

Advancing Sustainable Transport Systems

Strengthening environmental considerations and sustainability perspectives in Strategic Choice of Measures

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Academic Dissertation which, with due permission of the KTH Royal Institute of Technology, is submitted for public defence for the Degree of Doctor of Engineering on Friday the 14th June 2024, at 9:00 a.m. in F3, Lindstedtsvägen 26, Stockholm.

Doctoral Thesis in Land and Water Resources engineering (LWR)
KTH Royal Institute of Technology
Stockholm, Sweden 2024

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ISBN 978-91-8040-969-8
TRITA-ABE-DLT-2419

Printed by: Universitetsservice US-AB, Sweden 2024

ABSTRACT

Addressing cross-cutting issues such as climate change, urbanization, and environmental degradation in policy and planning is key for transitioning to a sustainable society. In the work of societal and transport system development, the integration of environmental and sustainability perspectives has never been more crucial. In urban areas, the interconnection between transport and land use is evident, and integrated transport and land use planning plays an important role in promoting sustainable transport systems. However, both the integration of environmental and sustainability considerations in transport planning and the integration of land use and transport planning are complex challenges.

This thesis explores the consideration of environmental aspects and sustainability perspectives in strategic transport planning, with a focus on the Swedish Strategic Choice of Measures (SCM) approach and lessons learnt from planning approaches in the Nordic countries. The thesis is primarily based on case studies of SCM processes in the Stockholm region. Empirical material has been collected through observations of SCMs involving public officials from the Swedish Transport Administration, municipalities in Stockholm Region, and Stockholm's public transport authority, as well as through semi-structured interviews, focus group interviews, informal interviews and document studies, with a qualitative research approach.

The thesis is a compilation of four scientific papers. Three of the papers (1, 2, and 4) discuss the SCM process, and in two of the papers (2 and 4), SCM processes in the Stockholm region are used as empirical cases of how strategic choices of measures have been made in transport and land use planning. Paper 3 explores and draws lessons from Nordic planning instruments to coordinate transport and land use planning with the aim of promoting sustainable development.

The results highlight the difference between engaging and non-engaging environmental aspects and advocate for a systems perspective in planning to

understand connections and promote holistic solutions. Planning approaches from different Nordic countries, such as the Finnish MAL and the Norwegian Urban Growth Agreements, demonstrate the effectiveness of integrating transport and land use planning through instruments based on collaboration between transport and land use actors. The results also identify challenges related to fragmented transport and land use planning, and that actors' vary in their engagement when addressing environmental and sustainability considerations in the SCM planning context. Effective collaboration and sustainable choices of measures relies on knowledgeable professionals being capable of interdisciplinary collaborations and innovative thinking, being part of and coordinating the planning process, i.e. SCM. The use of Integrated Landscape Character Assessment (ILCA) can provide a framework for cross-actor collaboration and has the potential to identify multifunctional solutions contributing to a sustainable societal transition. Overall, the results of the thesis emphasize the importance of integrating environmental and sustainability perspectives into transport planning to promote sustainable development.

SUMMARY IN SWEDISH

Dagens utmaningar såsom klimatförändringar, urbanisering och miljöförstöring ställer krav på tvärssektoriell aktörssamverkan och åtgärder som bidrar till omställningen till ett hållbart samhälle. I detta sammanhang spelar integreringen av miljö- och hållbarhetsperspektiv i transportplaneringen en viktig roll. Genom att studera det komplexa samspelet mellan transport- och markanvändningsplanering kan olika strategier och åtgärder identifieras för att främja hållbara transportsystem i urbana områden.

Avhandlingen utforskar integreringen av miljöaspekter och hållbarhetsperspektiv i strategisk transportplanering, med fokus på Åtgärdsplanering samt lärdomar från nordiska planeringsverktyg som möjliggör en samordning av transport- och markanvändningsplanering. Avhandlingen är i huvudsak baserad på fallstudier av åtgärdsvalstudier (ÅVS) i Stockholmsområdet. Empiriskt material har samlats in genom observationer av ÅVS:er där representanter från Trafikverket, kommuner i Stockholms län samt Stockholms kollektivtrafikförvaltning har medverkat, och genom semistrukturerade intervjuer, informella intervjuer, fokusgrupper samt dokumentstudier, utifrån en kvalitativ forskningsansats.

Avhandlingen är en sammanläggning av fyra vetenskapliga artiklar. Tre av artiklarna (1, 2 och 4) handlar om ÅVS processen och i två av artiklarna (2 och 4) används ÅVS processer i Stockholms region som empiriska fall av hur strategiska val av åtgärder gjorts i koordinerad transport och markanvändningsplanering. I artikel 3 utforskas och dras lärdomar av tillämpningen av planeringsverktyg i Norden som syftar till att samordna transport och markanvändningsplanering för att främja hållbar utveckling.

Resultaten visar på utmaningar relaterat till den fragmenterade transport- och markanvändningsplaneringen och till aktörernas varierande engagemang i att hantera olika miljö- och hållbarhetsfrågor i ÅVS. Vidare belyser resultaten skillnaden mellan miljöaspekter som engagerar respektive inte engagerar deltagarna i planeringsprocessen, vilket pekar på behovet av ett

systemperspektiv i ÅVS för att förstå samband och främja helhetslösningar. I den Nordiska studien redovisas olika Nordiska planeringsverktyg, bland annat finska MAL och norska Byveksavtal, som visar på möjligheter att integrera markanvändnings- och transportplanering som bygger på samverkan mellan de olika aktörerna. Effektiv samverkan, samt val av åtgärder som främjar hållbarhet, förutsätter kompetens och förmåga till tvärvetenskapligt samarbete och innovativt tänkande. Resultat från tillämpningen av Integrerad landskapskaraktärsanalys (ILKA) i ÅVS visar att verktyget har potential att identifiera multifunktionella lösningar i planeringen som bidrar till hållbar samhällsomställning. Sammantaget understryker avhandlingen vikten av att integrera miljö- och hållbarhetsperspektiv i transportplanering för att främja utvecklingen av ett hållbart samhälle.

Metodmässigt säkerställs tillförlitlighet, trovärdighet och överförbarhet av resultaten från denna studie till andra studier genom omfattande datainsamling, triangulering och internationella jämförelser. För att hantera subjektivitet i forskningen, utgår studien ifrån ett reflexivt tillvägagångsätt genom att spegla metodval och resultat utifrån olika perspektiv, med avsikt att stärka forskningskvaliteten.

Slutligen lyfter avhandlingen fram förslag till hur aktörssamverkan och integrering av miljö- och hållbarhetsperspektiv i strategisk transportplanering kan förbättras, vilket kan bidra till att identifiera åtgärder för att möta komplexa samhällsutmaningar och främja en omställning till hållbar samhällsutveckling.

ACKNOWLEDGEMENTS

This thesis is funded by *Trafikverket* [Swedish Transport Administration] through two research projects: *Strategier för integrering av miljöfunktioner i transportplanering för en hållbar stadsutveckling* (TRV 2016/108133) and *Hållbarhetsnytta i transportplanering: Samordning av målbild och miljöfunktioner i ÅVS* (TRV 2020/25406). Thank you!

I would also like to express my gratitude to the Nordic Road Association (Nordiskt Vägforum, NVF) and Åke and Greta Lissheds Foundation for your generous funding, which enabled a deeper exploration of key topics in this thesis.

I would like to thank my principal supervisor, Berit Balfors, for taking me on as a PhD student and for everything that followed. Your support and guidance have been invaluable, and I truly admire your ability to maintain focus on scientific progress, independence, and quality despite a complex administrative reality. Thank you also to my former co-supervisor, Ulrika Gunnarsson-Östling. You have been a great source of inspiration to me over the years, especially regarding your great intellect and how you manage your work-life balance. Thank you to Ulla Mörtberg for stepping in as a co-supervisor during the last few months, providing valuable input, and being an inspiring and supportive senior colleague. Additionally, thank you to Bosse Olofsson for reviewing this thesis, offering thoughtful comments and important insights, and for being an inspiring figure.

Thank you to Fredrik Pettersson-Löfstedt for reviewing my Licentiate thesis. Your comments and insights have been immensely valuable to my work since then.

A great thank you to Emily Wade and Carola Wingren at SLU, to Helene Geimar, Camilla Holmberg, Gustav Andersson, Linus Karlsson, and Linda Göransson at *Trafikverket*, as well as to Josefin Kofoed-Schröder at Sweco, Anna Persdotter at Ramboll (now at Trafikverket) and Jenny Andersson at

Tyréns (now at Värmdö municipality) for your guidance and critical reviews throughout the research projects.

