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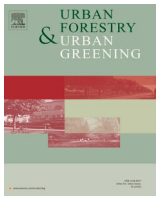

Original article

Developing business ecosystems around urban nature-based solutions: Evidence from Finland

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ABSTRACT

This study addresses knowledge gaps regarding key actors, benefits, barriers and solutions for mainstreaming nature-based solutions (NBS) within urban business ecosystems in the Nordic context. By investigating two member cities of the EU Mission on Climate-Neutral and Smart Cities, considered frontrunners in sustainable urban development, the study shows frontier examples of areas with high potential for mainstreaming NBS. Empirical evidence is obtained from 21 experts engaged in interviews or focus-group discussions held in 2023. The key actors were found to be, first and foremost, the two cities, which may play multiple roles in the local business ecosystem. Seven main themes were found regarding the solutions for increasing use and reach in the mainstream use of NBS in urban environments, namely economic aspects and instruments; policy instruments; reimagining existing structures, spaces and practices; multi-actor and -sectoral and collaborative business ecosystems; new knowledge, information and real-life examples of NBS to increase awareness and mainstream use; experimentation and going beyond mainstreaming; and long-range project planning and goal setting. Finally, NBS mainstreaming either succeeds or fails according to the actions and interactions of the business ecosystem actors, and fostering business development around NBS is at the core of this success/failure. Thus, we conclude a thriving city–business interphase to be crucial for reaching this outcome.

1. Introduction

In response to the European Union Nature Restoration Law (European Parliament, Council of the European Union, 2024) and its Article 8, each Member State should establish at least 45% overall green coverage and 10% tree canopy cover in urban areas by 2030. In the upcoming decades, these levels should be improved further to meet the EU's 2050 biodiversity commitments. To meet the challenge and to nudge systemic sustainability change, innovations facilitating climate- and biodiversity-positive operations in business and public sectors are needed. In practice, such innovations may concern, for example, the adoption of new products and technologies within business organisations but also new statutory mechanisms developed in political processes to consider climate and biodiversity impacts in various sectors (Moore and Hartley, 2008; Singh and Aggarwal, 2022; Zhou et al., 2026).

At the regional level, the European Commission Green Deal (European Commission, 2019) comprises a set of statutory (e.g., directives) and voluntary (e.g., funding schemes, reporting systems) mechanisms developed to nudge climate and biodiversity actions within businesses and other sectors. In the local context, cities and municipalities may use both statutory and voluntary approaches to support, for example, capability building and the development of new sustainability innovations to enhance the balance between natural ecosystems and the built environment (Koskivaara and Lähtinen, 2023).

Rapid urbanisation degrades natural areas, expands impervious surfaces and drives densification, thereby accelerating biodiversity loss (Haaland and van den Bosch, 2015). Climate-related extremes—floods, droughts, heatwaves and the urban heat-island effect—exert additional pressure on the built environment and its residents (Seddon et al., 2020). As city populations grow, urban areas must become more resilient if they are to remain habitable (Kabisch et al., 2016; Castaño-Rosa et al., 2022). Protecting natural capital and valuing ecosystem services are therefore pivotal for achieving urban sustainability goals (Raymond et al., 2017).

Nature-based solutions (hereafter NBS) are promoted as an approach that can address multiple environmental challenges simultaneously (Dorst et al., 2022; Adams et al., 2023), including both climate change mitigation and adaptation (Davies and Lafortezza, 2019). Through

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ecosystem protection and restoration, they promote planetary well-being (Seddon et al., 2021). According to Pedersen Zari et al. (2022), NBS consist of biodiverse vegetated urban habitats, whether they are connected to green (living vegetation and soil), blue (water systems) or hybrid (integrated grey and green) urban infrastructures, or building-integrated vegetation (e.g., green roofs and walls). Hence, they are based on ecological flows that are both supported by nature and contribute to biodiversity especially important in cities. With increasing urban densification, there is urgency in finding solutions that enhance the sustainability of not only natural environments but also in connection with buildings (Kandel and Frantzeskaki, 2024).

By 'bringing more, and more diverse, nature and natural processes into cities through locally adapted, resource-efficient and systemic interventions' (European Commission: Directorate General for Research and Innovation, 2021), NBS offer concurrent environmental, social and economic benefits and strengthen urban resilience (Tozer et al., 2023). They can also reconcile human activity with ecosystem functioning (Scott et al., 2016). However, mainstreaming NBS in cities demands coordinated action across public and private sectors (Bona et al., 2023). Nordic master and regional plans now stress multifunctional green spaces (Di Marino et al., 2024), while newer planning tools—such as green and blue-green factor requirements—target climate resilience more explicitly (Juhola, 2018).

By delivering multiple ecosystem services, NBS have the potential to offer a practical route toward more sustainable urbanisation (Eggermont et al., 2015; McPhearson et al., 2022). They can also enhance food security, safeguard water resources and reduce disaster risk. Yet NBS planning faces obstacles stemming from limited stakeholder awareness and uncertainty over the effectiveness of various applications (Kabisch et al., 2016, 2022). Much of the literature recommends participatory co-design, co-creation and co-management to allow interventions to satisfy a broad spectrum of interests. Although NBS are often described as cost-effective, their uptake in mainstream urban forestry and planning remains modest, and the roles of various stakeholders—along with viable business models—are still poorly mapped (Konietzko et al., 2023; Megyesi et al., 2024; Roitsch et al., 2024). Because urban NBS are largely financed by the public sector, attracting private investment could substantially scale up implementation (Calliari et al., 2022).

The literature is also ambiguous about how NBS are viewed within construction and urban planning circles and what levers might normalise their use. According to Kooijman et al. (2021), nature-based enterprises in the urban context contribute to a diverse range of sustainability-oriented economic activities, but standard industry classification systems poorly capture the range of these activities. In addition, the phenomenon of NBS is extremely place based and context specific, and solutions need to be implemented exactly where the challenges to resilient urban development occur. It is thus essential to examine, using local-level case study approaches, how key actor groups assess the feasibility, implementation and potential of NBS in their own contexts. To date, the business ecosystem concept has been applied to NBS chiefly from an innovation ecosystem angle (van der Jagt et al., 2020; Viljanen et al., 2025), from a construction sector standpoint (Pulkka et al., 2016; Vigren, 2024) or within the niche of residential wood construction (Viholainen et al., 2021; Viljanen et al., 2024). Van der Jagt et al. (2020) extended the view of business ecosystems to a nature-based innovation system, encompassing the institutions, networks and actors that initiate, advance and diffuse NBS. In Finland, only a rudimentary public–private interface has been identified for NBS, and a shared vision is still forming (Viljanen et al., 2025). Hence, the objective of this paper is to bridge the gap in terms of understanding business ecosystem structure and perceived benefits, barriers and solutions for mainstreaming NBS as solutions embedded in local contexts. More specifically, we focus on three research questions (RQs):

RQ1: What is the structure of the analysed NBS business ecosystems and who are the key actors involved?

