validity of thesis are discussed.

4.1 Context of the study: Cities of Helsinki and Turku and the identified BE

Based on different methods to evaluate the level of urbanization shows that the global megatrend of urbanization is also visible in Finland. Degree of urbanization, i.e., people living in urban areas based on the population register, was over 73.2 % and the share of population living within the area covered by a town plan was 78.8 %, both in the year 2021. Compared to 2011, the degree of urbanization has increased by 3.4 percentage points and the share of population living within the area covered by a town plan by 3.5 percentage points. (Finnish Environment Institute, 2023.) The urbanization degree in Finland is predicted to grow in upcoming decades and reach 79 % by the year 2050 (Airikkala et al., 2022).

The capital of Finland, Helsinki, is the largest city in the country by its number of inhabitants, with a population of 675 747. Turku, with a population of 202 250 is the sixth biggest city in Finland and the largest city in the southwest region of Finland. (City of Turku, n.d.; City of Turku, 2024; Sinkko, 2024.) Both Helsinki and Turku have increased

in population in recent years, and between 2022 and 2023 the population of Helsinki has grown by 1.65 % and Turku by 2.02 % (City of Turku, n.d.). The population density in Helsinki is approximately 3147 per land-km^2 and in Turku the equivalent value is 822 per land-km^2 (National Land Survey of Finland, n.d.).

Cities of Turku and Helsinki were chosen to be the case cities for this thesis as they both represent large Finnish cities and centres of urbanization that have been identified as carbon neutrality pioneer cities. The two cities are a part of six Finnish cities that were selected in 2022 by European Commission as European pioneers aiming to achieve carbon neutrality by 2030. (Ministry of Economic Affairs, and Employment, 2022.) Additionally, both cities have prior use of nature-based solutions and implications for a basis to increase the use of NBS in their urban areas. City of Helsinki applies green factor in their city planning, that is used to evaluate amount and quality of vegetation and surfaces on a plot or block level. City of Turku uses a blue-green factor calculation method, i.e., co-efficient, in their urban planning and building regulations, which core is similar to the green factor used in Helsinki.

In Turku's sustainable climate and energy plan for 2029, the city commits to follow and participate in developing new nature-based solutions for carbon fixation and to advance co-operation between relevant stakeholders. Nature-based solutions are also mentioned as a method for water management and the city commits to develop and adopt these solutions as part of the climate resilience goals. (City of Turku, 2022.) Helsinki is prepared for climate change induced extreme weather events and their indirect effects, and this preparedness is stated to link to urban planning and new construction and reconstruction. Helsinki city's strategy states to increase the number of trees and greenery in city area for climate change adaption and increase for example green roofs. (City of Helsinki, 2021.)

4.2 Thematic expert interviews

In this research the interviews were semi-structured, thematic interviews where experts from different organizations of urban planning and construction industry were interviewed. Conducting interviews is a flexible and easily applicable method for many purposes, that aids to gather profound information as well as find out views and experiences of the studied phenomenon. (Hirsjärvi & Hurme, 2004; Tiittula & Ruusuvuori, 2014.) Semi-structured interview method was chosen because the purpose of the

interviews was to gather knowledge and different actors' views for example on the use, hindrances for mainstream use and the future of nature-based solutions.

Interview is based on discussion and interaction between the interviewer and interviewee. In semi-structured interviews the form of the questions remains relatively the same. The interviewer can make some minor changes to the wording of the questions during the interviews, and they can also change the order of the questions depending on the situation. There are no prepared or existing answer options and thus the interviewees can answer the question with their own words. (Tiittula & Ruusuvuori, 2014.) Semi-structured interviews allowed a flexible atmosphere, that was seen important for the interviews. If some interviewees started to talk about other interesting points connected to the theme as a result of an asked question, this new direction was followed as an interesting opportunity to find out more what the interviewees think about the matter.

Thematic, or in other words, a focused interview is one of many semi-structure interview methods. Thematic interview considers that meanings are created based on interaction and both people's interpretations and the given meanings to things are in a central stage (Hirsjärvi & Hurme, 2004). In this particular interview method, the focus is on the themes, and the interview proceeds based on these key themes. Themes remain the same for all interviewees, but both the framing and order of questions might vary depending on the situation at hand. (Hirsjärvi & Hurme, 2004; Tiittula & Ruusuvuori, 2014.)

As Alastalo and Åkerman (2010) describe, the aim of interviewing experts is to gather information of the studied subject and to produce new knowledge by utilizing experts' special knowledge. The interest does not primarily focus on the expert itself but rather on the specific knowledge and know-how on the topic the expert is presumed to possess. In other words, the focus is not on the person being interviewed but rather on the knowledge and knowledge related interpretations the expert has. (Alastalo, Åkerman & Vaittinen, 2017.)

Here expertise is defined by action and interaction through professional role and institutional status (Alastalo, Åkerman & Vaittinen, 2017). The interviewees were all experts in the field of construction or land use planning and identified to have used or possess knowledge on the use of nature-based solutions as part of the identified business ecosystem bringing solutions into urban environments. With wide take of experts, a

diverse picture of business ecosystem's networks for use and implementation of NBS was able to be achieved. The interviewed experts are presented in Table 2.

The duration of the interviews was on average 59 minutes, varying between 46 minutes to 90 minutes. Interviews were all conducted in-person and one-on-one, during which only the interviewer and interviewee were present. Six interviews were conducted face-to-face by meeting with the interviewees. In five cases the interview was conducted remotely using Microsoft Teams. All the interviews were individual to assure a confidential atmosphere.

Table 2. Expert interviews.

Interviewee	Interviewee's professional title	Organisation type	Interview duration	Date and place
I01	Technology Manager	Construction and property consulting company	58 min	11.10.2023. Microsoft Teams.
I02	Planning Architect	City	90 min	16.10.2023. Turku. Face-to-face.
I03	Project Manager	Architecture, engineering, and consulting company	50 min	17.10.2023. Espoo. Face-to-face.
I04	Sales Director	Green construction company	57 min	27.10.2023. Microsoft Teams.
I05	Architect	Architecture company	46 min	31.10.2023. Microsoft Teams.
I06	Team Manager	City	60 min	1.11.2023. Helsinki. Face-to-face.
I07	Architect	Architecture company	60 min	2.11.2023. Helsinki. Face-to-face.
I08	Landscape Architect	Landscape architecture company	55 min	2.11.2023. Helsinki. Face-to-face.
I09	Project Manager	Architecture and engineering consulting company	62 min	3.11.2023. Turku. Face-to-face.
I10	Leading Sustainability Consultant, Digital Transformation Manager	Real estate and construction company	57 min	15.11.2023. Microsoft Teams.
I11	Assistant Professor	University	57 min	17.11.2023. Microsoft Teams.

Prior to the interviews, the interview frame was sent to the interviewees with a short research bulletin by email. This aimed to commit the interviewees for the upcoming interview and make sure the interviewees had time to gather their thoughts and think a little about the topic beforehand. This also served as a final reassurance that the invited interviewees were still up for the interview.

The interview frame was drafted based on the research questions and key concepts connected to the thematic and theoretical framework and structured based on the identified concepts on the literature review. Also, the questions for two workshops functioned as a basis for interview questions and similar themes were used in both cases for tying these two data collection methods together. The themes for the interviews were nature-based solutions in housing construction, low-carbon and sustainable housing construction, actors and cooperation, resilience of cities and residential environments and lastly future visions and prospects. The interview frame is presented in the appendices. Appendix 1 is the original Finnish version of the interview frame, and Appendix 2 the translated English version. With this flexibility the questions were able to be slightly adapted to more relevant format for each interviewee, regardless of the actor's status or background on working with NBS.

4.3 Expert workshops

Workshop is a useful arrangement where a chosen group of people, in this case experts in the field of urban planning and construction, come together to learn, acquire new knowledge and information, perform creative problem solving or to innovate regarding a specific issue. Workshop is a research method where the goal is to produce reliable and valid data about the domain or problem in question, and it is specifically designed to fulfil a research purpose. It is a resourceful method in combination with expert interviews, creating a good empirical approach duo. (Ørngreen & Levinsen, 2017.)

Table 3. Workshop attendees.

Workshop	Date and place of workshop	Group	Workshop duration	Participant	Participants' professional title	Organisation type
Workshop 1: Nature-based solutions as a part of sustainable built environment	29.8.2023. Turku.	A	64 min	W01	Accountability Manager	Construction company
				W02	Senior Specialist	City
		B	70 min	W03	Business Director	Construction company
				W04	Senior Specialist	City
Workshop 2: Resilient built environment by sustainable regional planning	30.8.2023. Helsinki.	C	71 min	W05	Architect	Architecture company
				W06	Project Manager	City
				W07	Senior Advisor	City
		D	72 min	W08	Project Director	City
				W09	Innovation Agent	City
				W10	Sustainability Manager and Innovation Lead	Construction company

Two separate workshops were held during August of 2023 in both case cities Helsinki and Turku. Workshops consisted of researcher presentations and focus group work, and the expert participants represented versatility of the field. The workshops were organized live as part of the FoREfront-research project. The purpose of the workshops was pre-defined, and researchers acted as facilitators in both workshops. No pre-studying was necessary or demanded from the experts. The workshops had altogether 10 expert participants, who were divided into two smaller units, resulting consequently in four discussion groups (groups A, B, C and D). The participants in the workshops are presented in Table 3. Altogether six city representatives attended the workshop, and three participants were working in a construction company and one in an architecture company.

The workshops were structured around themes considering the project's focus area. However, the focus of the workshop slightly varied depending on the case city as the discussions were wanted to be wide and cover the vast theme area with a constricted timescale. The first workshop focused on the question of how nature-based solutions are part of sustainable built environment, and the second one considered the resilience of the

built environment that could be achieved with sustainable regional planning. As the theme of the workshop varied between the cities, the prepared workshop questions were a bit different. These workshop questions are presented in the Appendices 3–6, both in Finnish and English.

The workshops provided some integral ideas on the research topic and experts thoughts on urban resilience and nature-based solutions. They also had an opportunity to uncover unrecognized or unacknowledged blind spots on the themes.

4.4 Reflexive thematic analysis

This study applies reflexive thematic analysis method for qualitative data analysis. It is a systematic, yet theoretically flexible, qualitative analytical method, that can be applied across a range of theoretical frameworks and research paradigms for identifying, analysing, and reporting meaning-based multifaceted and conceptual patterns within data by generating codes and themes. Reflexive thematic analysis reflects the values of a qualitative paradigm, centering researcher subjectivity, organic and recursive coding processes, and the importance of deep reflection on, and engagement with, data. (Braun & Clarke, 2017; Terry et al., 2017; Braun & Clarke, 2019; Terry & Hayfield, 2021; Braun & Clarke, 2023.)

Reflexive thematic analysis is an iterative and active process where themes are analytic outputs developed through and from coding, i.e., composing words and phrases of meaning to detect patterns in the data, created by the researcher. With respect to the research questions, generated themes capture information and key features about the data the researcher values and sees important. Coding was conducted with Computer Aided Qualitative Analysis (CADQAS) Atlas.ti programme to help the management of data and to systemize the analysing process as it allowed outlining the data set relevant for the research questions (Jolanki & Karhunen, 2010; Rantala, 2015).

Codes are research-generated interpretation and the smallest units of analysis that capture interesting features of the data potentially relevant to research questions (Rantala, 2015; Braun & Clarke, 2017). In this case the codes were a word or a short phrase, that helped to define specific parts of the language-based data or state its key contents. Themes, i.e., a shared meanings or ideas, that are organized around a core concept, are built upon the codes, and provide a framework for organizing and reporting the researcher's analytical

observations. In essence, the researcher plays an active and central role in identifying the patterns as they select the interesting ones and report their interpretation of the qualitative data set. (Braun & Clarke, 2017; Terry et al., 2017; Braun & Clarke, 2019; Saldaña, 2021; Terry & Hayfield, 2021; Braun & Clarke, 2023.)

In this study, the codes as well as the themes were constructed in an inductive way. This inductive analysis approach refers to not using pre-existing coding frame, or applying one's analytic preconceptions on the data, but the codes and themes are derived from the collected data 'bottom up' (Braun & Clarke, 2006; Terry et al., 2017). In inductive coding codes are created spontaneously as data is reviewed. The inductive coding system was then used to analyse the rest of the data, simultaneously staying open for new emerging codes. (Saldaña, 2021.)

Firstly, the meaningful and important segments of the data in relation to the research questions were observed and indicated through systemic organization of the data in the first stage coding. Line-by-line coding the first two transcripts aimed to minimize the risk for misanalysing the context and the intended meaning of the data. In the first stages of coding the codes were more semantic and while data analysis continued, they developed towards more latent ones. Semantic codes are close to the participants' own words and close to the meanings ascribed to those words, whereas latent codes tend to be more interpretative and conceptually laden with researcher's own theoretical lens and background knowledge. (Terry & Hayfield, 2020.) During the second cycle coding categorization was developed further to search for patterns to create themes and sub-themes. Similarly coded data was organized and categorized into groups possessing similar features and shared meaning (Rantala, 2015; Saldaña, 2021).

4.5 Reliability and validity

Reliability and validity were taken into account through enhancing the credibility of the study during the research design and implementation. The rigour and trustworthiness of the study as well as the findings was ensured through different strategies (Noble & Smith, 2015). Noble and Smith (2015) argue that in qualitative research the credibility of the research findings can be evaluated through the truth value, consistency, neutrality, and applicability of findings. For gaining this trustworthiness, the conducting of the study is described as meticulously as possible.

Truth value can be gained through recognizing existing of multiple realities. Personal biases or assumptions were aimed to be minimized through reflective working and precise documentation throughout the whole research project. Thus, the importance of being aware of one's own pre-existing understanding and comprehension was considered during conducting of the study.

It was taken into account that rich and diverse data is instrumental for interpretation and construction of meanings (Moilanen & Räihä, 2015). This is supported by 11 interviews that were complemented with data from two workshops' four focus group discussions. Interviews might present some limitations as a method, such as the researcher's interview skills and presence during the interview itself might affect the interviewees responses. Including this, the interviewees might not be equally articulate and perspicacious. (Creswell, 2003.) In order to minimize this factor, the interview questions were sent beforehand for all the participants to read, so the interview moment could be relaxed and easy-going. The interview frame helped to keep the interview in its tracks and mental preparations were made in advance to assure interviewer's own skills.

Both the workshop discussions and individual interviews were recorded and saved in digital format, what allowed more precise analysis and reporting. Access to the original recordings supported the analysis process. Recording the interviews was justified as the recordings permitted going back to discussions working as a memo and a tool to cross-check possible interpretations. Including this, the interview interaction could be examined and analysed helping to detect new nuances from the interview situation. (Tiittula & Ruusuvuori, 2014.)