Lisa Rehnström (*Trafikverket*), thank you for allowing me to participate in your SCM processes and for dedicating so much of your time to discussions. You have been invaluable to this thesis. Thank you also to all officials at *Trafikverket*, Region Stockholm, the involved municipalities, and other organizations (not least Nordic practitioners) who participated in the research activities with such enthusiasm.

I would also like to thank my colleagues at SEED, with a special thanks to my division, Sustainability, Assessment, and Management. An extra-special thank you goes to my fellow PhD students, both past and present - Celeste, Sigge, Deepa, Elina, Johan, Vincent, Sara, Nathalie, Zoe, Ahmad, Hampus, Erika, Sofie, Anneli, Lilly, Kedar, Flavio, Robert, Martin, Elias, Kåre, Hedi, Rajabu, Seema, Lina, Eleonor, Joe, Loris, Nicolas, Daniel, Elvira, Jonas, Xi, Carolina and others. Marie, Eva, Anette, Chi-An, and Kosta, thank you for your help with administrative issues and for being so cheerful.

Family and friends, thank you for your support and for bringing meaning and happiness into my life. Samuel, Ville, and Alvar, you are the top three individuals on this earth to me! Love you!

Finally, mamma och pappa, thank you for being outstanding parents and grandparents. Pappa, a special thank you for always finding the time to read and discuss the work I do, and for frequently reminding me to be mindful of my CO₂ emissions (since the day I was...born).

Sofia Eckersten

Stockholm, June 2024

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As the first author, SE has solely performed the collection and analysis of data, and has been the main contributor to the manuscript writing, with supervision and input from co-authors BB and UGÖ. SE participated in concretizing the research design and formulating overall aims in co-operation with the co-authors BB and UGÖ, and handled the submission and revision process with support from the co-authors.

2. Eckersten, S., Gunnarsson-Östling, U., Balfors, B., 2022. *Inclusion and exclusion of environmental aspects in early-stage planning of transport infrastructure projects: A Swedish case study. International Journal of Sustainable Transportation*, 1-13. <https://doi.org/10.1080/15568318.2022.2039978>

SE is the first author and has solely conducted data collection, data analysis and data visualization, and has been the main contributor to the manuscript writing, with supervision and input from co-authors UGÖ and BB. SE participated in specifying the research design and formulating overall aims in co-operation with the co-authors. SE has handled the submission and revision process with support from the co-authors.

3. *Eckersten, S., Balfors, B., 2023. Exploring practices for facilitating integrated strategic land use and transport planning in the Nordic countries. Journal of Transport and Land Use, 16(1), 409-435.
<https://doi.org/10.5198/jtlu.2023.2350>*

SE is the first author and has conducted the main part of the data collection, data analysis and data visualization. SE and co-author BB have both participated in specifying the research design and formulating overall aims. SE and BB are both main contributors to the manuscript writing and have together handled the submission and revision process.

4. *Eckersten, S., Balfors, B., 2024. The integrated landscape character assessment as a tool to bridge the gap between strategic transport and land use planning. Submitted manuscript.*

SE is the first author and has solely conducted data collection, data analysis and data visualization, and has been the main contributor to the manuscript writing, with supervision and input from co-author BB. SE specified the research design and formulated overall aims in co-operation with BB. SE has handled the submission process (so far) with support from BB.

LIST OF ACRONYMS

SCM/ÅVS	Strategic Choice of Measures/Åtgärdsvalstudier
ILCA/	Integrated Landscape Character Assessment/
ILKA	Integrerad landskapkaraktärsanalys
SEA	Strategic Environmental Assessment
EIA	Environmental Impact Assessment
CS/KVU	Concept Studies/Konceptvalgutredning
MAL	Maankäytön (land use), Asumisen (housing), Liikenteen (transport)
UGA	Urban Growth Agreement/Byveksavtal
UEA	Urban Environment Agreement/Stadsmiljöavtal
GHG	Green House Gas
PBA	Planning and Building Act
STA	Swedish Transport Administration
SEPA	Swedish Environmental Protection Agency
RPTA	Regional Public Transport Authority
OSLVF	Östra Sveriges Luftvårdsförbund [East Sweden Air Quality Management Association]

1 INTRODUCTION

The increasing challenges of cross-cutting issues such as climate change, urbanization, and environmental degradation underscore the necessity for sustainable societal transformation (UNEP, 2019). Rockström et al. (2009) defined planetary boundaries within which humanity can operate safely, however, evidently several of the boundaries has been exceeded (Richardson et al., 2023). To address these challenges, Steffen et al. (2015, 2011) emphasize the importance of planetary stewardship to enhance ecological, economic, and social sustainability. Central to this approach is the recognition of the intricate relationship between the transport system and land use. For instance, transport infrastructure influences ecological processes by creating barriers and altering disturbance regimes (Fahrig and Rytwinski, 2009), thereby modifying hydrological processes, potentially resulting in increased erosion and sedimentation (Forman et al., 2003). Moreover, it is one of several biophysical factors driving land use change (Jaeger et al., 2007).

In the dynamic field of societal development and the transport system, the call for sustainability and environmental consideration has reached a pivotal point (Finnveden and Åkerman, 2014; Seiler et al., 2019). In urban areas there is a strong interdependence between the development of land use density, diversity and design, and the transport system (Bertolini and Dijst, 2003; Cervero and Kockelman, 1997). According to several scholars, the integration of transport and land use planning emerges as a cornerstone for fostering sustainable transport outcomes (Arts et al., 2016; Banister, 2005; Brömmelstroet and Bertolini, 2010; Duman et al., 2022). However, this integration is laden with complexity and inherent tensions within the sustainable development paradigm (e.g. Dobson, 2018).

As competition for land intensifies, the demand for multifunctional landscapes capable of delivering eco-system services (Millenium Ecosystem Assessment, 2005) alongside traditional needs like housing, energy, and

transport becomes paramount. The social, economic and environmental dimensions of the city are entwined, often defying and/or suffering from targeted or one-dimensional intervention. The dynamic interplay between land use and transport planning, as highlighted by Bertolini (2017), underscores the importance of understanding mobility patterns, accessibility, and their reciprocal influence on land use and transport systems. This relationship is shaped by a myriad of factors, including policy frameworks, investment opportunities, and technological advancements.

Landscape approaches that embrace an integrated land-sharing philosophy have been increasingly promoted in science and in practice as an alternative to conventional, sectorial land use planning, policy, governance, and management (Arts et al., 2017). The land-sharing perspective, as applied in character-based approaches to landscape planning, has been highlighted by Fairclough et al. (2018, p. 3-4) as having the potential to address significant global challenges of the twenty-first century. These challenges range from climate change responses and resilience to issues like demographic change, migration, land abandonment, and land use and food security concerns. The idea of 'landscape character' is an important interdisciplinary tool in European as well as non-European countries that enable policy-makers, practitioners, landowners and communities to deal with the great variety of landscape challenges across scales (Fairclough et al., 2018a).

As previously mentioned, the planning of transport infrastructure is an inherently spatial practice, and the ways in which transport systems are designed and implemented can have significant impacts on the form and function of landscapes (Henningsson et al., 2015). For example, places derive its identity from various networks, i.e. from transport infrastructures but also from social, ecological and economic networks with local, regional or national widths – that overlap in a place (Castells, 2000; Heeres et al., 2017). The application of a landscape approach, such as a Landscape Character Assessment, in transport planning then becomes a tool for planners and decisions-makers to gain a better understanding of the ways in which transport systems are integrated into broader socio-ecological systems. Thereby they can design more sustainable and resilient transport

systems that are sensitive to local contexts and cultural values (cf. Angelstam et al., 2019; Arts et al., 2017). In addition, Loupa-Ramos and Pinto-Correia (2018) highlight that different perspectives are relevant at various scales in Landscape Character Assessments. At the local scale, the importance of landscape for connecting people with their local surroundings is relevant. At broader scales, the territorial expression of different sectors' activities and the integrity of the landscapes structuring features may be more important (Loupa-Ramos and Pinto-Correia, 2018; Selman, 2012). The various scales indicate an association with different administrative units and therefore with planning at national, regional and local level.

Friedman (1987) describes planning as a process of turning knowledge into action. This involves tackling broad issues and promoting sustainability through effective policy connections and collaborative efforts across local government sectors. Moreover, it necessitates the cohesive management of land use and transport at various governmental levels, from national to local (Hull, 2005). There are several forms of policy integration, each critical for advancing sustainable practices in land use, transport, and environmental policies (see further the chapter on theoretical framework below).