RQ2: What benefits and barriers do local business ecosystem actors recognise for mainstreaming NBS in urban environments?

RQ3: How do actor relationships within the business ecosystems influence solutions that would enable mainstreaming NBS?

Empirical evidence is drawn from interview and workshop data from two Northern European cities that are actively engaging in greening their urban spaces and are members of the EU Mission on Climate-Neutral and Smart Cities. Section 2 briefly introduces the conceptual background, followed by Section 3 concerning the study context, data and empirical approach, and Section 4 on the results, ending with Section 5 for the discussion and Section 6 for conclusions.

2. Conceptual framework: Nature-based solutions and business ecosystems

2.1. NBS in urban ecosystems

Urban resilience must be considered holistically, to reflect the complexity and dynamism of city systems (Dianat et al., 2022). Improved understanding is needed on how NBS can be integrated into the building stock due to their strong potential to contribute to, for example, climate change mitigation and biodiversity conservation in cities (Kandel and Frantzeskaki, 2024). In the built environment, NBS operate on three tiers (Bona et al., 2023): *green building materials* (i.e., renewable raw materials such as wood), *green building systems* (i.e., integrating living components such as green roofs, living walls and facade plantings into building structures) and *green building and urban surroundings* (i.e., land areas adjoining buildings performing blue-green functions and emphasising open, water-sensitive urban design).

Regarding *green building materials*, wood use provides the most promising opportunity for decarbonising cities (Marinova et al., 2020) due to its ability to act as carbon storage and enable the substitution of more carbon-intensive materials (Bejtullahu and Morishita-Steffen, 2021; Bjånesøy et al., 2023). Compared with wood, *green building systems* are based on the use of growing plants, which provide natural solutions for cooling, insulation and air purification in buildings (Su et al., 2024; Wang et al., 2024). Additionally, in connection with green building systems (Well and Ludwig, 2020) but also in their *urban surroundings* (e.g., lots and parks), solutions, such as bio-retention swales, permeable pavements, rainwater harvesting tanks and detention ponds, provide NBS that efficiently mitigate the hydrological impacts of both new and existing urban developments (Versini et al., 2018; Hamel and Tan, 2022).

2.2. Barriers in NBS mainstreaming

Mainstreaming NBS demands coordinated action among stakeholders whose priorities may diverge or even conflict (Seddon et al., 2020). Previous studies list numerous barriers for the diffusion of NBS: misalignment between short-term projects and long-term strategies, sectoral silos (Kabisch et al., 2016), limited policy support and collaborative governance (van der Jagt et al., 2023), climatic constraints, knowledge gaps (Dorst et al., 2022) and financing obstacles (Toxopeus and Polzin, 2021). In addition, from the actor perspective, NBS diffusion to provide scalable solutions for societal challenges requires the involvement of diverse stakeholders, including the private sector (Kooijman et al., 2021). However, previous studies reveal limited NBS-specific expertise in cities and lack of clarity in terms of contractor and consultant roles, as well as in operations and maintenance (Aguilera-Rodríguez et al., 2025). According to Megyesi et al. (2024), using stakeholder interview data from six European cities, NBS development may strongly foster cooperation among actors, and, in general, municipalities were found to play a pivotal role. However, a lack of awareness and knowledge among stakeholders was concurrently found to hinder NBS implementation, calling for more intra-community co-operation.

Due to land use monopolies over their territories, Finnish cities have

strong power to enhance sustainable construction and NBS adoption in local contexts by employing informal approaches (e.g., agendas and strategies) and statutory mechanisms (e.g., land use planning, building control, procurement) (Lähtinen et al., 2024). Through their connections with other actors, such as business actors, customers, national regulators, financiers and educators, cities also have strong potential to promote the adoption of construction sector innovations (Koskivaara and Lähtinen, 2023; Viljanen et al., 2025). Consistent with Raymond et al. (2017), we argue that city officials hold a pivotal leadership role in aligning NBS with broader urban planning and climate adaptation agendas.

2.3. Business ecosystem theory

A business ecosystem (originally from Moore, 2006) is chosen in our study as the conceptual lens that is most well-suited for making comparisons with other alternatives (e.g., the innovation ecosystem or multi-level perspective), as it is an entity that connects economic value co-creation through complementary resources from network participants. Although the multi-level perspective by Geels (2002) has established itself as the main theory in systems transitions, it has recognised limitations in capturing value co-creation mechanisms (Hörisch, 2015), which, however, are at the core of this study. Value creation in a business ecosystem hinges on resource integration and collaboration among ecosystem actors who rely on shared capabilities and relationships (Nuseibah and Wolff, 2015; Weber and Hine, 2015).

There are similarities between the innovation system and business ecosystem concepts (Gomes et al., 2018), such as the strong presence of various interactions between ecosystem members, a hub firm that can efficiently orchestrate knowledge sharing and an aim to generate innovation. However, the business ecosystem concept places more emphasis on collaboration and co-evolution (Aarikka-Stenroos and Ritala, 2017) and on generating value for the customer. This co-evolutionary logic of the business ecosystem—marked by interdependence, dynamism and relative stability—also distinguishes it from traditional project networks (Aarikka-Stenroos and Ritala, 2017). In addition, when environmental (e.g., climate and biodiversity) and social (e.g., citizen participation) issues are considered in business ecosystem operations, environmental and social value for multiple stakeholders are provided abreast with economic value creation (Pigola and Fischer, 2026).

The NBS business ecosystem has a large number of potential actors, as shown in Fig. 1, and illustrates various actor categories (i.e. city, construction sector, and NBS-specific actors, a group named customers consisting of civil society (citizens, residents, home or building owners) and a range of actors in the extended ecosystem, such as regulators, financiers and other relevant bodies.

However, a lead organisation, typically acting as a champion, is needed to "foster co-learning and catalyse innovation" by orchestrating diverse members and facilitating knowledge exchange (Martiskainen and Kivimaa, 2018; De Meyer and Williamson, 2020). These initiator(s) in the business ecosystem may also be, for example, cities and municipalities promoting innovation adoption for sustainable building solutions (Viljanen et al., 2023). Hence, the business ecosystem lens reveals interdependencies between technical and social facets of urban development and thus supports system-level value creation between, for example, construction management, urban development research and city planning (Koskivaara and Lähtinen, 2023; Vigren, 2024). However, it is not conceptually clear to say which one of these actors could actually take a leading, champion role in solution acceleration, and this remains a question that empirical data can shed light on.