The interviewees were informed of the confidentiality of the interview, and with the interview question interviewees received short research statement presenting the purpose of the study as well as handling and storage and safe keeping of collected data. Permission to conduct research were signed by all the parties. It was made clear to all the interviewees that the interview could be stopped at any moment, and they could be in contact with the researcher afterwards should any questions rise later. The workshops and interviews were held in Finnish, as all the participant in both cases were Finnish speaking professionals. The transcriptions were written in Finnish and no translation were made at this point. As the collected data was analyzed in the Atlas.ti programme, the coding was conducted in English. In other words, translation was made during the first round of coding from those data extracts that were important for the analysis. During this translation process it was

important to be aware of the culturally specific syntax and nuances of different languages that are hard to interpret in other languages to make sure the originality of the message stayed same (Saldaña, 2021). The participant's perspectives were aimed to be presented in clear and accurate manner.

Subjectivity of the researcher is an integral part of the analysis process (Terry et al., 2017). In reflexive thematic analysis the researcher acknowledges and reflects on the ways their values, experiences, interests, and social location informs the analysis being undertaken. Researcher engagement with the data is active and subjective in relation to the research questions. (Terry & Hayfield, 2020.) Reflexive thematic analysis approach embraces researcher subjectivity as a resource for research and understands the thematic analysis to be an inherently subjective method. This method emphasis researcher reflexivity and understands that coding can never be completely accurate as it is inherently interpretative practice. (Braun & Clarke, 2023.) In this case, the codes were not chosen beforehand but were produced as the coding progressed. Codes were either simple words or short segments that represented the data segment appropriately. Some of these codes were then merged with other similar codes to avoid unnecessary duplicate codes with the same meaning. Constructed themes and meaning structures and their validity and feasibility were critically examined.

5 Results

This chapter presents findings from reflexive thematic analysis of the empirical data, and the results will be discussed in more detail. The order of the chapter follows the sequence of the research questions, starting from the first question regarding the key actors of the business ecosystem that apply nature-based solutions in the residential housing regime, following with reflections on what challenges and hindrances are slowing down the mainstreaming of nature-based solutions in urban environments. Lastly, the benefits and perceptions of the nature-based solutions' future as well the possibilities to enhance their use in urban areas will be presented.

5.1 Key actors in the business ecosystem and multiple roles of cities

This section presents the analysis results for the perceived key actors in business ecosystem using and designing nature-based solutions in urban areas. Figure 4 illustrates these actors distinguished from the data analysis in a business ecosystem frame. In this illustration four actor groups represent the core business. The bubble itself represents business ecosystem as depicted in Figure 3, but no distinction between the extended enterprises is made from the business ecosystem as a whole.

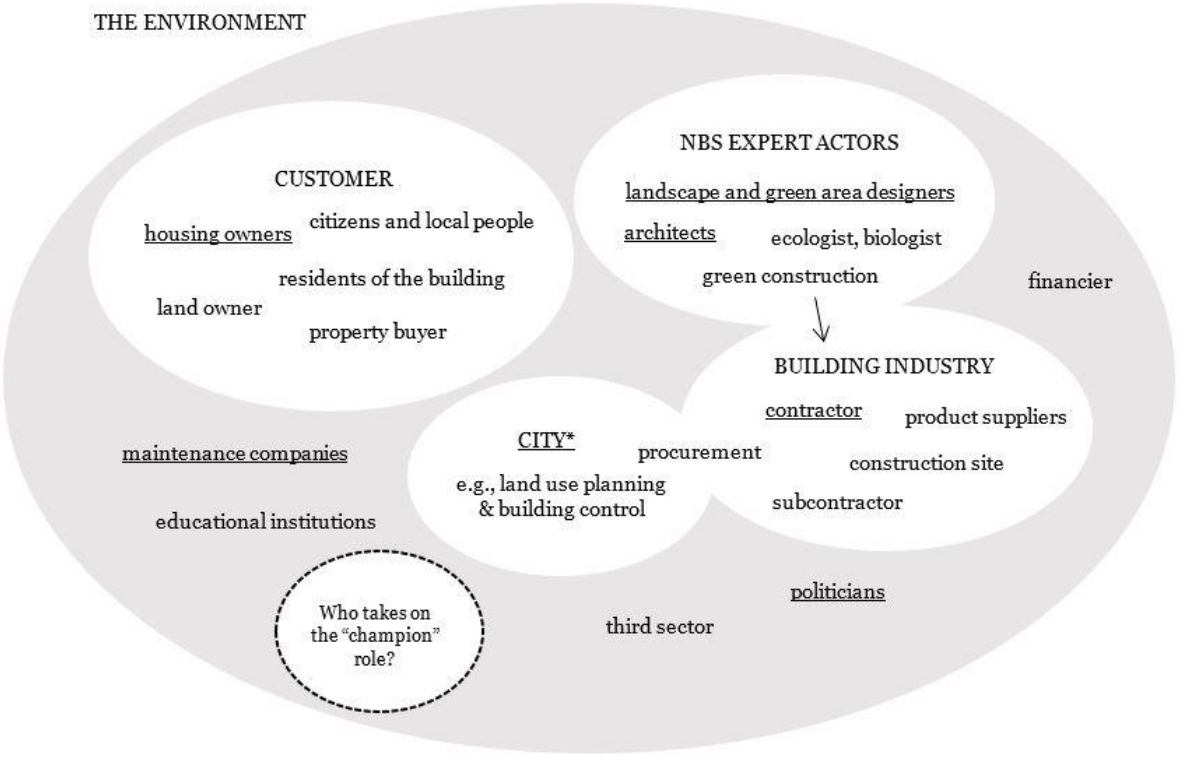


Figure 4. Identified key actors in the nature-based solutions business ecosystem in urban areas.

The business ecosystem consists of four distinguished groups of actors: customer, city, building industry and nature-based solution expert actors. Including these actor groups there are several other identified members in the ecosystem; maintenance companies, educational institutes, third sector organizations, politicians, and financiers. Several actors are recognized to hold a key role in using and mainstreaming nature-based solutions: housing owners, maintenance companies, politicians, contractors, landscape architects and green area designers, architects, and cities. The actors with key role are underlined in Figure 4. City has multiple expectations and roles and is seen as a fundamental actor in using and mainstreaming NBS and guiding and creating policies regarding them both by the other actors as well as the city representatives themselves.

The actors all collaborate with each other in multiple ways either directly or indirectly, depending on the project, and thus are interconnected within the nature-based solutions applying business ecosystem. The relationship between NBS expert actors and building industry is highlighted with an arrow, because there is a strong link between these actor groups. Including this, there is a connection between the city and building industry, that came evident in the analysis. Often the cities procurement methods affect the construction, and cities' land use planning and building control hold a lot of power over urban development. However, this link holds a lot of unused potential due to the raised issue of silo mentality and nature of development relying on individual projects rather than underlying strategy for increasing purposefully resilience in urban environments.

Some of the actors are described later in the analysis, such as the politicians – lack of political will and political weakness can be a barrier against the mainstreaming of nature-based solutions. Especially local politicians are often found absent from the discussions about using nature-based solutions. Educational institutions and other actors possessing key scientific knowledge were mentioned highly important in bridging the gap of knowledge in order to include NBS into building practices and urban development. In Figure 4 they are representing their own actor role, and based on the analysis, the role of educational institutions is important to increase know-how especially in maintenance and building sector, were more NBS expert actors are needed to appear in the field.

Financiers hold their own positions within the business ecosystem but were not present in a key or an active role in the analysis, even though they were recognized to hold strong guiding power for the residential building development. They were seen in a passive role, but however holding much unused potential for steering the development. The same goes

for the third sector, which is mentioned as an actor within the business ecosystem that holds lots of knowledge and expertise. This strong knowledge that third sector actors might hold about the local environment and resident's opinions is seldom used or realized to be applied during the urban development projects or greening of housing construction. Therein lies great potential for more active inclusion in urban development. However, the third sector was represented as a neutral party, perhaps due to its absence from the active ecosystem.

The environment

The environment, i.e., the nature surrounding us, is placed outside of the business ecosystem bubble. As it was highlighted in chapter 3.2, businesses and economy exists within the society which is nested in the biosphere. Thus, the detected business ecosystem exists within the environment and cannot be separated from it due to the interconnectedness. From the analysis it was pointed out that the environment often should have a dedicated active role in urban area or residential housing project planning and in this way incorporate more nature-positive outlook on urban development. This could also support mainstreaming of NBS if the benefits for the whole socio-ecological system would be more highlighted.

> "The nature is usually missing from those, that we have recognized as a pretty big gap, that nature cannot speak for itself. That is, in my opinion, a pretty significant missing element in the conversation. That humans easily create a comfortable environment for themselves, but what does nature need?" (I03)

Building industry

One of the four actor groups is the building industry. During planning and construction phase of residential building or area co-operation between different product suppliers, expert actors, and city planners is frequent. This makes construction a critical part of the business ecosystem. Building industry was seen connected to the hindrances of the NBS uptake, and it was represented to be an old-fashioned industry, that is interlocked with the business-as-usual practices and underlined with a collective goal of maximized profit seeking. However, notion was made that business do have also forward-looking visions and goals to incorporate more environment and sustainable objectives within their practices, and experts shared the idea that NBS could offer an easy, profitable, real solution, in this matter.

Contractors hold an especially important key actor role in the building industry and the business ecosystem. This role is perceived with mixed feelings. On the one hand, it is a critical role, that has a lot of power and is seen in a positive light with a will to build more sustainable and green buildings and environments, but on the other hand is seen in a negative light holding old fashioned values and holding monetary benefits over non-monetary ones with goals of maximized profiting. Contractor actors themselves expect city to offer possibilities for more green and innovative construction, e.g., projects containing nature-based solutions, with for example plot handover competition. The results of the analysis did not indicate that developers and contractors would build greener purely out of their own volition, but the city was expected to create opportunities and platforms for this. Maybe there is a lock in business-as-usual due to the conservative nature and high dependence on building industry's chains.

One issue raised from the analysis was how to connect the construction site operations with the acquisition for reaching out for the same goal. The project and the organization might have significant goals for a more sustainable building and want to implement NBS but while the construction itself is under making, the situation might change drastically as the responsibility moves along the chain. Budget cuts might have to be made and real-life barriers for NBS implementation might overrule the planned solutions. This issue is also raised later in the analysis if the project planning is detached from the practical implementation of the intended nature-based solution. However, building industry holds a key role in creating new, greener cityscapes.

NBS expert actors

Nature-based solutions expert actors include landscape and green area designers, architects and other experts holding relevant information considering designing, implementing, and maintaining NBS. Designer is recognized to be the connection between the other actors and holds a central role in bringing different actors and their knowledge together. Especially landscape architectural knowledge was seen to be connected with good quality design and implementation of NBS, and including this expertise more into urban planning a real change for more resilient cities could be achieved. Moreover, it was mentioned that more architects are needed in construction sites and by being more present there a quality of construction was not diminished.

> "We have a good landscape architect, and then this biologist has indeed been ensuring concrete, functional, and well-justified solutions, so that they are not just lightweight ideas, but they actually have the potential to succeed, and then we also fully take into account the existing conditions." (I07)

All in all, there is a need for ecologist type of knowledge within urban design and construction to know how to maintain the biodiversity that was planned to the plot or compensate the losses generated by construction. This role was seen empirical to an ecological or biological expert actor and connected with notion of ability to achieve real green construction.

City

City as an actor has multiple roles and thus is a critical key actor in the business ecosystem related to the use of nature-based solutions in urban areas. It is mentioned to be the most important actor with keystone actor role in promoting urban resilience. City has multiple versatile roles and simultaneously is expected to hold these many roles by the city representatives themselves and the other actors of the business ecosystem. This myriad of roles and expectations from other business ecosystem actors for taking up these different actor roles is presented in Figure 5.

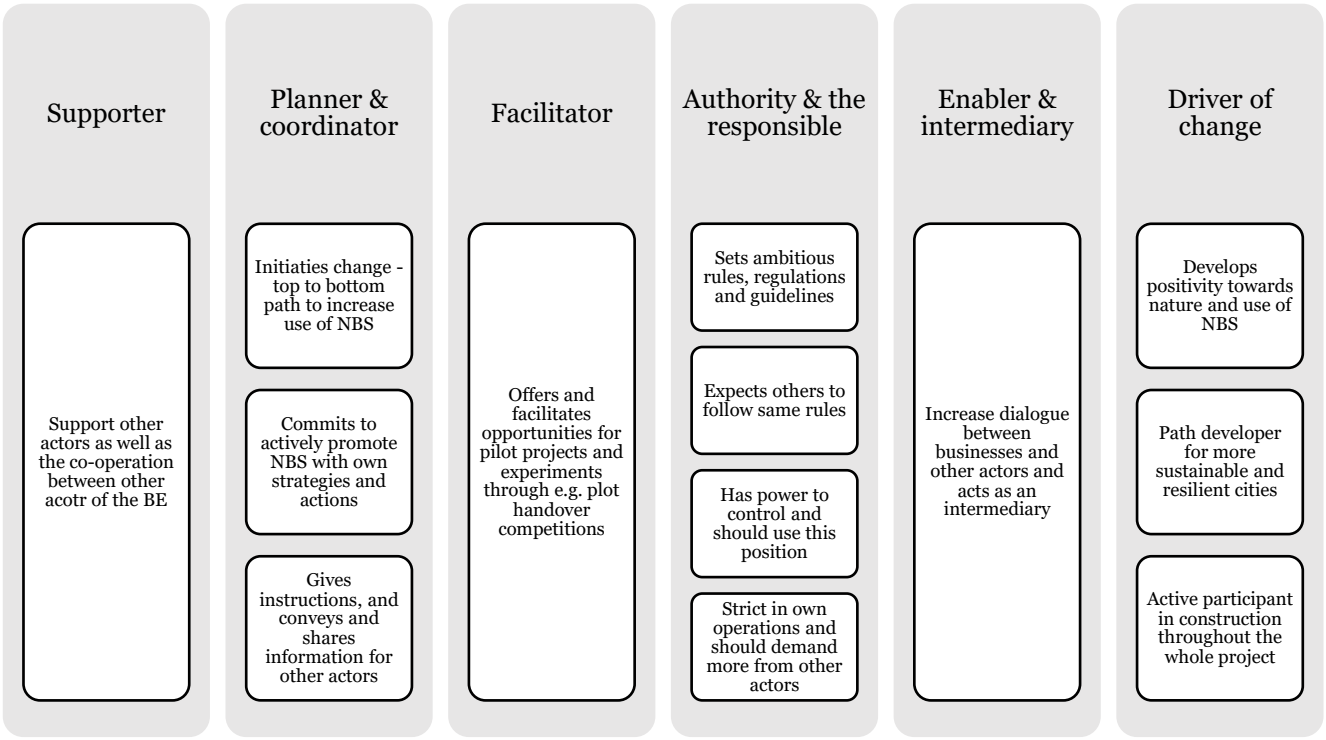


Figure 5. Multiple roles identified for the city as an actor.