Brömmelstroet and Bertolini (2010) highlight the importance of integrating planning stages such as strategy formulation and goal setting to establish common objectives, thereby fostering land use and transport initiatives that support each other. Van Geet et al. (2021) explain that the practical application of land use and transport integration is defined through two main perspectives: strategic, which focuses on policy integration, and operational, which deals with project integration within land use and transport. The strategic phase concern policy formation and the operational phase concern policy implementation. The phase that connects policy formation and implementation is policy adoption. The Swedish and Nordic strategic transport and land use planning practices studied in this thesis are categorized as policy adoption (and to some extent formation as well as implementation). For example, in the Swedish Strategic Choice of Measures (SCM) approach transport and land use policies are coordinated and actions are identified, i.e. adoption (see Chapter 2 below).

The distinctions among terms like integration, coordination, and cooperation between transport and land use planning have been the subject of extensive scholarly discussion (e.g. Stead, 2003). Keast et al. (2007) state that integration, cooperation, coordination, and collaboration should be considered as complementary approaches. Candel and Biesbroek (2016) suggest that addressing interdisciplinary issues doesn't always require the highest level of integration. Sometimes, simply sharing information or coordinating efforts might be more appropriate.

1.1 Research gap

The scholarly discourse strongly advocates for significant societal changes to address sustainability challenges (e.g. Elmqvist et al., 2019; Frantzeskaki, 2019; Hölscher et al., 2019; Loorbach et al., 2015; Witzell et al., 2022). The transport system, with its far-reaching consequences on the natural environment and both rural and urban landscapes, is crucial in this context. As such, the planning and design of the transport system and its coordination with land use planning are important to foster sustainable development. However, there remains a gap in understanding whether current practices contribute to the coordinated development of transport system and land use. To address this gap, this thesis focuses on the role of SCM and related tools to strengthen the coordination of transport- and land use planning as a means to enhance a sustainable transport system. In addition, this thesis explores potential approaches such as Integrated Landscape Character Assessment to incorporate environmental and sustainability considerations into the planning and decision-making processes for transport and land use. This research specifically examines Swedish and Nordic transport planning practices. It also considers the national (public) actors' collaboration with local and regional public actors (e.g. municipalities and regional public transport authorities) to address the challenges with land use and transport integration.

1.2 Research aim and research questions

The overall aim of this thesis is to develop knowledge and understanding to enhance the integration of environmental considerations and sustainability perspectives in transport planning, in order to foster the development of a sustainable transport system.

The research aim is addressed through three research questions:

1. *How can SCM facilitate the coordination of Swedish transport and land use planning in order to enhance a sustainable transport system?*
2. *What lessons can be learned from Nordic practices of integrating transport and land use planning?*
3. *How can landscape character assessment contribute to integrating environmental considerations and sustainability perspectives transport planning?*

The thesis involves a detailed empirical analysis of consideration of environmental aspects and sustainability perspectives in three Strategic Choice of Measures (SCM) processes in the Stockholm region. It also explores policy and planning instruments related to the integration of transport and land use planning in the Nordic countries. The thesis comprises this cover essay and four papers. The four papers consider various angles of the studied phenomenon, which together address the research questions. Paper 1, 2 and 4 concern the Swedish strategic transport planning represented by the SCM approach, Paper 3 concern policy and planning instruments that facilitate transport and land use planning in a Nordic context. Table 1 provides a summary of the aims, specific aims and research questions pertaining to each paper.

Paper 1	Paper 2
Theme	
Environmental considerations in Strategic transport planning – introducing SCM from an environmental perspective	SCM practice and application of systems perspective in transport planning – a case study
Aim	
To explore the consideration of environmental aspects the early stages of the Swedish transport planning process, when using SCM	To analyze how the system boundaries, as set by the SCM process, influence how environmental aspects are considered and what aspects are included, or left out, in strategic transport planning
Specific research questions	
<p>-How does the application of the SCM in transport planning address environmental aspects?</p> <p>-What are the challenges and opportunities of incorporating environmental aspects into SCM practice?</p> <p>-How can SCM practice be adapted to manage those challenges?</p>	<p>-How is the SCM process designed to enable the integration of transport and land use considerations?</p> <p>-How are the system boundaries for the SCM process defined in relation to the aim and the scope?</p> <p>-Which environmental measures were possible to recommend within the system boundaries used in the SCM processes?</p>
Connected to thesis' research questions	
RQ1	RQ1, RQ3

Table 1: Summary of the theme, aims and specific research questions pertaining to each paper. SCM = Strategic Choice of Measures; ILCA = Integrated Landscape Character Assessment.

Paper 3	Paper 4
Theme	
Strategic transport planning and transport and land use integration in Nordic countries – an outlook	The application of ILCA in SCM – a case study
Aim	
To explore the practical application of strategic policy and planning instruments and approaches, as concern: facilitating the integration of land use and transport planning, promoting sustainable policy measures through collaboration among stakeholders across various governance levels.	To explore whether and how the application of a landscape approach contributes to informing decisions on strategic choices of measures in transport and land use planning practice, with the aim of fostering sustainability.
Specific research questions	
<p>-How do the Nordic countries employ strategic policy and planning instruments and approaches to facilitate collaborative land use and transport planning?</p> <p>-What are the practitioners' perceptions of contemporary practices to bridge the gap between strategic land use and transport policy and planning?</p> <p>-How can strategic policy and planning instruments enable the integration of environmental aspects and sustainability perspectives in contemporary practices for land use and transport planning?</p>	<p>-What role can the ILCA play in the SCM process ?</p> <p>-How can ILCA contribute to bridging the gap between transport and land use planning?</p>
Connected to thesis' research questions	
RQ1, RQ2	RQ1, RQ3

1.2.1 *Delimitation and contribution*

This study examines transport and land use planning practices carried out by public authorities in Sweden and other Nordic countries. The primary focus has been on the Swedish Transport Administration's (STA) Strategic Choice of Measures approach. The STA's primary role centers around transport infrastructure, with the ambition to positioning the study's emphasis on infrastructure planning within the broader realm of strategic transport planning. However, transport planning influence linked systems and need to extend the scope of transport planning to a more holistic understanding of the system at large.

The thesis' scientific contribution in terms of its empirical material, offers new insights into the incorporation of environmental and sustainability considerations within strategic transport planning. It highlights key elements that enhance the integration of these considerations into the planning and decision-making processes. Additionally, the thesis offers practical insights valuable to both practitioners and policymakers, bridging the gap between theoretical research and practical application.

1.3 Thesis structure

Following this introduction, Chapter 2 provides a comprehensive background to the thesis topic. In Chapter 3, the theoretical concepts utilized in this thesis are described. Chapter 4 provides a summary of the research design followed by Chapter 5, which presents the results of this thesis structured as brief summaries of the four papers. Chapter 6 analyzes and discuss the main findings and how they respond to the research aim and research questions of the thesis. Concluding reflections on the thesis and suggestions for future research avenues are presented in Chapter 7.

2 BACKGROUND TO STRATEGIC TRANSPORT PLANNING IN SWEDEN

In this chapter, the Swedish national transport policy is discussed, with a particular emphasis on transport policy objectives, the Environmental Objectives, the Sustainable Development Goals, the Climate Law, and the Policy for the Designed Living Environment. In terms of these objectives and policies, the division of responsibility and the roles of the national agencies active in transport planning are examined. Subsequently, the Swedish transport planning system and land use planning system are briefly described. Finally, approaches to environmental assessment in transport planning are presented.

2.1 Swedish national transport policy

The Swedish transport policy endeavors to establish guidelines, objectives, and strategies for managing transport systems effectively and sustainably. The overarching transport policy objective, adopted by the Swedish parliament is to “ensure the economically efficient and sustainable provision of transport services for people and business throughout the country” (Government Bill 2008/09:93). The overarching objective is complemented by two secondary objectives related to the function of and aspects to consider in the transport system. The ‘functional’ objective [funktionsmålet] states that the design, function and usage of the transport system should contribute to basic and equal accessibility to everyone and in a gender equal way, and contribute to development in all parts of the country. The objective of ‘consideration’ [hänsynsmålet] states that the transport system should be designed to minimize fatal or serious injuries, while also contributing to environmental goals and promoting better health (Transport analysis, 2017). The Government bill (2016/17:21) asserts that to fulfill the overarching transport policy objective, the functional objective must primarily be developed within the framework of consideration objective.