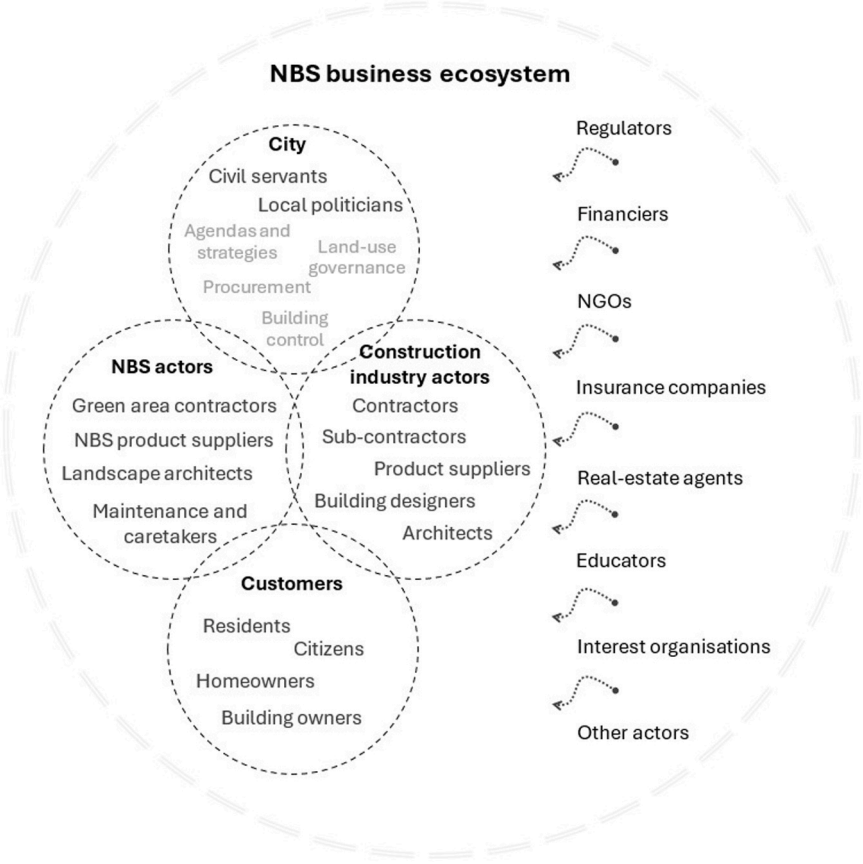

Fig. 1. Business ecosystem framework. Actors in the four circles, involved and connected to the NBS and building ecosystems, show the largest potential to act as initiators to uptake the champion role in system development.

3. Study context, data and methods

Previous research results on sustainable construction in Finland have shown that cities can be in a key role to advance the adoption and diffusion of innovations together with other actors (Koskivaara and Lähtinen, 2023). This study therefore adopts a city-centric view and examines the coastal cities of Turku and Helsinki in southern Finland. Both are major urban centres and recognised strong pioneers in Finland's national carbon-neutrality goal toward 2035. Both have been selected by the European Commission in 2022 as pilot cities aiming for net-zero emissions by 2030 (European Commission: Directorate General for Research and Innovation, 2022) and both cities already apply NBS in their urban planning and seek to scale them further. Helsinki has used a green factor tool for roughly a decade to assess vegetation quality and permeable surfaces at the plot or block level (Juhola, 2018). Turku employs a comparable blue-green factor coefficient in its planning and building regulations (City of Turku, 2022).

Turku's sustainable climate and energy plan for 2029 pledges to develop new NBS for carbon sequestration and to strengthen cooperation among key stakeholders (City of Turku, 2022). The plan also promotes NBS for water management as part of the city's wider climate-resilience goals. Helsinki, for its part, integrates climate adaptation measures into urban planning and new-build or renovation projects. The city strategy commits to expanding tree cover, adding greenery and increasing the use of features, such as green roofs, to mitigate climate change impacts (City of Helsinki, 2021). By investigating these two cities, which are members of the EU Mission on Climate-Neutral and Smart Cities and are therefore considered frontrunners in sustainable urban development, the study is able to explore how advanced urban areas leverage and mainstream NBS while pursuing ambitious carbon-neutrality targets.

This paper is based on a qualitative study with an empirical research approach. The empirical part of the study consists of data collected from two expert workshops, each including two parallel group discussions (see Table 1), and individual expert interviews. Altogether 21 experts were engaged. Prior to data collection, initial screening of city and business websites was conducted for ongoing projects, initiatives and architectural plans regarding NBS connected with these two cities. It was possible to identify suitable informants for data collection through this initial screening of Internet sources such as up-to-date news articles, blogs and reports as leads for identifying relevant experts.

Next, two separate workshops were held during August of 2023 in the cities of Helsinki and Turku, both consisting of the two parallel group discussions, which ranged in length from 64 to 72 min. This resulted in data from four group discussions in total and approximately five hours of taped conversations. The workshop participants selected were knowledgeable informants of the core topics of this study, namely representing building, environment and design (city and architectural), innovation and research, as these actors were recognised to play an instrumental role in shaping the built environment in their own localities. Thus, informants provide key input as local practitioners, which can affect NBS development in their own urban environments. The dialogue between the city and business informants in these areas was recognised to be important in the study context. The information gathered from the two large Finnish cities was considered more useful when aggregated to represent these types of urban environments in the Nordic context, and a comparison between the two locations was not targeted. Also, this would have required more longitudinal interaction with local actors, which we could not engage in at the time of data collection. As representatives of two major Finnish coastal cities, they represent the Nordic context quite well and may provide insight for other coastal cities with similar population size.

Next, semi-structured, thematic interviews were conducted where experts from various urban planning and construction industry organisations were interviewed. The interviewees were selected on the same grounds as the informants of the two workshops, with a similar type of interview guide as the workshop group discussion guide had been, to reach data saturation (see Appendix). These interviews ranged between 46 and 90 min, resulting in a total of 11 h of taped conversations. The informants of the two datasets were complementary in that they represented the planning side of both the city and business (see Table 1 in anonymised format), even if the data collection method varied (workshops with group discussions versus interviews with a single informant). Moreover, the interviewees were selected to supplement the informants of the workshop phase that took place earlier and were seen as key in reaching data saturation. Hence, both qualitative datasets, i.e. the workshop data and interviews, complemented each other, as they consisted of similar themes and similar question wording was used for all the informants.

The data were gathered in Finnish and transcribed by an external service provider for consistency. Coding was performed by the first author, who carefully read the transcribed documents line by line, making observations related to the research questions and coding them in English. The codes consisted of a word or a short phrase that helped to define specific parts of the language-based data or to state its key contents. After the number of codes grew, upper categories began forming, and gradually also the overall themes were identifiable from the data.

Table 1
Informant information, including their anonymised acronyms, professions, organisational information and data collection method. Informant acronyms in the results section can be connected to this table.