There is a shared expectation that city sets a positive example, i.e., implements sustainable design, increases greenery and use of nature-based solutions in its own projects, for other actors in the business ecosystem and both enables and facilitates collaboration between the other identified actors in the ecosystem. The connection between the building industry and city organization is illustrated in Figure 4 with a connection between the two actor bubbles.

The city is seen to be responsible for creating a more sustainable urban environment for the good of the residents, and to advance use of nature-based solutions in urban areas and to increase resilience with long-scale timeframe as a benefactor. City is seen as an actor that cherishes other than just monetary valuation but considers the multiple values and benefits NBS create for the environment and the society. It was also noted that city should be a frontrunner and set an example for other actors and enable experimenting in order to make NBS as a mainstream part of the cityscape. The city is seen as an irreplaceable actor that is crucial and needed to meet the targets set by both international and national level.

Moreover, it was evident from the analysis that city as an actor might have contradicting roles as different city departments might have different perspectives on urban planning and how they are able to take part in the development direction or urban planning. Furthermore, there might be opposing goals for the city development: on the one hand, city administration values growth and intensive building development but otherwise raises the issue of loss of natural areas and wanting to avoid problems generating from dense urban areas. Also, the city actors describe a so-called struggle for power as a lot of decision-making power lays elsewhere than in city organizations, and for example property and landowners affect greatly what development directions are being taken outside city owned land.

> “In my opinion, the city plays a crucial role in how NBS is utilized, both by setting an example with its own projects and when it has the opportunity to demand more. Even my own yard wouldn't look like this if it weren't a partnership planning area and if there weren’t a competition for plots. It would probably have been paved straight with asphalt.” (I10)

> “The city is definitely the most important from my perspective, as it is often the client. And of course, our job is to do what the client wants.” (I09)

> “We definitely need the city and other elements to achieve those goals.” (I05)

> “Then it helps a lot if there are specific regulations to support, or if the city stays firm that these must be done, so it's easier for us to argue that we need to do these to achieve this.” (I07)

> “At least the city is an enabler, that's for sure, but how far one can compel certain things, that's always more difficult and the city's authority only covers a small part of emissions, but still cities have taken on a bigger role. It's somehow natural though. And it's hard to imagine other actors who could take on a similar role, it's still something seen as reliable and somewhat impartial in some way.” (W02)

> “Primarily, it's the city's own ambition that drives these goals forward. One shouldn't fall too much into nihilism, but it's mainly the case that if in private land one starts urban planning and the city doesn't say anything about it, then there would be as many cheap residential buildings as possible, parking at ground level, and no yard, in many cases out of ten.” (I02)

From the city as a single actor few specific sectors were brought up from the analysis, and one of them was the building and construction inspection. Involving building inspection to the city development and construction projects already from the beginning was seen highly valuable, as they have a lot of power over what can be implemented in the building. This effected for example on what rate circular economy solutions could be used as well as how the inspection was disposed towards NBS as part of the construction. It was pointed out that too seldom building inspection and contractor were part of the planning.

To conclude, city can be described as an intermediary and one of the most important actors within the business ecosystem to apply more NBS in urban environment and achieve urban resilience. Cities could use new methods to spread awareness and knowledge about NBS also inside their own organization, as for example building inspections was not seen as innovative or encouraging for new types of city development to take place.

Customer

One of the main actor groups in the business ecosystem is the customer actor group. This group is composed of housing owners, citizens, and local people, building residents, landowners, and property buyers. Customer was found to be an important actor in developing urban nature-based solutions use, but mostly absent or forgotten from the development of residential buildings construction plans and nature-based solutions design projects if in the role of individual citizen or resident.

> “I feel like residents generally have far too few means to influence what kind of housing we design, what kind of environments we plan.” (W05)

> “But then again, residents are also a significant group of actors, with perhaps awareness gradually awakening among them.” (I03)

> “Property management companies are certainly a major player, and there, property managers have a big role. But residents could have the will. Things where resident's voice could be involved in the very early stages of planning. It's also an interesting idea, how to promote that.” (W02)

Professional role holders such as landowners and property buyers however were found to be a somewhat conflicting role. On the one hand, they were valued as willing to raise the building standards and increase resilience by using NBS but at the same time profit-seeking attitude was characterized to be a common value amongst these actor’s intentions. Key actors in this group were especially the housing owners, who directly would be beneficiaries from the use of nature-based solutions through the increased property value and enhanced living conditions and surroundings. Though, it was noted that often housing owners or housing co-operations don’t know where to find information or do not realize the potential the NBS have especially in retrofitting projects.

This was presented to be consequential of the lack of knowledge and overall awareness of the nature-based solutions benefits. Same thing applies to the citizens and local people of the location as well as the building residents as end users. This raises the question for whom the city is built and designed for, and how these actors could hold more active role opposed to current passive role in NBS implementation. The customer, in this case the buyer of an apartment or building, plays a key role in determining how the plot or building is desired to be developed. However, landowners may have their own plans for the building, such as seeking high returns.

Maintenance companies

One of the key actors of the nature-based solutions ecosystem was the maintenance companies. Separated from the main four actor groups represents their detachment from the construction industry as well as the city, even though they often operate under the city administration or are part of outsourced services for the buildings surrounding maintenance. The key issue is in the nature of project-based development, where the project in most cases is finished when the building lot is ready. This leaves the maintenance of the designed and implemented NBS on the buildings and the lot outside the development focus, and often left without proper resources or knowledge. However, they hold especially important role having correctly operating solutions on site that produce the intended benefits. They have greater importance than one would suggest based on the current situation, as it was evident from the analysis that they are almost left

out from the analysis of implementation of NBS. This is evident also from the later chapters such as the lack of maintenance being a barrier for implementation of successful NBS.

> "But otherwise, maintenance or upkeep probably also play a key role. Somehow those maintenance practices, if we're talking on a very concrete level, those maintenance practices precisely, so that they would then change, and we could implement those ideas in reality there." (I03)

Who is the Champion?

Noticeable from the analysis was the underlining of an important role of a champion, or as few experts described a primus motor. This is a role that no single actor in the business ecosystem automatically holds, but it was discovered that often there is this position that either a person within an organization or an organization itself can have. In Figure 4 this role is represented as a separate factor in the business ecosystem actor division as an open position that anyone could fill. This champion is described to have vision and ambition to truly achieve change in industry's practices and is most often highly valuable individuals for both the business itself and for the development direction of the city.

> "In that greener project, it was indeed a visionary, this developer who initiated it. But it required that one visionary project manager." (W05)

> "This is a very individual-centered development, if in a unit or team one employee is really interested in such a topic and spreads that knowledge, it affects everything. So, the progressiveness of an organization often depends on a very small number of factors. Of course, it's possible that everyone is very progressive, but it's enough that there are a few, but if there aren't any, then nothing happens." (I02)

> "I wanted the green factor definitely as the starting point for the planning of that new residential area. Well, my role has of course been in such a picture that I have been interested, enthusiastic, and tried to share that enthusiasm forward and wanted and demanded those in my own projects and put forward those requirements. I have that kind of an initiator role." (I06)

> "These are quite dependent on one's own interest, how one also reads them during leisure time and such." (I07)

> "And cities, well, they usually have their own goals to push things forward, to promote nature-based solutions and increase their quantity in areas managed by the city. To some extent, it may be easier in public or common areas, but then again, it also depends a lot on the individuals leading or managing it, whether they want to promote them." (I03)

However, in this sense any single actor can also be in a hindering role, if they support business-as-usual methods, or hold strong prejudice against nature-based solutions. Including this it was noted that a business actor holding this kind of true champion attitude is absent from the current business ecosystem of resilient housing business especially focusing on nature-based solutions use and creating truly sustainable environment.

5.2 Challenges for use and mainstreaming of NBS in urban environment

The thematic analysis of the challenges for mainstreaming nature-based solutions identified six themes characterising various barriers hindering more widespread use and implementation of NBS. These themes are depicted in Table 4 with identified 25 sub-themes. Perception of barriers related to economic and financial management barriers, governance and institutional barriers, valuation of NBS, technical and infrastructure related barriers, and the fragmentation of the business ecosystem. The detailed version with description of sub-themes is presented in Appendix 7.

Table 4. Barriers for use and mainstreaming of NBS in urban environment.

Main theme	Sub-themes
Economic barriers	Under appreciation of benefits
	Insufficient public resources and budget constraints
	Short-term vision
	City's size and markets - regional mismatch between supply and demand
	Procurement procedures in city administration
	Future resident’s capability and willingness to pay higher apartment prices
Governance and institutional barriers	Intensive urban development
	Complexity of city governance structures and urban administration challenges
	Conservative construction industry and business-as-usual practices
	Fragmented, linear process and silo mentality
Knowledge barriers	Lack of knowledge and sharing of information
	Knowledge on maintenance, and NBS functionality and performance uncertainties
	Lack of indicators and data
	Fear of failure
	Inability to ‘think for the future'

Table 4. (continued).

Main theme	Sub-themes
Valuation barrier	Lack of valuation, ambition and will
	Lack of effort and resistance or reluctance to change
Technical and infrastructure related barriers	Unrealistic or faulty solutions
	Retrofitting related uncertainties when integrating NBS to existing structures
	Safety measures may limit use of NBS
	Lack of nature-based design in construction
	Parking solutions can restrict possibilities
	Availability of the NB-solutions
Fragmented business ecosystem as a barrier	Lack of frontrunner businesses
	Lack of interest and valuation of green businesses

Economic barriers

Economic barrier accentuates both macro and micro level challenges for mainstreaming nature-based solutions. First of all, the city's size and markets might affect the use of nature-based solutions. This also affects the plots' location within the city area and whether it is interesting for development. Including this, the city administration's procurement procedures can be restricting and public resources insufficient with lack of resources, e.g., in maintenance, and constrained budgets with no room for additional features such as NBS.

> "In the framework agreement arrangement, the city has selected a few operators from whom it always assumes to order planning. In that sense, I don't believe that nature-based solutions always materialize in the best possible way there, because they don't play a very significant role in the competitive bidding of framework agreement partners." (I08)

Implementing NBS may increase quality of housing value but often raise the cost of the residential building, so future resident's capability and willingness to pay higher apartment prices poses challenges for application of NBS in urban environment. This is also related to the valuation of nature-based solutions, and whether the residents or contractors think on more long-term scale. Short-term vision relates to aiming for maximized direct profits and focusing on lowest cost solutions, even if additional costs during construction would produce multiple future benefits. This is interlinked with the under appreciation of other than monetary benefits and the value barrier for NBS use.

> “The economic equation often brings a lot of challenges to it, especially if there's no competition but just the actual project to be implemented. Often, there are quite high efficiency goals for plots, and then there may not be so much space to implement those. Unfortunately, economic benefit may then take precedence, and similarly, for example, in the case of green roofs, one might have to opt for a solution that's not as easily maintainable and affordable as a normal roof. These are sometimes the realities that come up.” (I07)

Governance and institutional barriers

Intensive urban development is a considerable barrier for mainstreaming nature-based solutions. In dense urban environments where building stock takes up the majority of surface area and maximizing permitted building volume on plot leaves very little or no room for NBS. There is high competition over urban space and land, and rapid urbanization is inevitably connected to loss of green and natural areas. There is a recognized conflict of interests and values within the urban administration that on the one hand aims to preserving green areas but at the same time sets high yearly residential building stock growth targets. The productivity goal of urban design affects the design solutions and what the urban environment and the city looks like.

> “Enough space to actually get the street greenery in there. These are exactly the kind of design solutions, but they have been influenced in part by urban planning ideology, the idealization of a certain type of urban image, and then the productivity aspect has come into play when calculating the cost of land on that street.” (W08)

Also, pressure towards streamlining zoning and construction processes was mentioned to lead into discarding “non-essential” parts from plans such as nature-based solutions. This underrating of NBS is connected to valuation barrier presented later in this chapter. The complexity of city governance structures and aforementioned urban administration challenges is partly result of sectoral silos and silo mentality, and the barrier of fragmented and linear processes with omission of information for different actors and detached teams during separate project phases. High path dependency in construction industry and its conservative nature supports continuous use of business-as-usual practices, and slowing down change towards using green, nature-based solution methods.

Knowledge barriers

Unfamiliarity with the concept of nature-based solutions can create uncertainties and misconceptions, as well as unnecessary caution with implementing NBS as wanting to avert possible risks or failure. Incorrect maintenance level due to uncertainties on nature-

based solutions maintenance need, incorrect maintenance practices and unclear responsibilities often result to mismanaged solution or to complete lack of maintenance all together.

> “Firstly, the resources allocated for the maintenance of outdoor spaces are ridiculously small, and the people who do it, they don't have expertise in nature-based solutions. Essentially, there's a lack of environmental management professionals, gardeners, or others who understand, for example, what plant species are here and what they are supposed to be, and how this area should be maintained.” (I08)

This would lead the local people and building residents feeling of not caring about them and giving negative feedback about untidy and neglected environment. Without knowledge, sharing of information or awareness of the possibilities of the NBS is often a cause not applying NBS into urban landscape design or retrofitting projects. Consequently, contractors are not able to suggest using NBS or property owners don’t realize to demand these beforehand. However, inability to think for the future and to make appropriate precautionary measures was highlighted.

> “And maybe we don't yet know how well our building should withstand the climate 30 years from now and what that climate is going to be like.” (I10)

Moreover, lack of data and indicators and a general valuation for measurable and quantitative information was mentioned as a factor behind not using NBS, as their benefits are often non-monetary and difficult to express in so called excel-format.

Valuation barrier

One main barrier was the lack of valuation. The experts expressed an overall valuation deficiency regarding nature-based solutions and more broadly the nature itself. This devaluation is interlinked with lack of ambition and will, as well as unwillingness for sustainable changes. Experts raised the issue that nature-based solutions are often seen as a nice-to-have, non-essential part in urban development or in construction design.

> “Then there should definitely be a system in place where it's not just seen as a 'nice to have' that can be cut out right away.” (W06)

Appreciation of monetary value runs over non-monetary values and benefits of NBS, that often are perceived ‘soft’ and non-visible in nature, creating apprehension towards NBS. Political weakness and lack of political will was seen as a significant barrier for mainstreaming the nature-based solution in urban environments.

> “But politicians have a huge influence on what municipalities, for example, decide to include in their own strategies and demands. We are certainly ready to offer all sorts of nice solutions, but they may not always be appealing if they are not familiar. There are a lot of doubts about how this implementation will work. The fact that there is momentum coming from somewhere is very beneficial for us.” (I08)

This lack of valuation, ambition and will results in lack of effort as well as resistance and reluctance to change. It was seen more common to stick with known and prior used techniques, i.e., continuing business-as-usual methods, instead of putting effort in applying new solutions and thinking outside the box. Shortly, NBS is not valued as something worthwhile which reflects on the other barriers and is coupled with the knowledge barrier.