Sweden has adopted 16 National Environmental Quality Objectives (NEQO) that describe the desired state of the environment (Government bill 1997/98:145). Sweden's Environmental Objectives serve as guidance for environmental work across society, encompassing government agencies, county administrative boards, municipalities, as well as businesses and other stakeholders (SEPA, 2023). In 2015, Sweden adopted the 2030 Agenda for Sustainable development and the 17 Sustainable Development Goals (SDG) (UN, 2015). The Swedish environmental objective system (SEPA, 2023) has been in place since 1999 and can be seen as the ecological dimension of the global sustainability goals in the 2030 Agenda for Sustainable development. The Swedish Transport Administration (STA) has concretized the transport policy objectives in relation to the SDG's which has resulted in 'Vision 2030 - accessibility in a sustainable society' (e.g. STA, 2023). Vision 2030 contains of 14 objectives, sorted into 10 aspects, seven which relates to the 'consideration' objective (climate, air quality, biodiversity, traffic safety, active travel and noise) and four which relates to the 'accessibility' objective (accessibility in the whole country, accessibility for everybody, punctuality and simplicity, and safety).

The Swedish Climate Act (SFS 2017:720) and the climate policy framework (The Parliamentary Committee for Environment and Agriculture, 2016) were introduced together in 2018. They stipulate that domestic greenhouse gas emissions from the transport sector, excluding air traffic, should decrease by 70 percent by 2030 compared to 2010. In 2045, there should be no net emissions. To meet the climate mitigation objectives, several strategic plans, public investigations and government decisions (SEA, 2017; STA, 2020, 2016) have emphasized the importance of working in parallel on measures in three categories: increased vehicle energy efficiency, fossil-free fuels and a more transport efficient society. The concept of transport efficiency lacks a unified definition. The term generally captures aspects of integrated planning of transport infrastructure and land use to strengthen proximity, utilization of digital solutions to provide accessibility in ways which doesn't necessitate travel, increased utilization of vehicle capacity and

pooling of passengers and goods, and shifting journeys from car travel to walking, cycling and public transport (STA, 2016; Witzell, 2021).

In 2018, the 'Policy for the designed living environment' (Government bill 2017/18:110) was introduced as an overall national architecture policy. The policy objective states that "Architecture, form, and design should contribute to a sustainable, equitable, and less segregated society with carefully designed living environments, where everyone is given good opportunities to influence the development of the shared environment" (Government bill 2017/18:110, p.19). The designed living environment, which includes urban planning, infrastructure development, housing policies, and related areas, significantly influences how people live and move within urban and rural areas. Therefore, these aspects are deeply connected to the planning of transport systems, as transport policy focus on enhancing accessibility, improving mobility, supporting public transport, and developing infrastructure. Accordingly, the STA has adopted an architectural strategy that aims to develop how STA operate in order to achieve the transport policy objectives, architectural policy objectives, the cultural policy objectives and environmental and climate policy objectives (STA, 2021). The architectural strategy establishes the STA's overall architectural goal: "The Swedish Transport Administration will contribute to the development of society by creating well-designed environments that are functional, sustainable and beautiful". This strategy also describes principles for how architectural work should permeate all work within the STA, and covers a large part of the agency's activities (strategic and operational).

2.2 National agencies in transport planning and their responsibilities

The Swedish Transport Administration (STA) is responsible for the long-term planning of national road, rail, sea and air infrastructure. STA oversees the construction, operation, and maintenance of national roads and railways. Established in 2010, the STA is a multi-modal transport administration that replaced the previous separate road and rail administrations. Concurrently, the Transport Analysis Agency was formed to monitor and evaluate

transport policy and planning. Just before the formation of STA and the Transport Analysis Agency, the Swedish Transport Agency had been assigned a comprehensive responsibility for legislative regulations and regulatory surveillance (Government bill 2009/10:59).

This division of responsibilities means that there is no single government agency assigned with the comprehensive responsibility for developing the transport system. Before 2010, the (previous) rail and railway administrations had a broad mandate and instructions to support activities contributing to fulfilling political transport objectives in collaboration with other national agencies, regions and municipalities. This 'sector responsibility' empowered the administrations to inform, disseminate knowledge, and coordinate activities of various actors (Witzell, 2021). STA's mandate has evolved, shifting its focus primarily towards infrastructure provision. However, in 2016, the STA was commissioned with the comprehensive responsibility for coordinating traffic safety issues (Ministry of Enterprise and Innovation, 2016), and in 2019 STA was tasked to inform and disseminate knowledge about the climate mitigation objectives (Ministry of Enterprise and Innovation, 2019).

During the reorganization of the Swedish transport planning system around 2010, the STA underwent a transformation towards marketization, transitioning into a 'Pure purchaser' organization (The Transport Administration Inquiry, 2009). Previously, tasks such as planning, projecting, construction, and maintenance of infrastructure were conducted in-house but were later separated and privatized. This implied that the project organizations for transport infrastructure investments were intended to focus on procurement and project management and the specific competence of carrying out the actual work tasks would instead reside with market actors (Ek Österberg, 2016; Witzell, 2021).

In conjunction with formal transport infrastructure planning, the government formulates transport policy through alternative channels. These include public investigations, commissions to public agencies and the establishment of coordination and collaboration between agencies. One

example is the so-called national negotiations of housing and infrastructure, in which co-funding by local government is explicitly discussed (Arts et al., 2016). Consequently, several policy initiatives aimed at developing the transport system are pursued outside the formal transport planning system (cf. Högström et al., 2018).

2.3 Swedish transport planning

In conjunction with the reorganization of the transport sector (Government bill 2009/10:59) and the reformulation of national transport policy goals (Government bill 2008/09:93), the transport planning system was changed (Government bill 2011/12:118). Sweden has a tradition of developing national long-term transport infrastructure investment plans, before the reformations there were separate investment plans for roads and railways, these have now merged into one multi-modal plan with a 12-year perspective and it is usually revised every fourth year (Witzell, 2017).

Today, Swedish transport planning consists of long-term strategic infrastructure investment planning and physical planning of individual measures (Figure 1). In long-term investment planning, the process begins with an assessment of the current state of the transport system, followed by the formulation of a comprehensive strategic development direction based on political objectives and instructions (Balfors and Gunnarsson-Östling, 2021). According to the comprehensive strategic development direction, an investment plan proposal is formulated, prioritizing measures and allocating resources based on a spending framework and planning directives established by the government (Lundberg et al., 2020).

Planning of individual infrastructure measures should be based on a so-called Strategic Choice of Measures (SCM) process (Tornberg and Odhage, 2018a). In the SCM process measures are investigated according to the so-called four-step principle (Figure 2), which is a stepwise analysis for finding alternative measures to a transport-related problem (Government bill 2011/12:118). The four steps aims at (i; “Rethink” and ii; “Optimize”) promoting measures that influence the need and demand for transport and

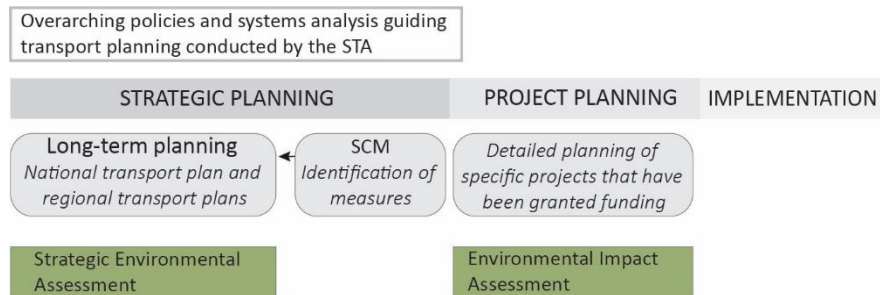


Figure 1: An overview of the national planning process facilitated by the Swedish Transport Administration.

choice of transport mode, (iii; “Rebuild”) using existing infrastructure more efficiently before reconstruction and (iv; “Build new”) implementing infrastructure (STA, 2014). The idea is that the implementation of the four-step principle should provide more open-ended analyses of how the needs for different transport modes can be fulfilled, both in terms of the actors involved and measures implemented. As for STA, their ability to finance measures under the four-step principle is limited since governance ordinances do not allow the STA to fund measures involving other actor’s infrastructure, such as municipal roads or regional public transport infrastructure. In addition, step 1 and step 2 measures are often associated with municipalities’ responsibilities in land use development, consequently municipal investments are needed to implement such measures. This weakens the ‘four step principle’ and risks strengthening the focus on capacity-increasing solutions in state-owned infrastructure (Johansson et al., 2018). Nevertheless, if the measures identified in the SCM are granted funding, physical planning and design of the measures can start, and when the physical plan (a road or railway plan) has legal approval, construction can begin (Government bill 2011/12:118).