No	Informant acronym	Profession	Organisation: business field or city unit	Data collection method
1	WP−1	Sales manager	Company: Building developer	Workshop
2	WP−2	Senior specialist	City: Environmental unit	Workshop
3	WP−3	Sustainability manager	Company: Building developer	Workshop
4	WP−4	Project manager	City: Environmental unit	Workshop
5	WP−5	Architect	Company: Architecture	Workshop
6	WP−6	Project manager	City: Climate unit	Workshop
7	WP−7	Senior advisor	City: Innovation services unit	Workshop
8	WP−8	Innovation agent	City: Innovation services unit	Workshop
9	WP−9	Project manager	City: Land zoning unit	Workshop
10	WP−10	Environmental expert	Company: Building developer	Workshop
11	I−1	Chief technology officer	Company: Design engineering	Interview
12	I−2	Zoning architect	City: Land zoning unit	Interview
13	I−3	Project manager	Company: Design engineering	Interview
14	I−4	Sales director	Company: Green construction	Interview
15	I−5	Architect	Company: Architecture	Interview
16	I−6	Team manager	City: Land zoning unit	Interview
17	I−7	Architect	Company: Architecture	Interview
18	I−8	Landscape architect	Company: Landscape architecture	Interview
19	I−9	Project manager	Company: Design engineering	Interview
20	I−10	Leading responsibility expert	Company: Design engineering	Interview
21	I−11	Assistant professor	University: Architectural department	Interview

Scientific discussions among the co-authors along with an official language check, in which the direct quotes of this paper and the overall language were checked by a native English speaker, diminished any risks of meanings being lost during translation.

Rich and detailed data allowed the analysis to search for deeper meanings and significant findings and to focus on emphasised issues and topics. The categories and overall themes were validated by the co-authors through regular debriefing and scientific discussions. The two datasets were analysed simultaneously with a clear focus on the research questions of this study, and this triangulation process strengthened the analysis, adding to the reliability and validity of the data. The Appendix shows the structures of the interview guide and workshop theme discussions.

In the study, reliability and validity issues were integrated using well-established research methods, analysis tools designed for qualitative studies and analytical approaches. Triangulation using, for instance, multiple data sources and methods, various informants and multiple researchers for studying a single phenomenon was used to increase both the credibility and validity of this research (Chand, 2025). The combination of applying the focus group method in the workshops triangulated with the interview data is a well-established research method in which method triangulation allows for nuanced and multidimensional understanding to be reached regarding complex social phenomena (Chand, 2025). Informants were triangulated by including another knowledgeable informant, i.e. an assistant professor from an architectural department of one Finnish university, side-by-side with the city and business informants, and this enabled the study researchers to cross check the reliability of the results. Finally, multiple researchers conducted the study, which enabled researcher triangulation.

The collection of qualitative research data in particular requires building a trustful environment for dialogues and communication, also regarding sensitive issues (Sim and Waterfield, 2019), which may also emerge in the context of urban planning and cities' decision-making (Lähtinen et al., 2019). This also relates to data validity, as perceived confidentiality of the situational factor in data collection reduces the likelihood of social desirability bias (Nederhof, 1985) as a tendency of participants to provide responses they consider to be acceptable (Blome and Augustin, 2015). As a difference to the interviewees, workshop participants recognised each other during the discussions, and attention was paid in the group discussions to create a trustful environment (Wilkinson, 1998) to share views, opinions and knowledge. During both information collection processes, the participants were informed that all discussions would be confidential and anonymised to ensure the validity and reliability of the results.

To gain reliable results, the data, consisting of 15 transcripts, were examined using reflexive thematic analysis—an iterative, active process in which themes are developed through coding, i.e., assigning meaningful words or phrases to detect patterns. The codes along with the themes were constructed in an inductive way, and no pre-existing coding frame was used. The coding was a thorough and carefully constructed process resulting in 16 themes, 71 subthemes and 313 codes. The meaningful and important segments of the data in relation to the research questions were observed and indicated through systemic organisation of the data during the first stage of descriptive coding (Gibbs, 2018).

The themes and sub-themes reported in this study were identified through recurring patterns across the dataset and were supported by contributions from multiple participants. While the analysis did not quantify the frequency of individual themes, attention was paid to the extent to which themes recurred across the dataset. Most themes were evident across both the interviews and workshop discussions, although the depth and emphasis of the discussions varied. Major themes were identified based on their relevance to the research questions and their recurrence across interviews and workshop discussions, rather than isolated mentions by individual participants.

Descriptive codes were used in the first stages of coding, and they developed more towards categoric codes as the data analysis progressed (Gibbs, 2018). During the second cycle, the coding categorisation was developed further to search for patterns to create themes and sub-themes. Coding was performed with the CAQDAS programme ATLAS.ti, which helped manage the material and systematise the analysis by delineating those data segments that were relevant to the research questions (Schreier, 2024). A separate codebook was stored as an Excel file and shared among the code authors. During the later stages of analysis, no new substantial themes were identified, indicating that thematic saturation had been reached.

The resulting themes capture features that the lead author deemed most significant for answering the study questions. However, during all the steps, the co-authors checked and discussed the proper coding, providing guidance, validation and advice to ensure the methodological soundness and relevant findings to be highlighted from the rich and detailed qualitative data. This thorough process of scientific discussions enabled the authors to reach a common understanding of the codes and upper themes of this study.

4. Results

4.1. Structure of local NBS ecosystems

Based on an analysis of both the interview and group discussion data, the business ecosystem around NBS consists of different actors: customers, actors in the building industry, the city itself as a large-scale and siloed organisation, and expert actors supporting NBS development. The structure and key actors of the business ecosystem applicable to the Finnish context are in alignment with Fig. 1, with the exception of not having firsthand information of a large group of customers. However, no clear champion business actor emerged within the existing NBS business ecosystem.

Furthermore, a strong interconnection between the city and the building industry was evident in the analysis, as an informant describes: *"the city plays a crucial role in how NBS is utilised, both by setting an example with its own projects and when it has the opportunity to demand more"* (Leading responsibility expert, I–10). Often the cities' procurement methods affect the construction business, and cities' land use planning and building control hold a great deal of power over urban development. However, this link holds unused potential due to the nature of development relying on individual projects rather than an underlying strategy for purposefully increasing resilience in the urban environment (Viljanen et al., 2025).

Other actors, such as the maintenance operators involved in NBS projects, are typically excluded from the development focus, as their role in most cases ends once the building lot is ready. No single actor in the business ecosystem automatically assumed the role of initiator ("champion"); instead, this role was often taken on either by an individual within an organisation or by the organisation itself, as the following quote also demonstrates: *"I definitely wanted the green factor as the starting point for the planning of that new residential area (.). I tried to spread that enthusiasm forward and wanted as well as demanded it from those in my own projects (.). I had that kind of an initiator role."* (Team manager, I–6). This shows that the lack of a clear actionable solution for the championing actor was an underlying challenge in the network structure.

4.2. Perceived benefits in mainstreaming NBS

The data showed a wide variety of benefits from mainstreaming NBS, as identified by the informants (Table 2). Even though many of these are interlinked, they are next discussed one by one.

4.2.1. Environmental benefits

From an ecological perspective, the engaged actors shared a common view of NBS as an integral element of the urban fabric and as highly

Table 2
Perceived benefits in mainstreaming NBS in the urban context.