Technical and infrastructure related barriers

Number of experts highlighted the barrier of restricting infrastructure and technical issues for use and implementation of nature-based solutions as well as overall scarcity of available solutions. Faulty selection or implementation of NBS was found to cause malfunctions, sometimes even contradicting to the intended purpose of the solution. This can be due to unrealistic design or choice of the solution, which then are hard or even impossible to maintain properly. Moreover, the existing structural conditions and infrastructure create challenges for integrating NBS later-on on a plot or a building.

> “Then there's, of course, the question of whether to plan parking garages, whether to build deck structures over courtyards. That actually prevents a lot of the possibility of having large trees growing there in the future, for example. It's something that should be considered in the big picture, how these are wanted to be done.” (I10)

Parking solutions were highlighted as a relatively big challenge for use of nature-based solutions, as growing of big trees is not possible on deck yards. Including this, factors as the angle of the roof and use of other solutions, such as solar panels, were seen difficult to combine with NBS. Uncertainties regarding seasonal durability create their own challenge for the use of NBS in Finnish environment. Interestingly, in few cases lack of nature-based design in construction was considered as a barrier.

Fragmented business ecosystem as a barrier

The experts described a fragmented business ecosystem regarding businesses and services offering nature-based solutions or related expertise. Absence of pioneer, frontrunner

businesses with ambitious goals for climate resilience with sustainable green solutions affected the availability of the solutions for construction companies and constructors to use.

> "There isn't such an actor who would want to do this initially, so it's at least through these special cases for now, but it might be that the change is just happening now. A player from the private sector is missing, one that as a construction company would be proactive in doing better than what is minimally required, especially in terms of these [nature-based] solutions." (I02)

Moreover, experts valued the idea that a single business offered both the nature-based solution and its maintenance as a "package deal" service but described scarcity and unawareness of these businesses hindering the use of NBS. This was seen connected with lack of overall shared interest of the topic and consequently valuation of green businesses that offer sustainable solutions for residential housing construction such as nature-based solutions.

> "But in such a transition, especially when trying to actually implement nature-based solutions, it requires that the entire project organization tries to solve it. It can't be the responsibility of just the project initiator, or the sustainable development consultant, or a single designer, but everyone needs to know what the other is doing." (I01)

5.3 Multitude of benefits from nature-based solutions

In this section, the identified multiscale benefits and synergies related to nature-based solutions are presented. It was commonly recognized among the experts that nature-based solutions are highly beneficial for both people and the environment and hold multiple both short- and long-term benefits with high synergies. Three main themes and 21 sub-themes were generated based on the analysis, collated in Table 5. The benefits include economic, societal, as well as support, restoration and provision of ecosystem services and biodiversity benefits. All the descriptions of themes and sub-themes is available in Appendix 8.

Table 5. Multitude of benefits and synergies from nature-based solutions.

Main theme	Sub-theme
Economic benefits	Opportunities for existing and completely new businesses
	Increased property value
	Reduces buildings' emissions and increases energy efficiency
	NBS decrease the amount of built (often underground) technology, i.e., grey infrastructure
	NBS offset future risks and repair costs
	Decrease in long-term costs
	Way to mobilize public and private investment
	A competition benefit for businesses
Societal benefits	Increased citizen's health, well-being, and welfare
	Attractive and pleasant living environments
	Community spirit
	Connectedness to nature
	Improved living conditions in buildings
	Improved city image and desirability for visitors and both current and new residents
	Increased urban resilience for climate change
Support, restoration and provision of ecosystem services and biodiversity benefits	Climate change mitigation
	Heat island effect mitigation
	Decrease noise pollution
	Hydrological benefits
	Decrease air pollution and improve air quality
	Support city biodiversity and ecosystems

Economic benefits

The experts described multiple economic benefits from nature-based solutions. NBS offers opportunities for existing businesses, for example a competition benefit or a way to enlarge services to reach out s new market hold, and completely new businesses.

> "But at the same time, it offers new business opportunities both on the product side and on the maintenance side. One can specialize in certain structures and their implementation and maintenance." (I11)

NBS can decrease long-term costs, e.g., offsetting future repair needs, enhancing energy efficiency, and increasing resilience of the built environment against extreme weather events and heat island effect. These solutions can also indirectly decrease the amount of built technology and thus reduce emissions.

> "For reducing carbon emissions or achieving carbon neutrality, there are two routes. There is research on how we can increase carbon sequestration in urban environments and voilà, there comes nature-based solutions. But then there's also the fact that we know green roofs, for example, can act as insulation. These nature-based solutions can impact building's energy emissions or energy efficiency. They can provide additional insulation or cool the building as the green roof evaporates water. Or adjacent wooded areas can shade the building so that energy isn't needed for cooling, and so on." (I11)

It was also stated that use of sustainability driven solutions, such as nature-based solutions, is often a prerequisite for international investors. Therefore, NBS are seen to attract investments and new businesses for the business ecosystem and the market.

Societal benefits

The experts describe nature-based solutions to have a positive impact on people's quality of life and happiness as they increase the aesthetic value and quality of cityscape, i.e., the attractiveness and pleasantness of living environments. This is connected to improved city image and desirability for both current residents and for new visitors and inhabitants. NBS are valued to increase citizen's health, well-being, and welfare as well as enhance the overall community spirit and connectedness to nature. Individual people might face improved living conditions as for example green roofs or façades create shadow and cool down the building. There is also a consensus that NBS are in a key position to increase the urban resilience to climate change.

> "They promote sustainable development and generally improve well-being, increase comfort, and enhance the attractiveness of cities." (I04)

Support, restoration and provision of ecosystem services and biodiversity benefits

Including the benefits for individual people, urban population and whole society, nature-based solutions are highly beneficial for the environment - they can support city's biodiversity and urban ecosystems and are consequently interlinked with ecosystem services. With NBS there is a possibility to increase urban greenery and greenspaces, as well as ecological resilience. Especially thoughtful use of domestic species in NBS application is seen as a great benefit for supporting local biodiversity. Experts also highlight that NBS aid halting biodiversity decline and deteriorating quality of urban environments, through their support of the ecosystem services provision and restoration. Some examples of these services are the hydrological benefits, air quality improvements and mitigation of both local heath island effect and global climate change.

> "All stakeholders benefit, but residents, of course, benefit the most, both human residents and also certain animal residents if they can be attracted there, but the fact that greenery, especially trees, provide many benefits like shade, stormwater absorption, and reduction of windiness, etc. But then also all other people who move around in the area and such, at the very least the aspect of comfort is conveyed to others as well." (I02)

5.4 Solutions for mainstreaming NBS

From the analysis of the empirical data, seven main themes were found regarding the solutions for increasing use and reach the mainstream use of nature-based solutions in urban environments. These themes and their sub-themes are presented in Table 6 and the more detailed description in Appendix 9. In this chapter also the visions of the future are presented, highly connected to the solutions theme frame, and the six main themes for the wanted future are illustrated in Table 7, and further on in Appendix 10.

The solutions to overcome challenges and barriers for increased use and implementation of nature-based solutions in urban environments include economic aspects and instruments, policy instruments, reimagining existing structures, spaces and practices, multidisciplinary and collaborative business ecosystem, knowledge, information, and real-life example on NBS, experimentations and their next step, as well as long-range project planning and goal setting.

Table 6. Solutions to remove barriers and increase use of NBS.

Main theme	Sub-theme
Economic aspects and instruments	Economic incentives and subsidies
	Securing sufficient resources and budget
	Cost-benefit and life-cycle impact calculations with adequate time frame
	New business models and opportunities for innovations
Policy instruments	Land use planning tools to increase urban greenery and resilience
	Regulations and legislations
	Participatory methods in urban development
Reimagining existing structures, spaces, and practices	Rethinking prevailing maintenance practices and resources
	Retrofitting with NBS
	Awareness of future risks: climate change and biodiversity decline
	Location-based design
	Examples and drawing inspiration from abroad
	Upgraded urban design and city planning practices
	Education to react to new needs of expertise and know-how
Multi-actor and -sectoral and collaborative business ecosystem	Increased multi-actor and -sectoral co-operation throughout the whole business ecosystem
	Overcome internal organization silos
	Applying tools and methods to bring actors together
Knowledge, information, and real-life examples on NBS to increase awareness and mainstream use	Sharing information, knowledge, know-how and experiences with all relevant stakeholders
	Changing doubting or negative perceptions to positive ones
	Increasing awareness throughout the whole business ecosystem
Experimenting and going beyond it	Opportunities for testbeds, pilot projects and willingness to experiment
	Monitoring and follow-ups including sharing of post-project experiences
Long-range project planning and goal setting	Ambitious, clear, and unbending shared goals
	Applying NBS as the premise of the project
	Competence and know-how in planning phase

Economic aspects and instruments

Economic aspects and various instruments create one of the seven main themes for the solutions for increased use of urban nature-based solutions, as depicted in Table 6. Economic incentives and subsidies are valued as a positive push for using NBS through for example green funding schemes and certification. With NBS business actors have opportunities to innovate and create completely new business models, thus gaining competitive advantage in the markets. Providing a product-service system, where one

company provides both the design and application of NBS and takes care of its' maintenance was highlighted as a gap in the business ecosystem and offers opportunities for completely new businesses. Also, through certification schemes there is a possibility to increase urban greenery and use of NBS.

> "Environmental certifications facilitate cooperation because then there's not constantly someone questioning the targets or bringing in economic perspectives, but it's clear to everyone that these goals are wanted. But construction companies have also been interested in how nature-based solutions can be utilized and whether it can be a quality factor and competitive advantage for them as well. Environmental certifications can certainly be competitive advantages for them." (I08)

The significance of green finance was evaluated only to increase in the future, also creating strong base for new businesses. While the resources for example for the maintenance of NBS was said to be too low at the moment, a solution for this and for an overall step towards widely used NBS was securing sufficient resources and an adequate budget. This subtheme is connected to the one where the importance of thorough research and sufficient timeframe is needed in order to calculate successfully all the cost-benefits and life-cycle impact of nature-based solutions not to overlook the possible receivable monetary and non-monetary benefits generated by NBS.

Policy instruments

Main theme of policy instruments covers three sub-themes, that all represent different tools affecting urban planning and development. Land use planning tools that increase urban greenery and resilience can serve as a seamless method in increasing NBS in urban environments. This includes for instance the green and green-blue factors that are currently used in cities of Helsinki and Turku. Green efficiency targets, planning regulation, building ordinance, and local master plans were some other mentioned tools seen to be key methods in increasing NBS use. These methods are mainly controlled by the city, thus emphasizing the big role cities have in mainstreaming these more natural solutions within urban design.

> "The green coefficient calculation has greatly facilitated cooperation and understanding because it sets a specific goal, and everyone involved in the project is behind that goal. In that way, in my opinion, such measures do improve cooperation, just like environmental certifications. Similarly, the fact that green efficiency has now been introduced into the building regulations in Helsinki." (I08)

> “The fact that we are now actively, the city is doing, directing, and supporting these energy renovations for housing cooperatives, so that they would consider the courtyard also in terms of its adaptation. And hopefully, the state could also have, or some other actor, some forms of support for greening the courtyard. Because even here, the numbers are currently lacking, there should be some metric. This is perhaps something that isn't yet done much, retrofitting. There have been some, through some individual projects, but there isn't a model for it.” (W06)

Including these tools, the guidelines, policies, and strategic policy goals were represented as key policy instruments. By integrating goals into city’s legislation and regulation a minimum level for use of NBS could be set and this way increase urban greenery. This can be supported by both international and national regulation. Also, political decisions have leverage to increase use of nature-based solutions, putting local politicians in key role in increasing knowledge and use of NBS. City supported participatory methods such as partnership zoning, plot handover competitions and alliance projects were mentioned as one of the important policy tools by the experts.

Reimagining existing structures, spaces, and practices

The reimagining existing structures, spaces and practices is about changing the values and priorities within the business ecosystem and ability to rethink and reimagine the urban planning. By upgrading urban design and city planning practices new possibilities are opened for increased use of NBS in urban environments and residential areas. Reversed planning principles have a strong emphasis on landscape architecture, and the planned area is first filled with greenery and after this phase the grey infrastructure is placed where it is possible with least harm. Continuity for built areas should be thought from the beginning, and not to manage plants and trees as single-use-items were after the need of renovation grown greenery is removed from the way.

> “When we have collaborated with the Danes, the green planning actually starts by first filling all the streets with greenery, and then we start clearing space for the roadway and pedestrian, or combined traffic-pedestrian path, and so on. It's a kind of reverse approach.” (I05)

> “Continuity in developing built-up areas: it's just that vegetation isn't disposable, brought there and then after 30 years there's a renovation and everything is levelled and then start at the beginning. So, if we start from the premise that it needs some permanent backbone, which could rely on things like watercourses or just on how stormwater is naturally directed, through that, the place would root itself there and start living its own life.” (I08)

This new methodology could be backed up also by seeking examples abroad, as the experts mentioned Copenhagen as a pioneer city of climate wise urban planning. The sharing of knowledge was highly valuable, and connected to the knowledge, information, and examples solution theme. Retrofitting is a key part of reimaging the city around us and offer a real solution for increased use of NBS and resilience within the city. This means implementation of NBS in renovation sites and buildings. However, as said in the barriers, availability of knowledge could exist as a barrier here. Retrofitting could also support the mentioned location-based design where nature-based solutions are included into building practices and guidelines in such a way that supports use of NBS instead of continued use and design of business-as-usual methods.

The rethinking and reimagining the city is also connected to education of both experts and the citizens. Education of citizens and experts answers for the need for more knowledge on NBS altogether and more detailed know-how and expertise. Consequently, education and sharing of knowledge was highlighted as one of key solutions for mainstreaming NBS in cityscapes. This is connected to rethinking prevailing maintenance practices and resources, and with proper updated knowledge the redefining maintenance practices to meet the NBS and to reassure the carrying out of benefits. Knowledge about the current resources and maintenance ability support also the right choice of designed NBS and the used plant species.

> “It’s perhaps more about ambition. If those things are genuinely wanted to be addressed, then it's understood that it requires sufficient expertise even in the planning phase. Then again, there need to be resources to embark on sufficient collaboration so that there's adequate expertise or that our field's education can respond to what's needed out there in the field. This applies to the entire chain from planning to implementation.” (I11)

> “Through nature-based solutions and by aiming to consider biodiversity more in urban areas and green spaces, we have to rethink the ways of maintenance and resourcing, and that it might not necessarily reduce the need for maintenance. On the other hand, it could indeed reduce the need for maintenance because, for example, lawns are mowed extensively. If it were directed differently, suddenly there could be much more resources available. In that way, with the same effort, more could be achieved for the same amount of money.” (I08)

Awareness of future risks related to climate change and biodiversity decline can result into consideration of local compensation and support applying NBS as a solution to meet these aforementioned challenges. With NBS climate change adaption methods could be applied

in residential construction project simultaneously supporting local biodiversity and ecosystems.