In the SCM process, affected national, regional and municipal actors collaboratively investigate different solutions to an identified problem or deficiency in the transport system. The SCM guidelines outline how the SCM process should be conducted (STA, 2014). The process is structured into four procedural phases (Figure 4). (i) In the initial phase, a planning

process is organized based on initial assumptions and assessments of problems and solutions related to the transport system, as defined by the STA. Additionally, resources are determined, a process coordinator is appointed by the initiating organization (often STA), competencies and co-actors are engaged by the process coordinator, and the purpose of the study is defined in dialogue with all engaged actors. The role of the process coordinator is intended to be neutral, i.e. not to be biased towards any particular interest. The process coordinator's assignment is to coordinate the process activities, i.e. the gathering and analysis of knowledge, as well as dialogues between actors. (ii) The second phase is about understanding the context, and a workshop is organized to gather information from multiple perspectives to broaden the scope of the SCM. After an initial phase of broadening its scope, the focus is subsequently narrowed down.

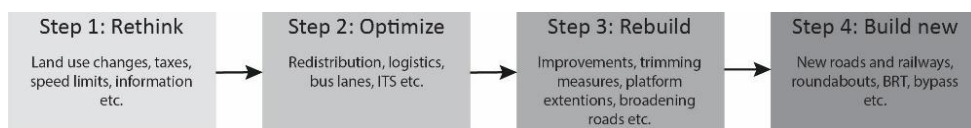


Figure 2: The Swedish four-step principle (Johansson et al., 2018; STA, 2014). The principle outline in what order types of solutions to (transport related) problems should be considered in a planning process, such as the SCM.

Additionally, SCM objectives are established, and indicators to guide the process are identified. (iii) In the third phase, multiple workshops are usually held involving actors and stakeholders with relevant knowledge and responsibilities to generate alternative measures for the particular SCM. The most appropriate and efficient measures are investigated more in-depth and compared with each other, with the assistance of the four-step principle (see above). (iv) In the final phase, recommendations about the most effective measures are made. These recommendations are based on an overall impact assessment, and every measure is appointed a responsible organization. The final measures proposed by the SCM process does not formally commit organizations to apply them; decision-makers of each organization will handle this after the SCM process is finalized.

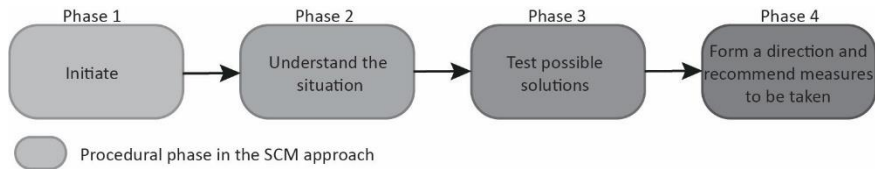


Figure 3: The SCM process and the four procedural phases outlined in the SCM guidelines (STA, 2014).

2.3.1 Swedish land use planning

A large proportion of political and administrative power in Sweden is delegated from the State to the local level, that is, to the 290 municipalities in Sweden (Hedström and Lundström, 2013). The municipalities' responsibilities in relation to land use planning is regulated in the Planning and Building Act (PBA) (SFS 2010:900), The Law on municipalities' housing responsibility (SFS 2000:1383) and the Law on public transport (SFS 2010:1065). The responsibility according to the planning and building act comprehend planning of land and water resources within the municipal borders. The PBA provides municipalities with planning instruments with varying levels of concreteness and different degrees of control, through which they can steer the development and the preservation of the built and physical environment (SNBHBP, 2022). There are two main planning instruments: the Municipal Comprehensive Plan and the Detailed Development Plan. The Municipal Comprehensive Plan is not legally binding but should include guidance on future land use development and describe long-term strategic developments within the municipality. The Municipal Comprehensive Plan guides the Detailed Development Plan, which is legally binding and regulates the use of land and water (SFS 2010:900). Municipal land use planning must account for general interests such as the functioning of roads, conservation or protection of land or water that is of national interest, or certain geographical areas with high cultural or ecological value and environmental quality standards (Lidmo et al., 2020). How the municipalities intends to handle these 'general interests' is presented in the Comprehensive Plan.

Sweden is divided in 20 regions with a responsibility for regional development and growth (SNBHBP, 2022). The planning instruments at this level are a Regional development strategy, Regional transport plan and a Regional traffic supply program. The regional development strategy must constitute an integrated and cross-sectoral strategy for the regional growth, including goals and long-term priorities. The regional transport plan is an integral component of the national transport plan, focusing on infrastructure investments specifically within the regional transport system. The regional traffic supply program outlines basic principles for the development of public transport in the region. Additionally, the county administrative boards are responsible for monitoring the implementation of national policies at the local and regional levels (SFS 2017:868).

The Transport Administration Inquiry (2009) recommends that the STA should increase its collaboration with municipalities, emphasizing the need for coordinated transport and land use planning, as well as the implementation of measures. The restructuring of the transport system (STA, 2010) intended to improve the flexibility of the planning processes and thereby also the interplay between the STA and the municipalities. The SCM process has a central role in terms of coordinating transport and land use planning, and the implementation of measures, by gathering the different actors to collaboratively solve planning issues (e.g. Tornberg and Odhage, 2018b). In this process, the different actors can acquire a collective understanding of goals and the need for particular transport-related and land use-related measures (STA, 2014).

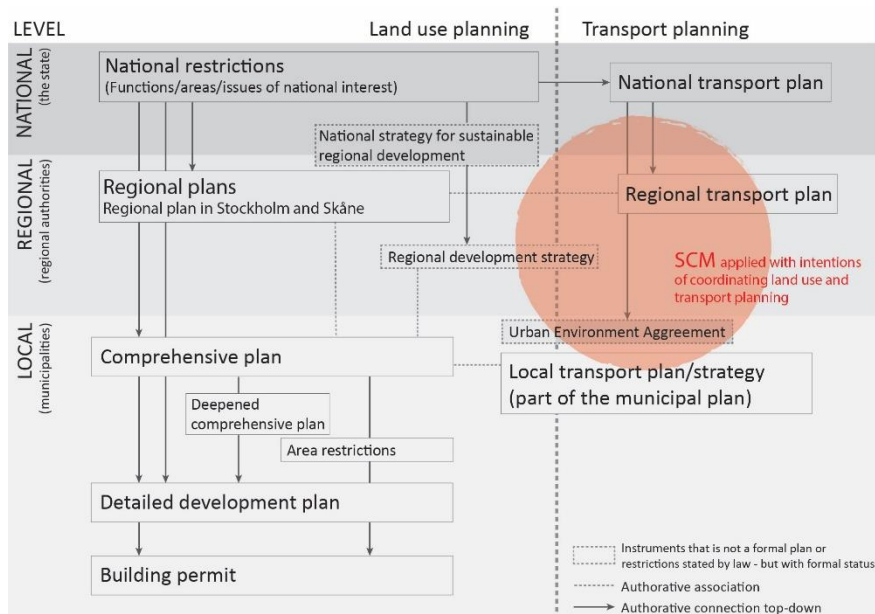


Figure 4: Land use and transport planning in Sweden.

2.4 Environmental assessment in Swedish transport planning

Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) are two mandatory assessments required for projects (EIA) (EU Directive 2014/52/EU) and plans (SEA) (EU Directive 2001/42/EC) respectively, when they are expected to have significant impacts. One difference between, for example, the Environmental Impact Assessment (EIA) and other assessments is that there are legal requirements for EIA that regulate the process and the contents of the EIA report. The Swedish environmental code state that “The aim with environmental assessment is to integrate environmental aspects in planning and decision making in order to promote sustainable development” (SFS 1998:808, 6 chap. 1 §). The legislation on environmental assessment in the 6th chapter of the Environmental code applies to transport planning (SFS 1971:948, 1 chap. 3; SFS 1995:1649, 1 chap. 3§). The Swedish Environmental Code

stipulate requirements for Strategic Environmental Assessment (SEA) for plans and programs, as well as environmental impact assessment for projects. The SEA is a tool for integrating sustainability aspects in national and regional transport planning (Lundberg et al., 2020). Similarly, the EIA is applied to the physical planning of transport infrastructure investments.