Main theme	Sub-themes
Environmental benefits	Climate change mitigation
	Heat island effect mitigation
	Decreased noise pollution
	Hydrological benefits
	Decreased air pollution and improved air quality
	Support city biodiversity and ecosystems
Economic benefits	Opportunities for existing and new business
	Increased property value
	Reduced buildings' emissions and increased energy efficiency
	NBS decrease the amount of built technology, i.e. grey infrastructure
	NBS offset future risks and repair costs
	Decrease in long-term costs
	Way to mobilise public and private investment
	A competition benefit for businesses
Social benefits	Increased citizen 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

relevant for strengthening resilience to climate change and associated extreme weather events such as heatwaves and flooding. Moreover, NBS benefits are linked to offsetting the negative impacts of construction on urban biodiversity: "*On the one hand, we [build] (.) and we lose things, [like] (.) trees, and then [the pressure] is even stronger. Not only is there stronger pressure for not building in nature areas, but there is also a pressure [for] compensating measures (.). In my experience, that is quite a new way of thinking (.) and these can be influenced with nature-based solutions*" (Zoning architect, I−02). The inherent environmental benefits of NBS were found to include the urban biodiversity enhancement and the support of ecosystem service delivery, as one city representative reflects: *" For example, the canopy cover in the city centre grid plan area is only about 7%, and even small-scale greenery is therefore essential for both biodiversity and people, [contributing to] all these health and biodiversity benefits, for the microclimate and everything. It is quite essential, of course, that these new types of solutions are especially brought into urban environments."* (Senior specialist, WP−2).

Thus, with NBS mainstreaming there is a possibility to increase urban greenery and green spaces along with promoting ecological resilience. As one aspect to this, the thoughtful use of domestic plant species in NBS application is seen as beneficial for supporting local biodiversity.

4.2.2. Economic benefits

Experts described multiple economic benefits arising from NBS. In addition to increasing resilience of the built environment against extreme weather events and the heat island effect, NBS can decrease long-term costs, e.g., by offsetting future repair needs or by enhancing energy efficiency with passive solutions, i.e., creating a cooling effect and diminishing heating costs: *"But then there's also the fact that we know green roofs, for example, can act as insulation. These nature-based solutions can impact a 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."* (Assistant professor, I−11).

In addition to public benefits, NBS offers opportunities for existing businesses. NBS can be a competition benefit or a way to enlarge services to reach out new market hold and completely new businesses, as the following quote demonstrates: "*But at the same time, it offers new business opportunities both on the product side and on the maintenance side. One can specialise in certain structures and their implementation and maintenance."* (Assistant professor, I−11). Hence, NBS were seen as a means of attracting investment, as the use of sustainability-driven solutions, such as NBS, is often a prerequisite for international investors.

Social benefits.

Social benefits to city residents were frequently mentioned in the data, such as added comfort through shading. NBS were considered important for creating a less windy and less polluted built environment, as some informants perceived vegetation to capture air pollutants. Moreover, informants identified perceived well-being, recreational and health-related aspects as some of the key advantages of NBS. The perceived benefits included the creation of a sense of community e.g. through communal gardens: *"The comfort will come from the streets not being so scorching hot in the summer or then, in particular, through these communal gardens that bring communality and (.) useful plants"* (Sales manager, WP−1).

In addition, NBS were seen as important in delivering multiple other social and economic co-benefits associated with housing solutions, such as building better human connectedness to nature. It was voiced that even the smallest solutions can deliver benefits for biodiversity and local climatic conditions, regardless of whether they are visible to the public, as the following quote demonstrates: "*All stakeholders benefit, but residents (.) benefit the most, both human residents and also certain animal residents (.), [when] greenery, especially trees, provide (.) shade, stormwater absorption and reductions in windiness etc.* " (Chief technology officer, I−2). Overall, perceived benefits around NBS were seen to appear at multiple scales, ranging from solutions for the buildings (e.g., green roofs and facades of specific buildings, private gardens) to solutions for neighbourhoods (e.g., local green areas supporting resident health, well-being and connectedness to nature) and the development of entire urban spaces (e.g., city structures supporting sustainable housing and transportation).

4.3. Perceived barriers in mainstreaming NBS

The barriers perceived to hinder the more widespread use of NBS were found to be multifaceted and interlinked in similar way as their benefits. The main barriers identified from the data were: economic and financial factors, governance and institutional hurdles, knowledge, the immature valuation of NBS in the housing market, technical and infrastructure constraints and fragmentation within the local NBS business ecosystem (see Table 3).

4.3.1. Economic barriers

Considering the economic barriers, while NBS can enhance overall housing quality, they often raise construction costs. *"Barriers and risks, they are money, resources and inexperience. So, as long as something is experimental building, so long is it also an economic risk to the builder, and (.) acquiring it is more difficult. [That is where] the budget explodes, and they are typically the first to be cut out"* (Team manager, I−6). Future residents' capabilities and willingness to pay higher apartment prices pose challenges for NBS application in the urban environment. Additional hindrances may rise from municipal procurement procedures that are not fully equipped with NBS and that lack sufficient public financing for developing and maintaining these new types of solutions for a greener urban environment. It was pointed out that constrained municipal budgets often leave little room for additional features such as NBS.

4.3.2. Governance and institutional barriers

Governance and institutional barriers are linked to siloed mentalities and differing objectives across units and individuals within city administration. For instance, city zoning is typically mentioned as an aspect that Finnish municipalities have considerable control over, and it has been used successfully to advance NBS according to workshops conducted in our forefront cities. However, even in these locations, the city planners have received feedback from the upper management that *"in general, zoning regulations are too precise and there are too many of them"* (Team manager, I−6) and they should be *"streamlined"* (Team

Table 3
Identified barriers for mainstreaming of NBS.

Main theme	Sub-themes
Economic barriers	Underappreciation of benefits
	Insufficient public resources and budget constraints
	Short-term vision
	City size and markets - regional mismatch between supply and demand
	Procurement procedures in city administration
	Future residents' 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 regarding maintenance, and NBS functionality and performance uncertainties
	Lack of indicators and data
	Fear of failure
	Inability to 'think for the future'
Valuation barriers	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 NBS use
	Lack of nature-based design in construction
	Parking solutions can restrict possibilities
	NBS availability
Fragmented business ecosystem as a barrier	Lack of interest and valuation of green businesses
	Lack of frontrunner businesses

manager, I−6), which can lead to different interests than NBS development and, instead, *"focusing on important things"* (Team manager, I−6) could mean diminishing certain zoning demands that have been important to NBS development. Thus, it is a hurdle inside the city organisation to combine the various interests together.