> “On the one hand, in urban planning, construction is carried out, and things are lost, including nature, and then there's increasing pressure that construction doesn't happen on natural areas, but then there's also pressure that if construction does happen somewhere, efforts are made to ensure that compensatory actions could be taken at some level in that environment. And these can be influenced precisely by these nature-based solutions.” (I06)

Multidisciplinary and collaborative business ecosystem

Common and shared understanding of the importance of cross-sectorial collaboration between actors over organization silos as well as increasing multidisciplinary co-operation throughout the whole business ecosystem is one of the described solutions for mainstreaming use of NBS in urban areas. Especially more technical NBS demand collaboration in planning, implementation, and maintenance phases of every actor. Overall, the inclusion of the whole construction chain ensures that knowledge share with all relevant actors in construction and urban planning projects and brings actors together. Silo mentality was a significant hindrance for functioning business ecosystem when creating resilient urban areas and overcoming these both between different actors and within single organization, e.g., city administration's institutional silos, was seen possible by strengthen inner collaboration models.

> “When we talk about the built residential environment as a comprehensive entity, then it's the entire chain from planning to maintenance and all the actors in that chain. In planning, it might involve collaboration between different planning levels. Perhaps at the master plan level, we could already identify nature-based solutions and at that master plan level, there's perhaps an emphasis on recognizing the multi-benefits of broader green structures. This is where we see their significance for the entire urban area in different ways whether from the perspective of resilience or urban biodiversity.” (I11)

Knowledge, information, and real-life examples on NBS to increase awareness and mainstream their use

One of the main solutions was the knowledge, information, and real-life examples of nature-based solutions to increase the awareness and mainstream their use in urban environments. Sharing of information, knowledge, know-how and experiences was highlighted an important aspect of this as well as the availability of open data. This could support clarifying the benefits generated from NBS and increase awareness throughout

business ecosystem. The familiarity with the concept of NBS is key for also increasing its demand. Experts also pointed out that with correct information the perceptions on NBS could be change into positive ones and increase this way the valuation of more “soft”, non-monetary benefits of nature-based solutions. This could aid that NBS are not seen as an extra cost in construction. This solution is interlinked with the multidisciplinary business ecosystem as trough cross-sectorial information sharing the needed knowledge and expertise is available for the whole organization or organization coalition in question.

> “Then, when it comes to maintenance, it's a whole new aspect. If we're developing new types of structures and solutions, which can be quite technical and are expected to provide multiple benefits, then how do we convey that message and vision from planning to implementation and maintenance? And is there expertise in maintenance if, for example, there are stormwater structures and there's a heavy rainfall situation, are they filled with sediment, do they require special maintenance? Or a green roof, if it doesn't start growing properly, what corrective actions can be taken in maintenance?” (I11)

Experimenting and going beyond it

Creating opportunities for pilot projects and experimentations is an important way for mainstreaming nature-based solutions. They simultaneously offer businesses possibilities for testing and showcasing innovations and new nature-based solution applications, as has been already pointed out in other solution themes. By enabling platforms for pilot projects to test out different solutions helps mainstreaming NBS as they can demonstrate how to increase greenery on construction sites or on buildings. It was pointed out that experimentations on how to increase greenery and retrofit existing areas and especially buildings with nature-based solutions are needed. This creation of positive real-life experiences was valued as a key in also increasing awareness on NBS and supporting their wider use.

> “When there's a pilot experiment, some kind of business ecosystem can be involved, which starts to consider it. Through that, when it's time to scale up, then it can be integrated into the regular procurement mechanism again. Easily, when dealing with public procurement, it can happen that there are very innovative, new solutions, but they can't be included due to the procurement system. And if cities have the opportunity to create example projects even in residential construction, whether it's by the city or the state, through that, pioneers get platforms where they can show that their system works.” (I10)

Monitoring and follow-ups of these experimentations including sharing post-project experiences is helping to take the next step from pilot projects for wider scale use of NBS.

Including this, post-project information sharing between the business ecosystem helps to avoid remaking unsuccessful solutions and focusing on implementing location-based, and functioning NBS.

Long-range project planning and goal setting

Connected to the experimentation theme is theme of long-range project planning and goal setting. From the analysis it was clear that ambitious, clear, and unbending shared goals in a project network or in the business ecosystem help to stick to set threshold values for the NBS use. With clear goals and thorough planning that focuses on resilience values right from the beginning, misconceptions and oversights are able to be avoided.

> "I just think that we need to boldly try things out. And it would be really good if the designer could continue to hear about user experiences later on. It's crucial information if it's been found that something really wasn't a good solution or if something worked well. Then that feedback should reach the designer's ears, and it would be good to have more on-site services or follow-up from us as well, to see what solutions have been experienced as good and which haven't. I believe these things evolve all the time, and you just have to be proactive and keep track of what's going on. It's all about practical experience and long-term use." (I09)

> "Indeed, it's important that the project management can pass on the project's goals as it transitions to next phase. It might not be feasible to delegate this to a single person, especially as it moves within the city organization from one unit to another. There might be a gap of two years in between, and people might leave and so forth, but it needs to be clearly outlined in the plan somehow." (I03)

These factors underline the importance of the competence and know-how especially in the planning phase of a construction or urban design project that aims to apply NBS. To create multiscale benefits in long-range project planning the location and the given context of the intended solutions should be closely evaluated. Understanding the site preconditions aids to choose right and correctly sized NBS and avoid omitting or faulty implementation of these solutions.

5.5 Expectations for the future

These several aforementioned solutions are interlinked with the actors' ideas and hopes for the future as could be seen from the analysis. In this next part the result of the analysis for the question how the future of NBS is perceived in cities by the business ecosystems actors. In this case, the future means how the experts valued NBS as part of resilient urban future

and what they underlined the future of urban landscapes and environments should look like. For the desired and expected future four main themes with 16 sub-themes were delivered from the analysis. These themes include human scale city by holistic approach to urban design, systemic change in society's values and going towards sustainable urban societies, greener city, and controversy between NBS quality and NBS quantity. The themes and their sub-themes are presented in Table 7, and with more details in Appendix 10. Altogether these images and hopes build up into ternary picture of the future urban areas where city develops symbiotically with the environment, or in other words where nature becomes one with the city and city one with the nature as there are no seen artificial boundaries between these areas.

Table 7. The desirable and expected future for cities.

Main theme	Sub-theme
Human scale city by holistic approach to urban design	Planning city for the good of the citizens
	Being aware of NBS related societal risks
	Posthumanist urban environments and posthuman urban design
	Multispecies and more-than-human thinking
Systemic change in society's values and going towards sustainable urban societies	Valuation of non-monetary benefits of NBS
	Regime shift - from business-as-usual practices to sustainable and location-based NBS
	"NBS are part of the cities' future"
	New building practices using multiple materials (e.g., wood-based construction, combining wood and concrete) and retrofitting create opportunities for NBS
Greener city	Increasing urban greenery on block and plot scale evenly in the cityscape
	Fading out artificial boundaries between built and natural environment
	Integrating nature into the buildings and built environment with NBS
	Thinking beyond city borders
	Re-evaluation of the city structure to be able to adapt to future changes creates more demand for NBS
Controversy between NBS quality and NBS quantity	Quality overcomes quantity
	"Mighty oaks from little acorns grow"
	Quantity overcomes quality

Greener city

Greener city, i.e., to have more plants, trees, and other living green nature, was viewed as a way to achieve resilience and sustainability in built environment, and this was interlinked with applying nature-based solutions in cities. Increasing urban greenery on both block and plot scale evenly in the city can be achieved by applying NBS in urban design, and especially integrating nature into the building and built environment with nature-based solutions. Concepts like green block and forest yards are some examples brought up from the analysis on how to have more nature within the city and designing new more nature connected areas. This can be achieved with conscious increasing of urban greenery in construction projects and new urban area design.

However, valuing unbuilt areas and preserving existing urban greenery and green networks is also key part in creating greener city, and this is connected to theme of systemic change of societies values. This is about valuing what we already have in the environment, and trying to build what is needed by terms of existing surrounding nature. Multifunctioning areas and elements and multiuse of sustainable solutions, e.g., urban agriculture, green roofs and solar panels on the same roof, pervious green parking plots, were mentioned as some of useful implementations where NBS can be highly effective in increasing urban resilience. This is part of bringing nature into residential environments and fading out the boundaries between built and natural environment.

When nature-based solutions are integrated into the buildings and its structures, the construction can be part of natural processes and create environmental services. This is applied in the soft edges design principle, where a building plot is part of surrounding nature and nature reaches out and is present on plot. This is connected to more holistic view or urban development and thinking beyond also single city's boarders. This could aid regional co-operation with neighbouring cities for example in areas of dense urbanization. Re-evaluation of the city structure to be able to adapt to future changes creates demand for NBS. Accelerating climate change creates more demand for NBS and adapting to changing climate and environment means the need to increase greenery in urban environments.

> "Regarding the urban heat island effect, it's really important that we're able to create more green spaces in cities. It's also related to overall environmental comfort and experiential aspects, liveliness, having green and pleasant environments to spend time in and live in. It plays a critical role in increasing resilience. And we really need to be able to reconsider our entire urban structure so that it can adapt to future changes." (I03)

> “Essentially, it involves consciously incorporating urban greenery into construction projects and structures.” (I06)

> “It's important, in my opinion, to recognize the multifunctionality, whereby in urban land use planning green structures in urban areas are valued. They are given a purpose, a role within the entire urban context. But equally, it could be a human-made solution, such as a green roof. Our actions towards these green structures stem from generating benefits. And alongside that, there's perhaps now also consideration due to biodiversity loss, pondering its significance for the broader urban natural diversity.” (I11)

As one of the interviewed experts mentioned, it is highly relevant that the target level for chosen NBS is recognized with the intended purpose of which the solution is thought to answer. This then affects how the solution is planned, built, or implemented and later maintained. Therefore, nature-based solutions also involve the awareness that part of the green infrastructure provides ecosystem services, which are goods and services enjoyed and consumed by people.

Controversy between NBS quality and NBS quantity

However, from the analysis it was pointed out that there is a possible controversy between NBS quality and quantity. Quality of the urban greenery and nature-based solutions is valued as highly important for biodiversity and resilience. Experts raised the question of green roofs that could be made with a diverse meadow species but often are just stone crop models. Proper, place-based design and right implementation and maintenance result into functioning solutions and provision of multiple benefits from NBS. On the other hand, due to urban densification and increasing construction all green is needed wherever possible, and here quantity is highly important. All in all, the conclusion could be made that multiple small scale, good quality NBS multiply into widespread benefits and when this relates to systemic change of both societies’ values and design practices, resilient and sustainable environments are seen to be able to be achieved with diverse use of NBS in urban areas.

> “We're building denser cities now, so the amount of green space might not be extensive, but then the quality should be exceptionally high. Every spot where we can incorporate greenery should be maximized for its benefits.” (I02)

> “To make the city sustainable, we really need to integrate nature-based solutions much more into the buildings, so that we could create a sponge city that absorbs stormwater and utilizes it. From there, we would reap various benefits for both humans and nature.” (I03)

> "It seems that some of the challenges with nature-based solutions revolve around people questioning their effectiveness if we implement something small. However, the benefits of nature-based solutions also rely on having small-scale interventions in many places, which then contribute to overall benefits. Often in my work, I find myself having to justify that these interventions are important for the bigger picture, even if individually they might seem to have only minor impacts, such as in managing stormwater." (I03)

Human scale city by holistic approach to urban design

Human scale city was described from the analysis as a positive view what future cities should look like. This scale implies that the urban planning and development is first and foremost done for the good the citizen in such a way that is for example accessible, not too over-scaled, with enjoyable public areas and community-led placemaking. More pleasant and attractive public spaces have great societal importance and including these into cityscape is highly relevant in the future. This is supported by being aware of the societal risks related to NBS such as gentrification and rise of apartment prices.

Human scale approach is about listening to existing communities and giving voice to the residents of the city, neighbourhoods, and residential buildings as well as their future dwellers. In this view the human actions, e.g., living, working, and going to nature, becomes more intertwined in space. To have more human scale city is connected here with cities also remaining to be functional, safe, and healthy even in the face of climate change. This is described to be able to be achieved with holistic approach to urban design that creates liveable and sustainable as well as resilient cities and neighbourhoods within them. Holistic planning includes the interdependence of the environment, people and businesses and creates environmentally responsible built environments that are healthy, sustainable and support human well-being. More sustainable relationship between society and nature is also described to be achievable through posthumanist urban environments and posthuman urban design, where other species are considered.

Key objective of posthumanist urban design is in ecological and social processes and systems, for instance integrating nature into buildings and harnessing buildings to recycle water and nutrients. This is supported by using nature-based solutions. In this theme is embedded the multispecies and more-than-human thinking. This was highlighted from the analysis that cities should transition in design that takes other species in consideration when creating and developing urban environment. This was connected to the goal of urban resilience meaning ability to live together with other species and integrating habitats into

built environment. This view was scaled up into one were societies and urban populations live and co-exist symbiotically with the environment. This represents a planetary thinking model where the bottom line is to work symbiotically with nature.

> "Exactly, it's about adopting a planetary mindset. Often, when we engage stakeholders and shift from human-centric thinking to considering multiple species, nature-based solutions quickly become recognized as valuable." (I11)

> "Indeed, there has been a prevailing notion that humans control their environment and cities, with precise zoning defining separate functions for each area. It's like every aspect has its own compartment. Now, I see that in the future, these will somehow intertwine, and the fabric will stretch in both directions so that they become part of a common network. Residential plots will become integrated with nature, or nature will branch out upon residential plots." (I06)

> "Benefits for all residents, those living in the city, and the entire environment, including animals." (W01)

Systemic change in society's values and going towards sustainable urban societies

Systemic change in society's values was highlighted as a key going towards sustainable urban societies. Valuation of non-monetary benefits of NBS and realizing the multitude of ecosystem services NBS provide was wanted to be part of the urban futures. Realization of these factors and the intrinsic value of nature are connected to valuing environment in urban landscapes. This is aided with new building practices that use multiple materials and apply retrofitting which simultaneously create opportunities for nature-based solutions. Retrofitting with NBS was highlighted as key part of future cities and increasing their climate resilience.

> "Can strengthen, and strengthens [resilience], and in my opinion, [NBS are] key in that. Nowadays, urban environments are designed incredibly dense, and there is tremendous potential to create more nature-based solutions there. If we look at the possibilities of retrofitting existing buildings, there are opportunities to increase those nature-based solutions. And their significance in developing resilience is, in my opinion, pivotal in preparing for the extreme phenomena caused by climate change." (I03)

> "Overall, it's about understanding both resilience and biodiversity, so that we move towards the idea that even residential buildings would be surrounded by nature in a certain way, rather than just having a built yard with a sign saying 'no ball games!'. Parks are another aspect; when creating parks in neighbourhoods, should they be built, or should diverse nature-based construction be allowed? Is it about construction, or would it sometimes be better to leave things as they are instead of clearing everything and rebuilding

> anew? It's a big challenge for new areas, where large trees that have been growing for decades are cut down and then more are planted, and we consider that satisfactory." (I10)

A regime shift from business-as-usual practices to more sustainable and location-based NBS is in core of the system change of construction industry which was connected to the mainstreaming of NBS. There is a need for cultural change as well as common will to increase use of NBS in cities and in urban building practices, land use planning and residential building structures. Even though development for wide use of nature-based solutions and the realization of need for adaption is slow, experts see immerse potential of nature-based solutions and estimate them to have growing importance in future urban development decisions. Nature-based solutions are perceived to be inherently part of future cityscapes and part of urban design, construction and living as the solutions have recognized potential to increase cities' resilience. Therefore, it can be stated that nature-based solutions are both necessary and relevant in construction business.