In the context of the SCM process, there is no requirement for any formal environmental assessment. This procedure implies that decisions (that affect people's health and the environment) still are made without any requirements for investigations and documentations that follow the environmental assessment process (Balfors and Gunnarsson-Östling, 2021). According to the STA's guidelines for application of environmental assessment in road and railway projects (STA, 2022), the SCM should encompass analysis of environmental objectives as well as effects and impacts on the environment. The outcome of the SCM process includes recommendations for the direction of transport system development and specific measures. In order to consider these recommendations in subsequent planning, they must be accompanied by disclosed motives with regard to the environment.

As support for consideration of environmental aspects in the SCM, the planners (and other participants) are provided with, for example, documentation and guidance on assessments of STA's environmental priorities as well as Vision 2030 (STA, 2019, 2014). The environmental priorities include climate and energy, air quality, noise and vibrations, landscape, water, material and chemical products, and contaminated soils, and are derived from the National Environmental Goals (STA, 2023). In the SCM process (STA, 2014) environmental concerns can be addressed in the first and the second phases (Figure 5) as part of identifying and understanding the problems.

They can also be addressed in the third and fourth phases (Figure 5) as part of the assessment of measures, i.e. a measure should be assessed based on whether it contributes to the fulfilment of the project-specific objectives. This encompasses concerns regarding the transport system’s capacity to minimize negative impacts and promote positive development in alignment with STA’s environmental priorities.

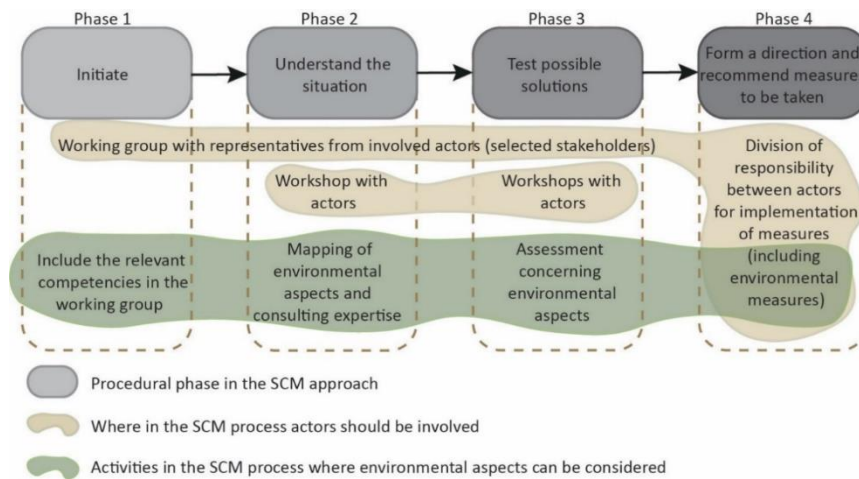


Figure 5: A description of where in the SCM process, in the ideal case following the SCM guidelines (STA, 2014), actors are involved, and environmental aspects are considered, as developed in Paper 1. An extended figure can be found in an Appendix to Paper 1.

2.4.1 Integrated Landscape Character Assessment in transport planning

The STA is commissioned to work towards the national goal for the designed living environment (Government decision I2020/03340). As part of this multifaceted effort undertaken at different organizational levels, the STA aims to enhance SCM practices. This involves emphasizing the coordination between STA and municipalities’ planning activities and highlight architectural, landscape and cultural aspects in strategic planning (STA, 2021). The overarching goal is to facilitate more effective resource utilization and ensure a more comprehensive consideration of the existing environment. Another integral aspect of this ongoing effort, initiated several years ago, involves the development of a methodology designed to enhance

the comprehension of landscape functions and prerequisites in planning and investments. This methodology is known as the Integrated Landscape Character Assessment (ILCA) method, drawing inspiration from an approach developed and implemented in England (Clemetson and Schibbye, 2015; Swanwick, 2003). Landscape character assessment is a well-established tool for implementing the landscape perspective in planning (Arts et al., 2017). While landscape character assessment was initially developed to assess and understand the character of rural landscapes, its principles and methodologies have been adapted and extended to different contexts, considering a landscape's physical, ecological, and cultural attributes (e.g. Clemetsen and Schibbye, 2016; Dobson, 2018). Landscape character assessment serves to aid planners, policymakers, and researchers in understanding the perceptions and values associated with diverse landscapes, as well as their potential contributions to the well-being of individuals and communities (Fairclough et al., 2018b). This is achieved through thematic analysis and characterization of the landscape, coupled with the integration of insights from various professions into the planning process.

The ILCA, as developed on behalf of the STA, can be applied in different planning phases, i.e. strategic and operational. In the documentation on methodology provided by the STA, the most detailed instruction for application is provided for the formal (operational) planning phase, i.e. post SCM. However, as previously mentioned, the ILCA can be applied in SCM processes as well. Figure 6 presents a process scheme of the SCM and the ILCA, as developed in Paper 4 by the authors.

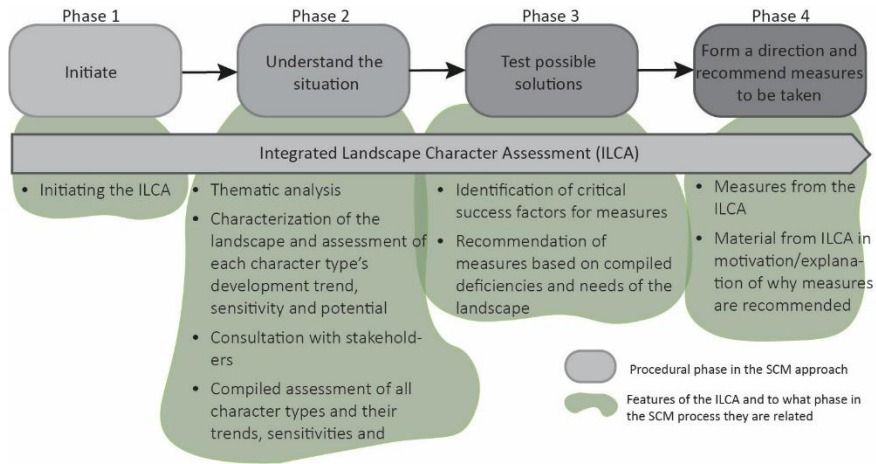


Figure 6: Process Scheme of the SCM process and the Integrated Landscape Character Assessment, as developed in Paper 4.

3 THEORETICAL FRAMEWORK

In this chapter, the theoretical perspectives that have significantly influenced the research process and design are compiled, illustrated in Figure 7. The approach is rooted in the quest to comprehend the consideration of environmental aspects in strategic transport planning. The ‘journey’ commenced with trying to understand the interrelationship between the transport system and the environment, as well as, the theoretical context in which transport planning occurs. Subsequently, as the interdependence between transport and land use features became evident, different strategies for assembling knowledge concerning the complex interactions between transport and land use have been studied. This exploration led to embrace theories centered around integrated systems approaches and landscape analysis. Further, the studied theories addressing the integration of transport and land use planning, encompassing policies and instruments designed to bridge the gap between these two domains. Finally, in seeking to comprehend the impact of a tool for operationalizing the landscape perspective (Integrated Landscape Character Assessment), in strategic transport planning (SCM) towards fostering a sustainable society, transformative capacity framework was applied.

3.1 Transport infrastructure and environmental aspects

The transport system has a significant impact on both the living (biotic) and non-living (abiotic) elements of the natural landscapes (Coffin, 2007). It influences the dynamics of plant and animal populations, changes material flows in the environment, introduces foreign elements, and alters the availability of resources such as water, light, and nutrients (Bennett, 1991; Forman and Alexander, 1998). The interaction between the environment and transport infrastructure depends on factors like ground slope, wind patterns, and surrounding land use (Seiler et al., 2019).