4.3.3. Knowledge-related barriers

As noted in relation to economic barriers for NBS uptake, prospective residents' abilities and willingness to pay higher apartment prices may constrain the uptake of NBS if their intangible value is not perceived to outweigh the added financial costs. This reflects on the broader undervaluation of NBS and to whether residents or contractors adopt a long-term perspective—both of which constitute clear knowledge-related barriers, as illustrated: *"Maybe economic factors are the ones that you encounter in this job. So you would also see the long-term gain and not only what you gain in this moment or what the current expense is in building."* (Architect, I−7). Moreover, knowledge of maintaining the NBS solutions seems to be lacking, as one architect points out: *"…it is not enough that you bring the solutions in the planning phase, but (.) does that knowledge and knowhow also suffice during other phases? You need to know how to care for these solutions, that you don't make a green roof or biodiversity yard in vain, one that is not maintained, you put resources in it and then it is an extra expense or it deteriorates faster (.) And of course, only after 10 or 20 years do you see how the solutions thrive"* (Architect, I−7). This underlines the NBS maintenance aspect as an important factor for the longevity of new solutions, which deserves more attention since it was not focused on a great deal during the discussions.

4.3.4. Valuation barriers

Valuation barriers are highly connected to knowledge-related ones–discussed above–but by going one step further to fixed mindsets on current (grey) practices. An informant describes: *"The biggest reason is the lack of knowledge or even (.) the fixed ways of thinking. Perhaps there is a certain kind of resistance to change in some fields. Of course, change is always hard, and time to adjust [to the new practices] is required"* (Project manager, I−9). The experts noted an overall undervaluation of NBS, which linked to limited innovation effort. This risks positioning NBS as non-essential or luxury additions rather than as a concrete mainstreaming strategy for enhancing urban resilience.

4.3.5. Technical and infrastructure-related barriers

Technical and infrastructure-related barriers were found to stem from existing structural conditions, as established infrastructure can pose challenges for integrating NBS at later stages of plot or building development: *"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 [we] want these to be implemented."* (Leading responsibility expert, I−10). Parking solutions in particular were highlighted as a significant constraint to NBS expansion, since fully-grown trees are not feasible on deck yards constructed above parking garages. In addition, certain factors, such as roof slope and the incorporation of other technologies, including solar panels, were perceived as difficult to combine with NBS. Finally, uncertainties related to seasonal durability present an additional challenge for the implementation of NBS in the Finnish context, characterised by a cool Nordic climate.

4.3.6. Fragmented business ecosystem as a barrier

The absence of pioneering or frontrunner businesses with ambitious climate goals and strong focus on sustainable green solutions, such as NBS, was seen to limit the availability of NBS options for construction companies and contractors. Experts further described the business ecosystem for NBS-related services and expertise as fragmented. As one of the informants noted, *"maybe (…) there is not a single actor that is the "brakeman", but each organisation has their own brakemen (.) or -persons"* (Senior specialist, WP−2). The NBS market in Finland is still small in terms of supplier numbers and is constrained by public funding, as described earlier.

In the analysed context, several measures were identified to further promote the uptake of urban NBS, including experimentation, pilot projects, alliance-based approaches, city plot handover competitions and sustainability-driven zoning. In addition, other land use planning and building regulation instruments were suggested as means for bringing ecosystem actors together and supporting the achievement of shared goals toward enhanced urban resilience.

4.4. Actor relationships supporting the mainstreaming of NBS solutions

Based on the results, seven main themes were identified concerning solutions for increasing the uptake and mainstreaming of NBS in urban environments. These themes are presented in Table 4 and include economic aspects and instruments; policy instruments; reimagining existing structures, spaces and practices; multi-actor and cross-sectoral and collaborative business ecosystem; the availability of knowledge, information and real-life examples of NBS to increase awareness and mainstream adoption; experimentation and approaches that go beyond pilot projects; and long-range project planning and goal setting.

4.4.1. Economic aspects and instruments

Economic aspects were mentioned as a key barrier, and navigating this barrier is therefore crucial. The importance of new green finance was concurrently highlighted as a potential solution, providing a solid foundation for business opportunities. Although current municipal funding—particularly for the maintenance of NBS—is considered inadequate, securing sufficient financial resources and allocating appropriate budgets were viewed as essential steps toward their mainstream adoption. Moreover, demand from the end user is required for construction companies to develop viable business models around NBS, as one expert noted: *"If knowledge of nature-based solutions can be provided to apartment buyers, and why not to renters [the situation would improve].*

Table 4
Identified solutions to support NBS mainstreaming.

Main theme	Sub-theme
Economic aspects and instruments	Economic incentives and subsidies
	Securing sufficient resources and budgets
	Cost-benefit and life cycle impact calculations with adequate time frames
	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
	Overcoming internal organisation silos
	Applying tools and methods to bring actors together
Knowledge, information and real-life examples of NBS to increase awareness and mainstream use	Sharing information, knowledge, know-how and experiences with all relevant stakeholders
	Changing doubting or negative perceptions into positive ones
	Increasing awareness throughout the whole business ecosystem
Experimenting and going beyond	Opportunities for testbeds, pilot projects and willingness to experiment
	Monitoring and follow-ups including sharing of post-project experiences
Long-term project planning and shared goal setting	Ambitious, clear and unbending shared goals
	Applying NBS as the premise of the project
	Competence and know-how in the planning phase

Then if we have two multistorey buildings next to each other, and we have very pleasant yards in one [building] (.). So, this [yard solution would be] marketable in a totally different way than [a yard] with a lump of concrete and an asphalt road." (Leading responsibility expert, I−10).

With NBS, business actors have opportunities to innovate and create new business models. Providing an integrated product–service system, where a single company is responsible for the design, implementation and maintenance of NBS, was highlighted as a notable gap in the current business ecosystem and as a promising opportunity for new market entrants. In addition, certification schemes were viewed as a means of promoting NBS use and for increasing urban greenery, as the following quote shows: *"Construction companies have also been interested in how nature-based solutions can be utilised and whether [NBS] can be a quality factor and competitive advantage for them as well. Environmental certifications can certainly be competitive advantages for businesses."* (Landscape architect, I−8) Environmental certifications were described as facilitating cooperation, along with being perceived as potential quality indicators and sources of competitive advantage for construction companies.

4.4.2. Policy instruments

Policy instruments currently in use include green and blue-green factors. Other tools identified as key measures for increasing NBS use include municipal green efficiency targets, planning, building ordinances and local master plans. As these instruments are primarily controlled by the city, they underscore the significant role that cities play in mainstreaming NBS within urban design, as one expert stated: *"The green factor 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 do. Similarly, green efficiency has now been introduced into building regulations in Helsinki."* (Landscape architect: I−8). By integrating NBS-related goals into municipal legislation and frameworks, a minimum standard for their use could be established, thereby increasing the quality of urban greenery. Such efforts can be supported by both national and EU regulation in line with the Nature Restoration Law. In addition, political decision-making plays a significant role in promoting NBS uptake, placing local politicians in a key role for increasing awareness, knowledge and implementation of NBS.