> "Indeed, it should be increasingly seen that construction occurs based on the functionality of the environment, rather than the other way around." (I07)

6 Discussion

This chapter discusses the results in the light of the existing literature in the order of the research questions. This thesis aimed to answer three research questions considering the actors in the nature-based solutions business ecosystem, value of NBS perceived by the expert actors and what kind of barriers there are against mainstreaming these solutions. Including this, thesis set to find answers to what kind of benefits there are derived from the use of nature-based solutions and resulting greening of cities. It was also asked whether these solutions are part of the city's future based on expert opinions and what kind of urban future there could be with the nature-based solutions.

The identified benefits and the future vision the actors have about the greener and more sustainable future city form the basis and the cause to look for solutions in order remove barriers against the mainstreaming of NBS. The barriers, or in other words the challenges for using more nature-based solutions in urban environment are important to acknowledge and identify. From these elements it is possible to find the solutions to upscale and mainstream the use of NBS within Finnish cities. In this the identification of the business ecosystem and actors are also important.

6.1 The key actors around NBS and resilient urban environments

In Europe, the application of nature-based solutions most often focuses on urban environments, and this is why it was highly interesting to investigate what kind of thoughts key experts have about urban nature-based solutions in sparsely populated Finland, and how they value these solutions use in Finnish cities (Kabisch et al. 2016). Inclusion of the whole network of actor through the business ecosystem approach aids in increasing these solutions by understanding better the network of actors. By analysing the roles and experiences of involved actors in using NBS in Finnish cities a picture can be drawn who hold key roles in increasing these solutions.

Key actors in the business ecosystem who apply nature-based solutions in the residential housing regime were discovered to be multiple and extend into different actor within the society. Sarabi et al. (2019) have identified in their research multiple actors relevant for NBS development, that include for example citizens, business owners, municipal departments, and national authorities. This multitude of actors connected to urban resilience is also found from the Engez et al. (2021) research. Especially municipal actors

have been found to play multiple roles such as initiators and monitors of NBS and to be in key role for transforming construction to be more sustainable (Salmi et al. 2020) which support the results of this study as well.

The experts did connect NBS with urban resilience and valued them as a key feature of future sustainable cities. These solutions should already be used in wider scale, but this was not seen as a reality at the moment. Yet, the importance of these decisions was underlined greatly in the analysis, and these solutions should be in the handbook of every decision of urban planning and construction project plan. The business ecosystem is perceived by the actors riddled with different problems that slow down the development for more sustainable city development, but key actors hold an important role in overcoming these issues. Defining the business ecosystem helps to find out the key puzzle pieces in this multi-actor network.

A key to building more resilient cities is to understand the local actor's cooperation. For example, Paloniemi et al. (2019) have stated that in order to increase use of nature-based solutions in Finnish cities more holistic planning and wide cooperation throughout the business ecosystem network is needed between different actors. This view was also shared with the results. Similarities between the actor roles have also been described by Nyström et al. (2014).

The regional business ecosystem related to nature-based solutions is constructed around the city as one of the main actors in the business network. Cities as actors in the business ecosystem create market for nature-based solutions and for example through land use planning and building regulations they can regulate what new innovations and solutions businesses can apply in urban areas. Using regional and town planning, plot handover conditions and blue-green factor as part of urban planning cities can have a positive impact on the use and mainstreaming of nature-based solutions. Moreover, by informing the local people and by activating residents these solutions could become more known and gain acceptance as part of the city's sustainability and greening objectives.

6.2 Benefits of NBS and hindrances for mainstreaming in cities

Nature-based solutions are ecologically, socially, and economically sustainable solutions. They serve as a complementary or alternative method to conventional and technical solutions such as grey infrastructure. Nature-based solutions offer multiple benefits for solving societal problems that are based on the opportunities and models the ecosystem processes create. (Kabisch et al. 2016.) Inherent with biodiversity benefits and support for ecosystem services delivery, nature-based solutions additionally deliver multiple other environmental, social, and economic co-benefits. NBS applications deliberately include natural system processes within human environments in order to obtain relevant ecosystem services (European Commission, 2021).

Maes and Jacobs (2015) define nature-based solutions as any transition to a use of ecosystem services with decreased input of non-renewable natural capital and increased investment in renewable natural processes. These transitions have multiple benefits in short-, medium- and long timescales, covering the short-term costs, which was also evident from analysis. With NBS the ecosystem services delivery is improved leading to increased housing value with lower maintenance costs and depreciation of initial investments over time. Relatively small increments of NBS in urban environments have potential to generate large-scale socioeconomic benefits. Benefits related to ecosystem services have been brought up in previous research, such as Keesstra et al. (2018). They point out that nature-based solutions have multiple societal benefits related to biodiversity, carbon sequestration, land restoration, food security and water security. Thus, NBS are inherently connected to ecosystem services.

It is recognized that because of the nature of providing multifunctional benefits of nature-based solutions' they are not easily incorporated within the sectoral organization of urban planning and development (van der Jagt et al., 2020). Including this, lack of governance has been studied to be a driver for lack of resilience, which is one of the underlying motivations for use of NBS (Castaño-Rosa et al., 2022). Several research papers and articles have been published considering barriers and benefits related to use of nature-based solutions related to global challenges such as climate change and located in urban context. The findings considering the barriers from these studies support the ones from this thesis (see Egusquiza et al., 2019; Sarabi et al. 2019; Wihlborg et al., 2019; Nelson et al., 2020; Sarabi et al., 2020; Seddon et al., 2020; Zuniga-Teran et al. 2020; Toxopeus &

Polzin, 2021; Calliari et al., 2022; Dorst et al., 2022; Duffaut et al, 2022; Van Cauwenbergh et al., 2022). Moreover, the benefits derived from NBS are multiple which is also highlighted in previous research (see Boano et al., 2020; Kolokotsa et al., 2020; Cortinovis et al., 2022 Epelde et al., 2022; Mihalakakou et al., 2023).

The benefits derived from increased use of nature-based solutions and challenges as a barrier for mainstreaming are multiple in urban environments. Based on the analysis, there are still several barriers for the mainstreaming and widespread use of nature-based solutions. Several themes were found relating for these multilevel challenges in order to gain more tractions on the way towards more commonly used NBS and increased valuation of their multiple benefits for the society, people and the environment. They are still a "niche" in the construction regime, which is described to be old-fashioned and stagnant industry with long-lasting and strong linkages in business-as-usual methods.

The range of themes within this dimension demonstrates the differentiating perceptions what factors on multiple levels and practices in society and business are held by the experts - the barriers are clearly complex. Barriers for wider application and use of NBS are identified to be the difficulty to estimate benefits and the long-term effects and lack of both practical experiences and legislation to support application, also noted in previous research by Vikström et al. (2019). The actors view NBS very important part of the cities structure, and thus can be argued that they are highly relevant for resilience.

Threats for both biodiversity and society have led to recognition of the importance of green and blue spaces within urban areas. Green and blue spaces offer environmental, economic, and social benefits and support the biodiversity conservation and climate change mitigation and adaptation goals. (Kabisch et al. 2016.) Scott et al. (2016) have also pointed the need for fundamental rethinking of the natural and built infrastructure resilience for future challenges.

In order to mainstream the use of nature-based solutions, political, economic, and scientific challenges need to be overcome. There is a clear need for political will and economic subsidy schemes, and a conscious choice of NBS over conventional techniques as well as a need to consider choices and decisions on a larger temporal and spatial scale and integrate diverse values. As Maes and Jacobs (2015) propose the economic risk could be shared by society, e.g. using subsidy systems, if long-term net societal benefits don't concur with businesses' short-term interests. This was also visible from the analysis.

6.3 Solutions to increase use of NBS and views on resilient future cities

Urban resilience can be increased through inclusion of nature-based solutions and the associated delivery of ecosystem services in urban areas. Urban nature-based solutions create healthy environments and aid tackling challenges posed by climate change and biodiversity loss. There several found keys to increase use of nature-based solutions in urban areas. Multiple solutions were found with what NBS could be increasingly used in urban environments in cities. Similar results identified here have been found in other studies, that have researched the solutions to spur adoption and increase use of NBS (see Madsen et al., 2017; Nesshöver et al., 2017; Cohen-Shacham et al., 2019; Davies & Lafortezza, 2019; Dorst et al., 2019; Sarabi et al., 2020; Wamsler et al., 2020; Xie et al., 2020; Dorst et al., 2021; Kooijman et al., 2021; Wickenberg et al. 2021; Duffaut et al, 2022; Tozer et al., 2022; Van Cauwenbergh et al., 2022; Xie et al., 2022; Adams et al., 2023; Collier et al., 2023; Mell et al., 2023).

One of these found solutions to increase use of nature-based solutions is using pilot and alliance projects, plot handover competitions, partnership zoning and other methods of land use planning and building regulation. These were found to offer opportunities for experimentation and bringing actors together reaching for the same goal. Workshop-like interactions during for instance building projects were found to create synergies and cooperation between the business ecosystems actors. With experiences from pilot projects there was identified to be an opportunity to create repeatable models that could help mainstream NBS use in cities.

Applying NBS requires more easily adaptable, practical information and more efficient planning methods. Information is needed to argue for solutions in decision-making and to stir up more public discussion. Institutionalizing nature-based solutions requires stronger national guidance and education. It is also stated that good and bad examples of NBS as well as sharing information and experiences and communication between cities should be increased. Including increasing knowledge also new methods to mainstream NBS are needed. Defining the economic value of NBS could be an effective method to argue for implementation of NBS. (Vikström et al., 2019.)

NBS should be mainstreamed on national level as it most probably promotes their application on local levels and in cities. Succeeding in implementing NBS needs integrating different planning levels and their processes. Thus, NBS should extend from strategic

plans to master plan, town plan and to both technical implementation and maintenance practices. Key actors were identified to be land use and urban planning. Clear economic incentives were seen important in order to guide private investors. (Vikström et al., 2019.)

Including this, integrating natural values into planning was deemed highly important, which is also suggested in other research such as introduced change for nature-based thinking in paper by Randrup et al. (2020). From the results of this study there is a bigger cultural change to be seen by the experts and a change in values to adapt for climate change with using NBS in urban context. Conscious increase of urban greenery is one key factor in these values change.

Raymond et al. (2017) highlights the importance of a holistic approach to nature-based solution design. Firstly, it is crucial to understand environmental and socio-ecological context of NBS design, implementation, and evaluation. This aids identifying, assessing and managing the expected costs and benefits for various stakeholder groups before NBS design. Secondly, it is important to utilize co-benefits of nature-based solutions by designing NBS to address multiple interconnected challenges. Thirdly, to implement NBS across multiple scales it should be combined with learning-by-doing approach, in order to nudge societies towards ownership of NBS and more adaptive management. Fourthly, long-term managing, maintaining, monitoring, and assessing NBS with multiple actors is necessary to grasp the value of manifold co-benefits. This holistic approach was also supported by the analysis and experts thoughts on future prospects of the solutions.

This holistic approach was visible from the experts view of biophilic multispecies cities on what the future city should look like. The concept of biophilic cities in urban frame includes the idea of biophilic design, where nature is incorporated in multiple various ways into the design of structures – such as availability of natural daylight and use of natural materials on buildings (Scott et al. 2016). The theme of greener city could be seen similar to the idea of biophilic city where cities are full of nature with plentiful greenspaces, high canopy coverage and extensive biodiversity. Studies have shown that the proximity of nature and citizens connectedness to it have a positive effect on physical and mental health and quality of life. To reach for more sustainable urban development and future, design, planning, policy, and governance of NBS should be based on systemic understanding, benefit people and the environment, i.e., biodiversity, be long-term inclusive solutions, be context specific considering the local conditions and to be able to foster the cooperation between multiple different actors and roles in the urban regime (Kabisch et al., 2021).

Green spaces are valued as highly important, and this is coupled with the maximation of quality and quantity of green within cities. Interesting question risen from the interviews was the issue of visuality - do NBS bring increased value to a housing company or neighbourhood if they are not seen? This is especially relevant with green roofs and other solutions not on the level of pedestrians or other local people, but as it was derived from the analysis it can be argued that the value should also be measured by the value for the whole environment. Even with smaller scale solutions, whether they are seen or not by the people, great benefits can be achieved for biodiversity and local climatic conditions. It was noted by the experts that green roofs are being built on regular basis and becoming a normally used feature in buildings and consequently don't stand out so much anymore. Maybe this is the first step in the way for more green cities, where NBS are normal part of everyday design.

It can be stated that nature-based solutions are highly relevant to urban resilience. Here it can be argued that this green construction is not able to be achieved without applying of NBS into the building structures and on the plots, thus creating truly circular and holistic solutions, that are connected to nature and produce multiple ecosystem services. Mokhlesian and Holmén (2012) define green construction as a situation where both construction firms and their clients are faced with leaving their “comfort zones” of conventional construction. Green and sustainable construction aims for environmentally sustainable construction industry that creates and responsibly manages built environment, coupled with resource efficient and ecological principles.

To conclude, a will of change of mindset was visible. Experts described more biophilic, green city, that is designed with more-than-human thinking. Urban residents delve in greener cities that are designed with human and non-human well-being in mind. This picture is underlined a value of coexistence, that cities and buildings are not separate places from the environment but connected to the surrounding space with no clear boundaries. Nature becomes one with the city, and city with the nature.

6.4 Limitations

The main limitations identified for this thesis are three-fold. Firstly, it is recognized that the results do not represent the society and the situation as a whole but present views and conclusions from a limited scope of experts working around nature-based solutions and developing more sustainable and resilient cities in the fields such as construction, land use planning and architecture. The sampling, i.e., the interviewed professionals and experts who participated in the focus groups, does not represent the whole business ecosystem which is, and as mentioned before, composed of multiple actors on three different levels that are highlighted in Figure 3.

As the interviewees represented a narrow sample of the whole related business ecosystem and represented their own viewpoints on the field, it might limit the generalization outcomes of study. However, it is noted that in qualitative research generalizations are constructed based on the interpretations and not on the text and collected data itself. Keeping this in mind, some generalizations can be made from the analysis by referring it to other research and available data throughout the research process. (Moilanen & Räihä, 2015.) This was considered in the discussion where the empirical analysis results were linked to previously presented theoretical discussion and findings were elaborated with referring it to relevant existing literature.