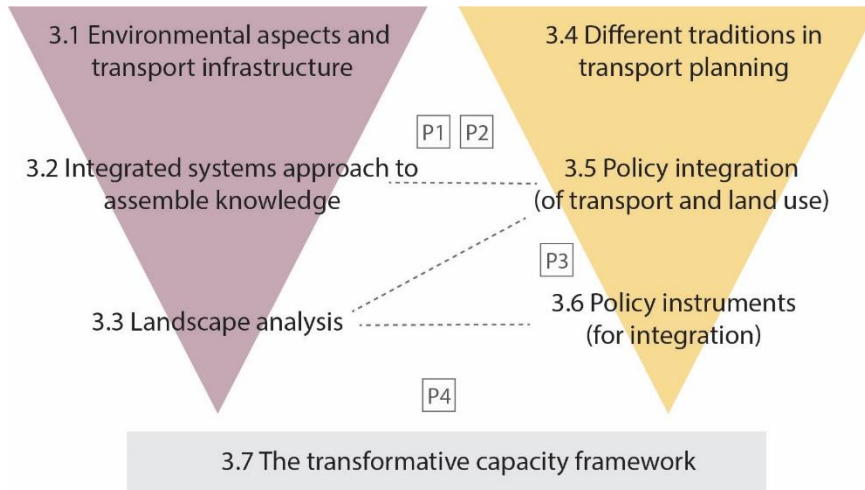


Figure 7: The figure show an overview of the theoretical approach used throughout the research process. The four papers (P1, P2, P3 and P4) is placed in close proximity to the theories applied in each paper respectively.

However, in order to handle these environmental effects, it is necessary to consider them early in the planning phase (Nilsson and Dalkmann, 2001). This approach raises awareness and helps develop ideas for mitigation measures to reduce or minimize environmental impacts. Moreover, early identification and mitigation of environmental risks can prevent costly remediation efforts later (Fundingsland Tetlow and Hanusch, 2012). In addition, considering environmental factors in strategic planning enhances an organization's ability to anticipate and respond to environmental risks and challenges. This highlights the crucial role of strategic transport planning in ensuring a systems approach that integrates environmental considerations and sustainability perspectives. Below are some examples of important environmental aspects and effects linked to the transport system.

In terms of hydrology, roads can serve as both sources and sinks of water. Water runoff from road surfaces or its accumulation can affect the natural flow downhill. Roads can act as barriers to water flow while simultaneously expediting water removal (Jones et al., 2000). At a larger scale, roads interact with stream networks, impacting stream drainage density, overall peak flow,

and the occurrence of debris flows in drainage basins (Pechenick et al., 2014). Drainage swales along roads can connect directly to stream networks, extending the drainage network (Forman and Alexander, 1998). Consequently, transport infrastructure can lead to channel erosion, scouring, and an increased risk of downstream flooding. Additionally, road cut-banks near streams may cause sedimentation, contributing to further environmental impact. Moreover, the presence of transport infrastructure has measurable effects on the morphology of stream and river channels, subsequently affecting the surrounding biota (Perkin et al., 2013). Shallow pools, increased turbidity, and reduced vegetation along banks influence water temperature, stressing aquatic species that require colder temperatures (Jones et al., 2000).

Air and water pollution represent well-recognized environmental consequences of road systems (e.g. Bignal et al., 2007). Toxic chemicals associated with air and waterborne particulates can lead to diseases and increased mortality in humans (Coffin, 2007). These contaminants may deposit near roads or travel longer distances via wind or water. Stormwater runoff is a primary pathway for these pollutants to enter the broader landscape (Trombulak and Frissell, 2000). The ecological effects of these contaminants are challenging to measure due to their varying sizes and characteristics. Furthermore, volatile chemicals are introduced to the environment through emissions, with primary pollutants like carbon monoxide and nitrogen oxide directly affecting air quality (Truscott et al., 2005). Some primary pollutants react to form secondary pollutants, such as ozone. Although emissions like carbon dioxide are not directly toxic, they affect global natural systems and cause climate change (Contini et al., 2012). Air pollutants also find their way into aquatic systems, contributing essential inputs of nitrogen, metals, and hydrocarbons to water bodies (Hartmann, 2015).

Traffic contributes to increased noise levels that affect both people and animals (Khan et al., 2018). Efforts have been made to design and implement noise reduction measures for human well-being. Apart from noise-related issues, roads and similar infrastructure influence wind

direction, speed, temperature, relative humidity, and insolation (Forman and Alexander, 1998). Additionally, road dust covers vegetation surfaces, impacting photosynthesis, respiration, and transpiration (Farmer, 1993). These microclimatic changes can alter the composition of vegetation in the vicinity of roads (Forman and Deblinger, 2000).

The transport system also has repercussions for the living components of ecosystems. Roads can obliterate entire ecosystems, affecting both animals and plants (Coffin, 2007). The destruction of a small area for a roadbed may be particularly harmful to certain species, especially small animals with high site fidelity (e.g. Jaeger et al., 2007). Animals that move slowly or regularly cross roads and railways are at risk of collisions with vehicles (Forman and Alexander, 1998). Furthermore, the transport system acts as a conduit, introducing and facilitating the spread of exotic species across landscapes (Brock and Kelt, 2004; Getz et al., 1978; Oxley et al., 1974). Road and railway verges may also serve as important sources of biodiversity, especially in areas where native species have been displaced due to urbanization or agricultural development (Deckers et al., 2005). The transport system increases the contact of biotic components with human activities and land use.

Additionally, Karlson et al. (2014) highlight that road and railway structures can serve as attractive habitat for numerous species. These infrastructure often benefit generalist and disturbance tolerant species, and unfavorable for species with specific habitat requirements (Ottosson et al., 2012; Runesson, 2012). However, there are some exceptions especially concerning plants and invertebrates. Changes in the physical structure of these environments can lead to various species-specific responses, demonstrating the complex interplay between transport infrastructure and biodiversity.

As mentioned, transport infrastructure has numerous direct ecological effects on adjacent aquatic and terrestrial systems. However, as a network structure, it also exerts far-reaching cumulative effects on the landscape (Karlson and Mörtberg, 2015; Rütters and Wickham, 2003). These effects include habitat loss through land cover and land use changes induced by the

transport system (Angelsen and Kaimowitz, 1999). Moreover, transport infrastructure may reduce habitat quality through fragmentation and the loss of connectivity (Carr et al., 2002). Larger issues involve the synergistic effects of roads, railways, and transport networks on ecosystems at higher spatial scales.

3.2 Integrated systems approach for assembling knowledge about the environment in planning

Transport planning involves several environmental aspects, each with its own system boundaries. The concept of "system" takes on various meanings across disciplines. Disciplines like ecology, sociology, planning, engineering, and economics contribute with different perspectives to its definition (Gudmundsson et al., 2016). A comprehensive definition that encapsulates various viewpoints is offered by Haines (2010, p.2), who defines a system as "a set of elements or components that work together in relationships for the overall objectives/vision of the whole."

Accordingly, the ecological systems perspective provide a holistic approach to analyzing interactions and transactions between biological and ecological systems (e.g. Holling, 1973), and this approach, i.e. the systems perspective, is useful to capture the broad array of environmental aspects pertaining to the transport system, their status and how they may develop in different scenarios of development. However, to account for the networked character of society (rural, peri-urban and urban) the relationships among many different systems must be understood, i.e. an integrated systems approach is needed (Bai et al., 2017; Meerow et al., 2016).

One systems representation that is well-known and that tries to capture society's complexity is the social-ecological system (Berkes et al., 2003). It combines the concepts of natural and social systems. Natural systems refer to natural resources and physical phenomena, such as air, water, biodiversity and ecosystems (Pickett et al., 2011). Ecosystem is a term used in ecology to describe an assemblage of organisms interacting with the physical environment within a defined area (Pickett et al., 2004). The interconnection

between organisms in nature contributes to the persistence and functioning of an ecosystem (Martin et al., 2016). In the beginning of 2000 the concept Ecosystem services were launched, defined as benefits to humans provided by the natural environment and from healthy ecosystems (Millenium Ecosystem Assessment, 2005). Based on an anthropogenic perspective ecosystem services frameworks is one way to portray the interdependencies of human and natural systems as well as to ascribe values to particular system states in land use decision-making (Fisher et al., 2009; Löfgren, 2020a). Changes to land use due to for example transport infrastructure affect parts of the social-ecological system and system properties, processes, and components that ecosystem service provision relies upon. Examples of biophysical factors driving land use change (Jaeger et al., 2007) are the introduction of barriers and disturbance regimes (Fahrig and Rytwinski, 2009), and altering hydrological processes with subsequent changes to erosion and sedimentation (Forman et al., 2003). Social systems encompass the socio-economic, political and institutional dimensions, including variables such as personal income, culture, governance, demography, justice, education and health (Berkes et al., 2003).