4.4.3. Reimagining existing structures, spaces and practices

The thematic area of reimagining existing structures, spaces and practices is interlinked to the theme of long-term project planning and shared goal setting. When NBS are integrated into buildings and their structural elements, the built environment and construction align with natural processes and support ecosystem services provision, as the following quote shows: *"It's important, in my opinion, to recognise the multifunctionality, through which green structures in urban areas are valued in urban land use planning. 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."* (Assistant professor, I−11). This is applied in the soft edges design principle, where a building plot is treated as part of the surrounding natural environment. Such approaches reflect a more holistic view of urban development and thinking beyond the borders of single cities.

4.4.4. Multidisciplinary and collaborative business ecosystem

A broadly shared solution for mainstreaming NBS in urban areas is stronger cross-sectoral collaboration that cuts across organisational silos, coupled with deeper multidisciplinary cooperation throughout the entire business ecosystem. Technical NBS, in particular, require close coordination among all actors during planning, implementation and maintenance. Engaging the entire construction chain ensures knowledge sharing among stakeholders in building and urban planning projects and brings the right actors together. A silo mentality remains a major obstacle to a functioning business ecosystem; overcoming it—both between organisations and within individual entities, such as municipal departments—will depend on reinforcing internal 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.* (Assistant professor, I−11). Thus, uniting planners and actors from various levels for realising the multi-benefits of broader green structures is needed.

4.4.5. Knowledge, information and real-life examples

One of the key solutions identified was the availability of knowledge, information and real-life examples of NBS, as the creation of positive real-life experiences was viewed as a key factor in raising awareness and supporting the mainstream adoption of NBS. The sharing of information, knowledge and practical know-how, alongside access to open data, was highlighted as a crucial component of this process. Such knowledge exchange can help clarify the benefits generated by NBS and raise awareness and familiarity with NBS across the wider business ecosystem. Familiarity with the NBS as a concept was seen as essential for increasing the demand for these solutions and to shift perceptions in a more positive direction, thereby enhancing the valuation of their intangible benefits. This, in turn, may help prevent NBS from being perceived merely as an additional cost in construction projects.

Cross-sectoral knowledge sharing is elementary and ensures that the necessary expertise is available across organisations and organisational coalitions. In this context, challenges related to the transfer of knowledge across project phases, particularly from planning to implementation, and eventually use and maintenance, were highlighted. The successful delivery of multifunctional and technically complex services like NBS depends on whether sufficient maintenance expertise exists and whether responsibilities and corrective measures are clearly established.

4.4.6. *Experimenting*

Experimenting and moving beyond it through creating opportunities for pilot projects, was viewed as an important means for fostering collaboration and supporting the mainstreaming of NBS. Such initiatives concurrently provide businesses with opportunities to test and showcase new NBS applications, as also noted in other solution themes. By enabling platforms for pilot projects, various solutions can be demonstrated in practice, illustrating how urban greenery can be increased on construction sites and in buildings. In particular, informants emphasised the need for experimentations focused on enhancing greenery and retrofitting existing areas and buildings with NBS. The monitoring and follow-up of these experimentations, including sharing post-project experiences, is helping to take the next step from pilot projects to wider-scale use of NBS. Including this, post-project information sharing between the business ecosystem actors helps to avoid remaking unsuccessful choices and focusing on implementing location-based and well-functioning NBS.

4.4.7. *Long-range project planning and goal setting*

Finally, the results indicate that establishing ambitious, clear and unbending shared goals at a project level or in the business ecosystem helps to set threshold values for NBS use. With clear goals and thorough planning that focus on improving resilience right from the beginning, misconceptions and oversights could be avoided, as the following quote illustrates: *"Indeed, it's important that project management can pass on the project's goals as it transitions to the next phase. It might not be feasible to delegate this to a single person, especially as [the project] moves within the city organisation from one unit to another. There may be a gap of two years in between, and people might leave and so forth, but [the goals] need to be clearly outlined in the plan somehow."* (Project manager, I−3) These factors highlight the importance of competence and technical know-how, particularly during the planning phase of construction and urban design projects that aim to implement NBS. To achieve multiscale benefits through long-term project planning, the location and contextual conditions of the proposed solutions must be carefully assessed. A thorough understanding of site-specific preconditions supports the selection of appropriate and properly scaled NBS, helping to avoid flawed implementation.

5. Discussion

This study addresses the knowledge gaps related to benefits and barriers for mainstreaming NBS within urban business ecosystems. By investigating two cities that are members of the EU Mission on Climate-Neutral and Smart Cities and are therefore considered frontrunners in sustainable urban development, the study shows examples of solutions and areas with the potential to mainstream NBS in the Nordic context. Empirically our research contribution is related to providing information on NBS in the urban setting by addressing both in connection with natural environments and buildings. The novelty of our research addresses the aspects of mainstreaming NBS through the business ecosystem lens, which has not been a common approach in previous studies addressing NBS upscaling. Hence, our study provides new insights into the factors influencing the NBS adoption process and offers suggestions for actionable solutions on how to overcome existing barriers, while the main body of earlier research on upscaling NBS has focused on the barrier side. Gaining new practitioner-based knowledge regarding, for example, the linkages of business ecosystem actor relationships in NBS uptake is necessary for mainstreaming solutions in the future, as is the identification of environmental, social and economic perspectives as seen by business ecosystem actors in the uptake of NBS in urban environments.

Mapping and identification of key actors and enlarged business actors within the business ecosystem in the Finnish context (see conceptual framework in Fig. 1) constituted our first research task. The key actors were found to be, first and foremost, the city, who may have multiple roles in the local business ecosystem (for instance, creating a platform for business development around NBS, as the customer for new solutions or as a knowledge broker in informing the residents), and second, businesses who have been designing or producing urban NBS projects (thus playing a key role as producers or an enlarged business role as a designer). The engaged actors also interacted with an extended ecosystem that is elementary in supporting NBS development. In this study, by intention, we left out the resident perspective even though the informants stressed that they are developing and designing the NBS ultimately for the residents, as we focused on the functioning of the city–business interphase.

Furthermore, our results provided interesting insights into the perceived relationships among these actors, such as the strong connection between NBS experts and the building industry, as well as the evident links between the city and the building industry. As Calliari et al. (2022) point out, the costs of NBS in the longer term are not yet fully understood, particularly in comparison with conventional grey infrastructure or hybrid blue-green-grey solutions. Our analysis shows that, currently, private sector engagement in NBS development remains too limited. For example, a wider spectrum of regenerative business models (Konietzko et al., 2023) could be employed among businesses to advance the upscaling of NBS.