Secondly, it is important to take into account that as a concept, business ecosystem is rather complex and has not been extensively addressed in the context of nature-based solutions. This angle is relatively new. Consequently, there is a lack of similar research done that studies business ecosystem network linkages to sustainable residential housing building and connections to nature-based solutions. This factor can to some extent limit the comparability of the study. It is also worth to consider that the data was not fully capable to answer the concept of champion, and this actor role's deeper nature and connection to the business ecosystem concept was left somewhat limited.

Lastly, focusing on only two case cities of Turku and Helsinki in Finland and searching for interviewees within these cities or projects that have taken place in either of the cities, can affect the study as a limiting factor. There are sustainable construction projects also done in other Finnish cities and municipalities, with a goal of increasing local resilience using nature-based solutions. This additional expertise and experiments from these projects might enlighten the status of NBS use in Finnish cities more, if included into the study.

However, for the sake of narrowing down the scope of this research, and as Turku and Helsinki were identified as frontrunner cities which population and consequently housing production continues to grow, the choice was made to focus on these specific large cities.

6.5 Future research directions

This thesis recognizes many fruitful areas of future research. As the field of nature-based solutions is relatively new and still gaining wider knowledge, there are multiple directions for future research and development opportunities.

For instance, a long-term review of follow-ups and next steps taken from pilot projects with a longitudinal research strategy would answer the questions around how nature-based solutions could be transferred from experimentations to everyday use or how knowledge could be transferred from one project to another. There are multiple experimentations around nature-based solutions, and it would be beneficial to investigate what outcomes and post-project information these have had and how to avoid already unsuccessful claimed solutions.

Connected partly to this topic it would be highly valuable to research the readiness, attitudes as well as resources of both maintenance companies and property managers for nature-based solutions application on residential buildings and urban plots. Retrofitting projects around how these nature-based solutions could be implemented in existing residential buildings and how this building capacity could be aided to transfer into more resilient and climate ready neighbourhoods, would also be beneficial to accumulate knowledge on how to support cities' communities in sustainable transitions.

It would also be interesting to explore ways how cities residents both in condominium and rented apartments could affect the resilience of their surroundings and increase and support citizen participation in their neighbourhoods. From the analysis it was pointed out that even if residents and housing cooperative would like to increase their adaptation possibilities for future climate conditions, they do not know where to locate this information or know how to look for it. A study considering how this information need could be answered for would be highly relevant in cities that aim to incorporate their resident's into developing their city surroundings and increase their local environment conditions and resident's well-being.

7 Conclusion

The goal of this thesis was to study resilient urban housing business ecosystems in Finnish case cities of Turku and Helsinki and the role and use of nature-based solutions in these business ecosystems and urban environments. The thesis set out to study how experts within this business ecosystem perceive the possibilities NBS have for increasing cities' resilience and how they see the future of these solutions as part of building industry. The thesis was conducted around 11 expert interviews and 4 focus group discussions, which were analysed with reflexive thematic analysis method. Grounded on the analysis a structured description was produced based on the research questions with categorizing and themes.

This thesis discovered that there are several barriers in the way of mainstreaming nature-based solutions in urban environment and in use in residential construction regime. However, the actors in related business ecosystem value and realize the benefits nature-based solutions bring for the local people, buildings' residents, for a singular building or block as well as for the entire urban environment. There is a shared consensus that nature-based solutions are the key for urban resilience, and they are seen as inherently part of the future of urban planning and construction in cities.

However, this view seems to be still not achieved in real life, even though global and national level strategies emphasize the importance of the use and application of NBS in order to increase resilience and adapting to changing environment and climate, as well as to mitigate stressors for biodiversity and urban environment. Several different scale solutions were presented to improve the use of NBS and move forward to a mainstreamed use of them to reach greener cities and more balanced relationship with the surrounding nature. NBS are viewed very important part of the cities by the actors and highly relevant for resilience in urban environments. The study represents these possibilities as stepping stones for better inclusion of NBS in urban planning and residential building and how to engage with different relevant actors and to help identify who these actors are.

To conclude, nature-based solutions are an important and necessary part of cities future to increase resilience, halt diminishing of urban biodiversity, support urban residents' well-being and connectedness to nature as well as diversify the built environment with greenery. With these thoughts, one could hope for a change in our society's values for a more sustainable urban future.

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Appendices

Appendix 1. Original frame for expert interviews (in Finnish)

Taustatiedot

1. Voitko kertoa lyhyesti kuka olet ja mitä teet edustamassasi organisaatiossa?

Teema 1. Luontopohjaiset ratkaisut asuinrakentamisessa

2. Onko luontopohjaisten ratkaisujen konsepti sinulle tuttu?
3. Miten näet luontopohjaisten ratkaisujen merkityksen osana asuinrakentamista?
4. Tunnistatko jotain ominaisuuksia, jotka vaikuttavat näkemykseen luontopohjaisten ratkaisujen käytöstä asuinrakentamisessa?
5. Millaisia esimerkkejä ja kokemuksia sinulle tulee mieleen luontopohjaisista ratkaisuista tai näihin liittyvistä toimintamalleista?

Teema 2. Vähähiilinen ja kestävä asuinrakentaminen

6. Miten vähähiilisyyden tavoitteet näkyvät asuinrakentamisessa?
7. Minkälainen rooli luontopohjaisilla ratkaisuilla on asuinrakennusten vähähiilisyyteen?
8. Tuleeko sinulle mieleen esimerkkejä ja kokemuksia vähähiilisistä ratkaisuista tai näihin liittyvistä hyvistä toimintamalleista?

Teema 3. Toimijat ja yhteistyö

9. Minkälaisia toimijoita rakennetun asuinympäristön luontopohjaisten ratkaisujen parissa toimii?
10. Miten näiden eri tahojen välinen yhteistyö toimii tällä hetkellä?
11. Kenen koet olevan avainroolissa näissä luontopohjaisia ratkaisuja käyttävissä hankkeissa?
12. Millä keinoin yritykset ja kaupungit voisivat edistää luontopohjaisiin ratkaisuihin liittyvää liiketoimintaa?

Teema 4. Kaupunkien ja asuinympäristöjen resilienssi

13. Mitä mielestäsi tarkoitetaan kaupunkien ja asuinympäristön resilienssillä?

14. Millainen rooli luontopohjaisilla ratkaisuilla on kaupunkiympäristöjen resilienssiin ja ilmastoratkaisuihin?

Teema 5. Kehitysnäkymät

15. Miten näet luontopohjaisten ratkaisujen tulevaisuuden osana asuinrakentamista?
16. Miten mielestäsi tehokkaimmin voisi vaikuttaa luontopohjaisten ratkaisujen yleistymiseen ja liittämiseen osaksi asuinrakentamisen kulttuuria?
17. Mitkä tekijät hidastavat tai toimivat esteenä ratkaisujen hyödyntämisen yleistymisessä?

Lopuksi

18. Onko vielä jotain muuta mitä haluaisit tuoda esille tai kommentoida, tai mitä haluaisit kysyä tähän tutkimukseen liittyen?

Appendix 2. Translated frame for expert interviews (in English)

Background information

1. Would you shortly tell who you are and what do you do in the organization you represent?

Theme 1. Nature-based solutions in housing construction

2. Are you familiar with the concept of nature-based solutions?
3. How do you see the importance of nature-based solutions as part of housing construction?
4. Do you recognize certain characteristics or qualities which affect the perception of using nature-based solutions in housing construction?
5. What kind of examples or experiences do you have about nature-based solutions or operations models related to use of nature-based solutions?

Theme 2. Low-carbon and sustainable housing construction

6. How are the low-carbon goals visible in housing construction?
7. What is the role of nature-based solutions for low-carbon housing construction?
8. What kind of examples or experiences do you have about low-carbon solutions or low-carbon operations models?

Theme 3. Actors and cooperation

9. What actors can be identified working with nature-based solutions in built residential environments?
10. How the cooperation between different actors is currently working?
11. Who do you see to be in a key role in construction projects using nature-based solutions?
12. How could companies and cities promote business around nature-based solutions?

Theme 4. Resilience of cities and residential environments

13. What do you think the resilience of cities and of residential environments means?
14. What role does nature-based solutions have for urban environment resilience and for climate solutions?

Theme 5. Prospects

15. Do you see nature-based solutions to be a part of the housing construction industry in the future?
16. What measures or actions would have an effective impact on mainstreaming nature-based solutions and adopting them to the housing construction culture?
17. What factors slow down or even act as a barrier for mainstreamed use of nature-based solutions?

Finally

18. Is there something else that you would like to bring up or comment on, or know more about the research project?

Appendix 3. Original questions for the first workshop (in Finnish)

Työpaja 1: Luontopohjaiset ratkaisut osana kestävää rakennettua ympäristöä

Ryhmäkeskustelu – osa 1: Nature-based solutions eli luontopohjaiset ratkaisut rakentamisessa/asumisessa

1. Mikä on luontopohjaisten ratkaisujen merkitys asuinrakentamisessa? Mihin tarkoitukseen niitä tuotetaan? Kenelle ne tuottavat hyötyjä?
2. Mitä tarkoitetaan asuinympäristön resilienssillä? Mihin riskeihin ja resilienssi-uhkiin nämä luontopohjaiset ratkaisut voisivat olla vastauksia tai omalta osaltaan avuksi? Mitä esimerkkejä voidaan alueelta nostaa?

Ryhmäkeskustelu – osa 2: Toimijat ja yhteistyö

3. Minkälaisia toimijoita rakennetun asuinympäristön luontopohjaisten ratkaisujen parissa tunnetaan toimivan (esim. kunnat, tuottajat, kuluttajat ja muut edistäjätahot)?
4. Miten toimijoiden välinen yhteistyö toimii tällä hetkellä?
5. Olisiko tarpeita saattaa (esim. uudenlaisiakin) toimijoita yhteen ja millä keinoin?
6. Millä keinoin kaupungit ja yritykset voisivat yhdessä edistää luontopohjaisiin ratkaisuihin liittyvää liiketoimintaa?

Ryhmäkeskustelu – osa 3: Tulevaisuus ja kaupunki

7. Minkälainen olisi toivottava ja kenties kunnianhimoinen tulevaisuuden visio luontopohjaisten ratkaisujen osalta Turussa 2050? (Jokainen miettii yhden visiolauseen aihepiiristä, toivottava tulevaisuus kaupungille teidän organisaationne näkökulmasta.)
8. Mitä askeleita on pitänyt ottaa, että pidemmän aikavälin tulevaisuuden visioon 2050 luontopohjaisten ratkaisujen on päästy? (Katsoen tulevaisuudesta taaksepäin: mitä pitää olla pitkällä aikavälillä (2040-2050), mitä keskipitkällä aikavälillä (2027-2040) ja lyhyellä aikavälillä (2023-2027)?) Elementtejä esimerkiksi:
    a. Talous: innovaatiot, markkinointi, paikalliset markkinat – vienti
    b. Ympäristö: Odotettavissa olevat mahdollisuudet ja riskit
    c. Kaupunki ja sen sidosryhmät, verkostot
    d. Kaupungin ohjauskeinot, kaupunkiympäristön kehittäminen

Appendix 4. Translated questions for the first workshop (in English)

Workshop 1: Nature-based solutions as a part of sustainable built environment

Group discussion – part 1: Nature-based solutions in construction and housing

1. What is the meaning/relevance/importance of nature-based solutions in residential construction? What purpose they are designed for? For whom they are of benefit?
2. What is meant by resilience of residential environment? What kind of risks and threats against resilience these nature-based solutions could be answers for? What examples could arise from the area?

Group discussion – part 2: Actors and cooperation

3. What kind of actors are known to operate with nature-based solutions in residential environments (e.g., municipalities, producers, consumers, and other advocates)?
4. How the cooperation between actors is working at the moment?
5. Is there a need to bring (e.g., novel) actors together and if so, how?
6. How could cities and businesses together foster nature-based solution business?

Group discussion – part 3: Future and the city

7. What would a desirable and perhaps ambitious future vision of nature-based solutions be like in Turku in 2050? (Everyone thinks one subject related vision statement, that represents a desirable future for the city from your organization's point of view.)
8. What steps have had to be taken to achieve the vision of the year 2050 with nature-based solutions? (Backcasting: what must be done in the long run (years 2040-2050), in medium-term (2027-2040) and in short-term planning (2023-2027)?) Elements could be for example:
    a. Economy: Innovation, marketing, local market – export
    b. Environment: Expected opportunities and risks
    c. City and its stakeholders, networks
    d. Policy instruments of the city, urban environment development

Appendix 5. Original questions for the second workshop (in Finnish)

Työpaja 2: Kestävällä aluesuunnittelulla resilienttiä rakennettua ympäristöä

Ryhmäkeskustelu – osa 1: Kaupunkiympäristön resilienssi – määritelmä ja rajaus

1. Kuinka määrittelet kaupunkiympäristön resilienssin?
2. Miltä ilmastonmuutokseen liittyviltä riskeiltä tulisi Helsingissä rakennetussa ympäristössä suojautua? Mitkä ovat todennäköisimpiä ja kasvavia riskejä? Mitkä sään ääri-ilmiöistä uhkaavat resilienssiä Helsingissä?
3. Miten luonnon monimuotoisuus ja kaupunkiympäristön resilienssi liittyvät toisiinsa?
4. Miten rakennettua ympäristöä koskeva aluesuunnittelu voi edistää tätä kaupunkiympäristön resilienssiä?

Ryhmäkeskustelu – osa 2: Toimijat ja yhteistyö

5. Mitkä toimijat vaikuttavat aluesuunnittelussa rakennetun ympäristön resilienssin parantamiseen (esim. kunnat, tuottajat, kuluttajat, muut edistäjät)?
6. Miten yhteistyö toimii tällä hetkellä, olisiko tarpeita saattaa (esim. uudenlaisiakin) toimijoita yhteen ja millä keinoin?
7. Millä keinoin kaupungit ja yritykset voisivat yhdessä edistää rakennetun ympäristön resilienssin parantamiseen liittyvää liiketoimintaa?

Ryhmäkeskustelu – osa 3: Tulevaisuus ja kaupunki

8. Minkälainen olisi toivottava ja kenties kunnianhimoinen tulevaisuuden visio resilientistä kaupunkiympäristöstä Helsingissä 2050? (Jokainen miettii yhden visiolauseen aihepiiristä, toivottava tulevaisuus kaupungille teidän organisaationne näkökulmasta.)
9. Mitä askeleita on pitänyt ottaa, että tulevaisuuden visioon 2050 on päästy? (Katsoen tulevaisuudesta taaksepäin: mitä pitää olla pitkällä aikavälillä (2040-2050), mitä keskipitkällä aikavälillä (2027-2040) ja lyhyellä aikavälillä (2023-2027)?)