As a second research task, we explored perceived benefits and barriers of NBS that could be observed across multiple scales at the building, neighbourhood or city levels. The engaged actors in our study identified various benefits and co-benefits that the range of NBS provides to the urban environment: enhanced resilience to climate change and extreme weather events, improved urban biodiversity and strengthened support for a wider set of ecosystem services. Furthermore, economic benefits were emphasised by the actors, as NBS provide significant possibilities for existing and new businesses in an emerging ecosystem and support the decrease of long-term infrastructure costs regarding, for example, climate change adaptation in cities. The actors viewed NBS to also provide other social and economic co-benefits, such as societal benefits from enhancing residents' connection to nature or retaining real estate value. These findings are supported by the recent results of Kandel and Frantzeskaki (2024), in which especially recognising the potential of gaining multiple simultaneous environmental, social and economic benefits from NBS in urban environments has been found to have untapped potential.

In addition, we identified several barriers to mainstreaming NBS that need to be overcome to enhance their wider adoption. Our results are largely in line with the existing literature exploring the possible barriers for NBS adoption (Kabisch et al., 2016; Toxopeus and Polzin, 2021; Dorst et al., 2022), and the perceived barriers were related to economic and financial management, governance and institutional barriers, immature valuation of NBS in the housing market, technical and infrastructure-related barriers and the fragmentation of the local NBS business ecosystem.

While previous NBS literature has focused more on the barrier side, our study suggests several solutions to overcome these barriers to increase the adoption and use of NBS. These solutions were related to economic aspects and instruments, policy instruments, reimagining existing structures, spaces and practices, a multi-actor, multi-sectoral and collaborative business ecosystem, knowledge, information and real-life examples of NBS to increase awareness and mainstream use, experimenting and going beyond and long-range project planning and

goal setting. However, the mainstreaming of NBS either succeeds or fails according to the actions and interactions of the business ecosystem actors, constituting our third area of inquiry. According to this study, fostering business around NBS is at the core of mainstreaming it, and targeting the city–business interphase is crucial for reaching this outcome. As an example, policy instruments, such as establishing municipal green efficiency targets, sustainability-driven zoning and building ordinance and local master plans were seen as key measures in increasing NBS adoption. For overcoming the silo mentality (e.g., city administration's institutional silos), a barrier also identified earlier by Kabisch et al. (2016), i.e. the inclusion of the whole construction chain, would additionally help ensure that knowledge is shared among all relevant actors involved in construction and urban planning projects and would foster collaboration across the planning, implementation and maintenance phases. Furthermore, as shown by our results, which aligned with Toxopeus and Polzin (2021), financial barriers are significant for the wider adoption of NBS. The need for green financing from other than public sources is identified as one potential solution that could also create a strong foundation for new business opportunities. However, this area is yet underdeveloped (Ahmad and Du, 2026).

This study has several limitations. First, the findings reflect the views of a relatively small number of private and public sector experts—professionals in construction, NBS, land use planning and architecture—who work with NBS and urban resilience in the specific Nordic country context. Hence, their expertise does not necessarily represent that of the whole business ecosystem, and some actor groups with important local knowledge, such as residents, investors or environmental NGOs, are missing. This is due to the focus of this study lying in the city–business interphase, with key and enlarged business actors of the local NBS business ecosystems. However, we do see resident perspectives embedded in these thematics, and these have been the focus of some recent studies (Viholainen et al., 2021, García-Antúnez et al., 2023) and, overall, represent a more commonly targeted stakeholder group in NBS studies (Madureira et al., 2015). In addition, actors that are more skeptical towards the NBS were less likely to become involved in the data collection. Second, the empirical focus on just two Finnish cities and the actors or projects located therein, further restricts the generalisability of the results. Consequently, the comparability of the study remains inevitably limited since we present a relatively new angle that addresses practitioner-based evidence of the NBS business ecosystem (a few examples from previous studies from the non-Nordic context include e.g. Kooijman et al. 2021, Aguilera-Rodríguez et al. 2025). Third, as we are researching a rapidly evolving phenomenon, the data collected during 2023 constitutes a temporal limitation.

6. Conclusions

The mainstreaming of NBS either succeeds or fails according to the actions and interactions of the business ecosystem actors, who face many barriers for upscaling NBS that also requires fostering business development. For reaching this outcome, our findings show interactions between cities and businesses to be in a key role together with seeking for possible new roles regarding the coordination of responsibilities (e.g. costs) and sharing benefits (e.g., income) of NBS. Without recognising the key actors and their roles and inherent fragmentation in the network structure, it is not feasible to expect a strong acceleration in the mainstreaming of NBS. The business potential of NBS does not concern only the provision of economic value but also environmental and social benefits for multiple stakeholders in long time scales. Abreast with nudging NBS uptake in the short term, this relates to their long-term maintenance. Resulting from that, NBS network structures may also differ from those business ecosystems based purely on economic realities.

In addition, political decision-making plays a significant role in promoting NBS uptake, placing local politicians in a key role for increasing the awareness, knowledge and implementation of NBS. By integrating NBS-related goals into municipal decision-making, a minimum standard for their use could be established, thereby increasing the quality of urban greenery. Such efforts would clearly support national implementation of EU Nature Restoration Law.

Our results provide ample opportunities for future studies. Future research could, for example, broaden the scope by exploring the views of various actors within the business ecosystem that were less salient in our research, such as residents, financiers and environmental groups, in addition to practitioners and experts that directly engage with NBS projects. Acknowledging residents as caretakers and further building their agency in maintaining NBS in their neighbourhoods has been discussed but remains as small-scale neighbourhood-level experiments. We see great potential for future research regarding various local NBS business ecosystem actors, also by using a longitudinal research design instead of one-time interviews or workshops. Further research with more substantive quantitative approaches may also enhance understanding the heterogeneity in preferences and degrees of stakeholder acceptance on various NBS solutions. Extending the scope of NBS toward circular economy development could provide further interesting insights to NBS–circular economy linkages (Atanasova et al., 2021). Additionally, conducting similar research in other European localities and in the North American context could help produce more generalisable results. However, as the adoption of NBS is influenced by local conditions and place-based factors are decisive for future development, there is a need for research that is tailored to specific local contexts. These comparative studies could test the transferability of our findings, while locally tailored analyses remain essential because NBS adoption is highly place specific. Certain environmental resilience challenges persist across international urban localities and are, in some cases, surprisingly similar (Megyesi et al., 2024). Therefore, providing place-specific information of various circumstances can contribute to the wider mix of understanding the challenges of mainstreaming new NBS into the city fabric through proper policy measures and developing new business.

CRediT authorship contribution statement

Janina Harmanen: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Anne Toppinen:** Writing – original draft, Project administration, Funding acquisition, Formal analysis, Conceptualization. **Katja Lähtinen:** Writing – original draft, Funding acquisition. **Charlotta Harju:** Writing – original draft. **Anne Viljanen:** Writing – original draft, Validation, Supervision, Methodology, Formal analysis, Data curation.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of the original manuscript, the authors used ChatGPT−4o in final form English language editing. After using this tool, the authors reviewed and edited the content as needed, and in the revision stage we used professional proofreading by a human. We take full responsibility for the content of the publication.

Declaration of Competing Interest

We declare no conflict of interest.

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Appendix A. Supporting information

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