Appendix 6. Translated questions for the second workshop (in English)

Workshop 2: Resilient built environment by sustainable regional planning

Group discussion – part 1: Definition of urban environment resilience

1. How would you define resilience of urban environment?
2. What climate change related risks should the built environment be guarded against in Helsinki? What are probable and increasing risks? What extreme weather events threaten the resilience in Helsinki?
3. How biodiversity and urban environment resilience are connected?
4. How regional planning of built environment can foster urban resilience?

Group discussion – part 2: Actors and cooperation

5. Which actors affect the resilience of the built environment in regional planning (e.g., municipalities, producers, consumers, and other advocates)?
6. How does the cooperation currently work, is there a need to bring (e.g., novel) actors together and if so, how?
7. How could cities and businesses together promote business improving built environment resilience?

Group discussion – part 3: Future and the city

8. What would a desirable and perhaps ambitious future vision of resilient urban environment be like in Helsinki in 2050? (Everyone thinks one subject related vision statement, that represents a desirable future for the city from your organization's point of view.)
9. What steps have had to be taken to achieve the vision of the year 2050? (Back casting view: what must be done in the long run (years 2040-2050), in medium-term (2027-2040) and in short-term planning (2023-2027)?)

Appendix 7. Barriers for use and mainstreaming of NBS in urban environment included with descriptions

Main theme	Sub-theme	Description
Economic barriers	Under appreciation of benefits	Prioritizing monetary valuation of benefits
		Not valuing non-monetary 'soft' benefits
	Insufficient public resources and budget constraints	Strict budgets with no room for additions
		Lack of resources in many organizations' parts
		Lack of resources for maintenance of NBS
	Short-term vision	Focusing on the lowest cost in construction phase (additional costs for NBS could produce multiple benefits on long-term scale)
		Aiming for maximized direct profit
	City's size and markets - regional mismatch between supply and demand	City's attractiveness for investments
		Plot location within a city
	Procurement procedures in city administration	City's framework agreements can be restricting
		City's procurement and tendering practices
	Future resident's capability and willingness to pay higher apartment prices	
Governance and institutional barriers	Intensive urban development	Competition over urban space and land
		Inevitable loss of green/natural areas due to urbanization and growing city
		Goal to maximize permitted building volume leaves no room for NBS on often already small plots
		NBS difficult to implement in dense urban environments where building stock takes up majority of surface area
	Complexity of city governance structures and urban administration challenges	Conflict of interests and values within the urban administration - preserving green areas vs. high yearly growth target
		Pressure to streamline zoning and construction processes and to discard 'extra' things (like NBS)
		Urban design ideology of productivity affects design solution and what city looks like
		Sectoral silos
	Conservative construction industry and business-as-usual practices	(Un)necessary building of grey infrastructure
		Grey infrastructure seen as an easier, simpler solution
		Whole construction system is built to support BAU practices, making change slow

		Path dependence in construction industry
	Fragmented, linear process and silo mentality	Different teams look at the plans separately
		Detachment from other teams, which leads to lack of knowledge sharing and limited possibility to improve plans
		Omissions of information for different actors during different phases of a project
Knowledge barriers	Lack of knowledge and sharing of information	Lack of information for housing cooperatives about retrofitting with NBS
		Contractors (in)ability to suggest using NBS
		Land or property owners (in)ability to demand the contractor NBS and NB-features beforehand
		Unfamiliarity with the concept can create uncertainties and misconceptions
	Knowledge on maintenance, and NBS functionality and performance uncertainties	Lack of maintenance all together
		Incorrect maintenance level due to uncertainties on NBS maintenance need
		Incorrect maintenance practices
		Unclear responsibilities
		Residents and local people give negative feedback when NBS left unmaintained and becoming untidy - feeling of not caring about the people
	Lack of indicators and data	Valuing measurable, quantitative information
		E.g., lack of indicators to investigate the changes and state of biodiversity in urban environment
	Fear of failure	Caution with implementing NBS and wanting to avert risks
	Inability to ‘think for the future'	Uncertainties regarding future changes and need for adaption
Valuation barrier	Lack of valuation, ambition and will	Lack of political will and political weakness
		NBS valued as a nice-to-have, 'extra' thing in urban development or in construction design
		Appreciation of monetary values over 'soft' non-monetary values and (possibly non-visible) benefits
		Apprehensive attitudes towards NBS and will for green/sustainable changes
	Lack of effort and resistance or reluctance to change	Reluctance to 'think outside the box' and put effort in applying new solutions (NBS) instead continue with BAU methods
		Sticking with known and prior used techniques
		NBS not valued as worthwhile
Technical and infrastructure related barriers	Unrealistic or faulty solutions	Unrealistic (e.g., too extravagant, or otherwise unfitting) NB-solutions hard or impossible to maintain properly

		Seasonal durability uncertainties Faulty implementation of NBS
	Retrofitting related uncertainties when integrating NBS to existing structures	Structural durability of the building Restricting structures (e.g., parking solutions, or angle of the roof)
	Safety measures may limit use of NBS	E.g., fire safety measures
	Lack of nature-based design in construction	E.g., no opportunity for cross-ventilation in apartments
	Parking solutions can restrict possibilities	E.g., big trees can't be planted on yard decks
	Availability of the NB-solutions	
Fragmented business ecosystem as a barrier	Lack of frontrunner businesses	Absence of pioneer businesses with ambitious primary goals of climate resilience and sustainable green solutions Lack of businesses offering NBSs or whole service package (NBS+maintenance)
	Lack of interest and valuation of green businesses	

Appendix 8. Multitude of benefits and synergies from nature-based solutions included with descriptions

Main theme	Sub-theme	Description
Economic benefits	Opportunities for existing and completely new businesses	
	Increased property value	
	Reduces buildings' emissions and increases energy efficiency	E.g., green roof acts as an extra insulation layer during winter and cools down the building during summer
	NBS decrease the amount of built (often underground) technology, i.e., grey infrastructure	
	NBS offset future risks and repair costs	Preparing houses for future climate conditions E.g., green roofs act as a buffer zone which elongates the lifespan of roof surface material
	Decrease in long-term costs	NBS changes the need for maintenance e.g., no need to move the lawns so often
	Way to mobilize public and private investment	Use of sustainable solutions in construction projects often a prerequisite for international investors
	A competition benefit for businesses	
Societal benefits	Increased citizen's health, well-being, and welfare	Positive impact on quality of life and happiness
	Attractive and pleasant living environments	Increased aesthetic value and quality of surroundings
	Community spirit	
	Connectedness to nature	
	Improved living conditions in buildings	
	Improved city image and desirability for visitors and both current and new residents	
	Increased urban resilience for climate change	
Support, restoration and provision of ecosystem services and biodiversity benefits	Climate change mitigation	Carbon sequestration and storage in urban areas
	Heat island effect mitigation	Provide shade Cool down local temperatures
	Decrease noise pollution	

	Hydrological benefits	Increased water security and water storage Using rainwater on site for irrigation
	Decrease air pollution and improve air quality	
	Support city biodiversity and ecosystems	Local compensation of urban land use change More diverse plant community and use of local or domestic species Increase ecological resilience and halt deteriorating quality of urban environment Increase in urban greenery and green spaces

Appendix 9. Solutions to remove barriers and increase use of NBS included with descriptions

Main theme	Sub-theme	Description
Economic aspects and instruments	Economic incentives and subsidies	E.g., EU taxonomy and green funding Certification schemes to increase use of NBS and amount of urban greenery
	Securing sufficient resources and budget	
	Cost-benefit and life-cycle impact calculations with adequate time frame	
	New business models and opportunities for innovations	Selling the concept (e.g., Copenhagen as a concept) Provide a package deal – one company offering the application (NBS) and its maintenance Green finance in big role in the future Growing demand for responsibility as a motivation
Policy instruments	Land use planning tools to increase urban greenery and resilience	E.g., local master and detailed plans, planning regulation and building ordinance Green and green-blue factor Green efficiency targets
	Regulations and legislations	Political decisions have leverage to increase use of NBS International, national and city level regulation and legislation to oblige use and implementation of NBS Integrating goals into city's legislation and regulation to set the minimum level for use of NBS and increase greenery Guidelines, policies, and strategic policy goals as driver for change (e.g., Carbon neutral Helsinki by 2030, green roof policies)
	Participatory methods in urban development	Partnership zoning Plot handover criteria and competitions Alliance projects Participatory budgeting for residents
Reimagining existing structures, spaces, and practices	Rethinking prevailing maintenance practices and resources	NBS and plant species chosen based on the availability of resources and maintenance ability Upgrading and redefining maintenance practices to meet the need of used NBS for benefits to be carried out
	Retrofitting with NBS	Implementing NBS in renovation sites and buildings

	Awareness of future risks: climate change and biodiversity decline	Applying climate change adaption methods in residential construction projects Taking biodiversity loss into account Compensation on local areas
	Location-based design	Including NBS into building practices and guidelines and in a way which supports location based (NB)solutions instead of BAU
	Examples and inspiration from abroad	Seek examples from abroad how to conduct climate wise urban planning Sharing knowledge
	Upgraded urban design and city planning practices	Reversed planning principles Emphasis on landscape architecture
	Education to react to new needs of expertise and know-how	Education for citizens Education to react new needs of expertise and know-how Need for more knowledge on NBS
Multidisciplinary and collaborative business ecosystem	Increased multidisciplinary co-operation throughout the whole business ecosystem	Common and shared understanding of the importance of cross-sectorial collaboration between actors over organizational regimes Enabling collaborative development to innovate and test feasibility of various NBS Inclusion of whole construction chain Especially technical NBS demand collaboration in planning, implementation, and maintenance phases of every actor
	Overcome internal organization silos	Achieving to overcome city administration's institutional silos and strengthen inner collaboration models
	Applying tools and methods to bring actors together	Live workshops - discussions, getting to know the network, sharing of ideas and knowledge Utilize tools and practices that have made collaboration easier and increased mutual understanding (e.g., green factor)
Knowledge, information, and real-life examples on NBS to increase awareness and mainstream use	Sharing information, knowledge, know-how and experiences with all relevant stakeholders	Availability of open data Important that regulating actors have willingness, know-how, competence, and expertise Getting used to NBS and adapting aesthetic values
	Changing doubting or negative perceptions to positive ones	NBS are not just an extra cost or ‘humbug’ Value of ‘softer’ non-monetary benefits Will to create resilient environments, use and develop NBS Businesses willingness and potential to provide better solutions for construction, to innovate and try new

		Highlighting benefits
	Increasing awareness throughout the whole business ecosystem	Communication and dialogue
		Cross-sectorial information sharing - 'left hand needs to know what the right one is doing'
		Information flow through the whole organization in question
		Sharing information in and outside organization for all stakeholders/actors
		Increasing awareness throughout the BE
		Familiarity with the concept
		More information and examples and ability to wish and demand for the use of NBS
Experimenting and going beyond it	Opportunities for testbeds, pilot projects and willingness to experiment	Enabling a platform for pilot projects to test out different solutions and help mainstreaming NBS
		Pilot projects lay down the track to the right direction of construction industry development
		Demonstrations how to increase greenery on existing buildings and areas
		Positive real-life experiences to increase awareness of and support for NBS
		Willingness to experiment
	Monitoring and follow-ups including sharing of post-project experiences	Taking the next step from pilot projects for wider use of NBS
		From errors or successful implementation of NBS to knowledge accumulation
		Scaling up from a single solution to a repeatable model and to a new construction norm
Long-range project planning and goal setting	Ambitious, clear, and unbending shared goals	Clear goals to avoid misconceptions or oversights in project
		Shared goal within the network
		Sticking to set threshold values for the level of NBS use
	Applying NBS as the premise of the project	Thorough planning that focuses on resilience values right from the beginning and throughout the rest of the project
		Easier to have NBS on new buildings where they are implemented right in the beginning of the plan
		Possibility to ‘think outside of the box’
		Identification of target level for the NBS - What is wanted or expected from certain NBS?
	Competence and know-how in planning phase	Importance of competence and know-how in especially in planning phase
		Understand site preconditions site to use right and correctly sized NBS
		What works in given context (e.g., biophysical conditions and consumption levels)?
		To avoid omitting or faulty implementation of NBS

Appendix 10. The desirable and expected future for cities included with descriptions

Main theme	Sub-theme	Description
Human scale city by holistic approach to urban design	Planning city for the good of the citizens	Cities have to remain to be functional, safe and healthy even in the face of climate change
		More pleasant and attractive public places have social importance
		Giving voice for the future residents of the building and the city
		Human actions (e.g., living, working, and going to nature) become more intertwined in space
	Being aware of NBS related societal risks	E.g., gentrification and increase in apartment prices
	Posthumanist urban environments and posthuman urban design	Planetary thinking – bottom line to work symbiotically with the environment
	Multispecies and more-than-human thinking	Taking other species into account in creating and developing urban environments
		Living together with other species
		Integrating habitats into built environment
Systemic change in society's values and going towards sustainable urban societies	Valuation of non-monetary benefits of NBS	Recognizing monetary and non-monetary values
		Valuing environment and nature positive outlook
		Realizing the need for and importance of ecosystem services NBS provide
		Intrinsic value of nature
	Regime shift - from business-as-usual practices to sustainable and location-based NBS	Systemic change of construction industry and the society
		Cultural change and common will to increase use of NBS
		Positive change in values visible – NBS becoming more common, and their importance will only increase
		Development for wide use of NBS and realize need for adaption slow
	“NBS are part of the cities’ future”	NBS are the future method/solution - will be inherently part of urban design, construction and living
		NBS have immerse potential and relevance in construction business
		NBS are needed and necessary
	New building practices using multiple materials (e.g., wood-based construction, combining wood and concrete) and retrofitting create opportunities for NBS	Retrofitting with NBS can increase climate resilience
		Hybrid building

Greener city	Increasing urban greenery on block and plot scale evenly in the cityscape	Shared yards and shared NBS = no plot restrictions E.g., green block, forest yard Conscious increasing of urban greenery in construction projects and new urban area design Planning new residential area to try out and develop use of NBS on bigger scale Valuing unbuilt (green) areas and preserving existing urban greenery and green networks
	Fading out artificial boundaries between built and natural environment	Soft edges - Plot is part of surrounding nature and nature reaches out and is present on plot Bringing nature into residential environment One entity - building is part of natural processes
	Integrating nature into the building and built environment with NBS	Multifunctioning areas/elements and multiuse of sustainable solutions (e.g., urban agriculture, green roofs and solar panels on the same roof, pervious green parking plots)
	Thinking beyond city borders	Better regional cooperation with neighbouring cities
	Re-evaluation of the city structure to be able to adapt to future changes creates more demand for NBS	Accelerating climate change creates more demand for NBS Adapting to climate change means the need to increase greenery in urban environments
Controversy between NBS quality and NBS quantity	Quality overcomes quantity	Proper, place-based design and right implementation and maintenance result into functioning solutions and provision of multiple benefits
	"Mighty oaks from little acorns grow"	Multiple small scale, good quality NBS multiply into widespread benefits
	Quantity overcomes quality	Due to urban densification all green is needed wherever possible