Another framework, that builds on the social-ecological systems framework, is the social-ecological-technological system (Sharifi, 2023). The framework emphasize the important roles that technological infrastructures play in shaping and managing human-environment interactions (Meerow et al., 2016). For example, in cities, there is a strong interdependence between the development of land use density, diversity and design, and the transport system (Bertolini and Dijst, 2003; Cervero and Kockelman, 1997). In addition, previous studies show how combining transport infrastructure development, with other local land use development can improve the societal, economic, and environmental benefits of projects (e.g. van Geet et al., 2019). The social-ecological-technological perspective draws attention to the complex and dynamic networks of interactions between social, ecological and technological elements of urban systems that shape urban development trajectories in adaptive, self-organizing ways (Ernstson et al., 2010).

As mentioned above, the transport system can be considered as a technological system, as part of the social-ecological-technological system. However, there are multiple definitions of a transport system. For example, according to Geels (2005) the transport system is a socio-technical system with no clear distinction between its physical and social elements. Instead, the system is represented by a series of interconnected functional elements, i.e. policies and regulations, and socio-cultural norms. Another approach is to describe the transport system as an open system that interacts with its environment. Here “the crucial point [is] that the system is a social system and that it requires natural and manmade inputs that produce outputs which, in turn, impact the environment” (Gudmundsson et al., 2016, p. 61). However, this definition does not capture the interaction with other types of technological systems.

To make the complex integrated systems easier to handle in planning, societal development is often organized into projects. Viewed through a systems perspective, planning projects require decisions on the inclusion or exclusion of elements, relationships, and operations, with interactions defined by chosen system boundaries (Verweij et al., 2014). Examining diverse boundary types, Verweij et al. (2014) cover participation, territorial, functional, and structural boundaries. Participation boundaries in a project involve determining which actors are included in the planning process and in what capacity they are involved (Ashmos et al., 2000). Territorial boundaries define the geographical area under consideration (Verweij et al., 2014). Functional boundaries relate to the substantive scope focused on by the project. In the case of transport projects, the primary focus is typically on infrastructure, but non-focused functions like housing and nature can also be considered as boundaries. Structural boundaries involve demarcations concerning tasks and responsibilities (Ashmos et al., 2000), determining whether there is a strict division of tasks and responsibilities among actors or if the project aims at shared responsibilities and tasks.

In sum, an integrated systems approach contribute with the possibility to capture societal complexities relevant in transport and land use planning. To manage complexities in planning practice, a project structure is often

applied, which comes with decisions about which elements, relationships and operations that be included and excluded. These are important prerequisite for analysis, assessment and decision-making in planning.

3.3 Landscape analysis: holistic understanding of the specific context

Landscape analysis could be seen as a mean to conceptually separating the parts of the landscape and examining its interrelationships, in order to improve understanding (Stahlschmidt et al., 2017). In transport planning it is important to gather and create knowledge about the environment and its interconnection with social and cultural aspects. Transport planning is an inherently spatial practice, and the ways in which transport systems are designed and implemented have significant impacts on the form and function of landscapes (Löfgren et al., 2018; Seiler et al., 2019). Landscape analysis has much to offer in terms of gathering knowledge in this context (Stahlschmidt et al., 2017). The concept of landscape is one of few that fully integrates nature and culture, people and environment, social concerns and the economy (Arts et al., 2017). However, the concept of landscape can vary depending on individual perspectives and disciplinary backgrounds (Antrop, 2000; Buttner, 2001; Corner, 1999; Jackson, 1985; Jones, 2003; Olwig, 1996). It is also interchangeable, with other words such as nature, scenery, countryside etc. all of which are relevant to landscape approaches but not all landscape approaches involve them. One useful and influential definition of the landscape concept is the European Landscape Convention (Council of Europe, 2000). The ELC defines landscape as “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe, 2000, §1A). According to the ELC, the concept of landscape include natural, rural, peri-urban and urban areas as well as land, inland water and marine areas. Also, the ELC stresses the multi-dimensionality of landscape by stating that the identification, description and assessment of landscapes should involve “analysis of morphological, archeological, historical, cultural and natural characteristics and their interrelations, as well as an analysis of change” (Council of Europe, 2000, §1.1B). The knowledge of landscape incorporates both

tangible and intangible elements (Olwig, 1996). The ELC acknowledges this comprehensive perspective by identifying landscapes as integral facets of individuals' surroundings. Landscapes are not only manifestations of the diversity inherent in shared cultural and natural heritage but also serve as the underpinnings of identity (Council of Europe, 2000). Consequently, a landscape can be perceived as both a territorial entity with distinct characteristics and a culturally defined framework for perceiving and understanding a particular area.

Landscape analysis comprise several analytical concepts (Stahlschmidt et al., 2017). Central concepts are the analysis of natural factors, biophysical attributes and land cover (1), historical analysis (2) and spatial analysis (3). The first analysis address the connection between the natural factors and the current land use in the site. The historical analysis address the trajectory of change in the landscape, including critical drivers or events that have caused the landscape to change quickly or significantly. The spatial analysis analyze the spatial structure and expression of the landscape, such as the relative location and significance of different patterns, elements and features. It also address how we experience the landscape through our senses and through movement and physical engagement. These three analytical concept are often used to provide a thematic overview of a larger project area.

Other central analytical concepts are land classification and characterization (Fairclough et al., 2018b). The characterization of a landscape into homogenous areas aims to provide an overview of the composition of the landscape in question, and of the specific character of the individual areas identified (Stahlschmidt et al., 2017). A homogeneous region refers to an area characterized by homogeneity in both its biophysical and cultural attributes. This is in contrast to a functional region, where specific human activities (e.g. municipalities), define the region's boundaries and purpose. The word character refers to a distinct, recognizable and consistent pattern of elements in the landscape that makes one landscape area different from another. Particular combinations of landform, soils, hydrology, vegetation and land use create the character. The word characteristics means elements, or combination of elements that uniquely contribute to a distinct character.

The thematic analyses of a larger project area and the characterization of land into homogenous entities can be used in a landscape assessment, which considers the dynamics, condition and development of the landscape in terms of its values potentials, problems and sensitivities (Stahlschmidt et al., 2017). In a landscape character assessment (Swanwick, 2003), characterization aids in highlighting the unique identity of every landscape, not solely those perceived as valuable. The concerns for everyday landscapes, in a landscape character assessment, highlights the importance of collective values that shape landscape management practices, and the particular local values recognized by communities (Stephenson, 2008).

The previously mentioned ecosystem services is one set of frameworks closely related to the landscape concept and landscape analysis. Ecosystem services is a way of communicating societal dependence on ecological life-support systems that integrates perspectives from both the natural and social sciences (Angelstam et al., 2019). The framework also provide a basis for assessment and measurements that link to the policy-making arena. According to Angelstam et al. (2019) landscape approaches (representing the concrete coupled human-nature system) can foster learning about ecosystem services in land use development practices.

Another concept linked to landscape is the Nature-based solutions (NBS) concept introduced by the European Commission 2015, which have emerged to operationalize ecosystem services within spatial planning policies and practices (Albert et al., 2021; Khoshkar, 2020; Scott et al., 2016). NBS are defined as “actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits” (UNEA-5, 2022). Sowińska-Świerkosz et al. (2024) have identified several linkages between NBS and the notion of landscape, such as the contribution of landscape-based management to the implementation of NBS as well as landscape-based indicators that are used to assess the impacts of NBS. Additionally, Frantzeskaki (2019) draws several lessons related to various

planning stages (from ‘proof of-concept’ to implementation) of NBS in cities and concludes that “nature-based solutions require multiple disciplines for their design, diversity (of settings) for co-creation and recognition of the place-based transformative potential of nature-based solutions as ‘superior’ to grey infrastructure. (p. 101)”

Landscape analysis and assessment have much to offer in transport and land use planning and decision-making, particularly in enhancing the implementation of NBS. However, there are various approaches for landscape assessments that have been developed under the influence of numerous discourses and competing claims on nature conservation, sectoral land use policies, land and resources, ecosystem services and sustainable development (Arts et al., 2017). This is important to consider in relation to decision-making, because the structure and focus of the landscape analysis can be shaped in many different ways, such as the needs and visions of the people involved and base the analysis upon their knowledge and direct experience of the site, or on expert understanding and response to the site. Another consideration is determining which analytical tools to employ and their sequence (Stahlschmidt et al., 2017). Steinitz (1990) provide a framework for landscape planning that is structured as followed:

Understanding the situation:

- *How should the landscape be described?*
- *How does the landscape operate?*
- *Is the landscape working well?*

How to respond to the situation:

- *How might the landscape be altered?*
- *What differences might the changes cause?*
- *Should the landscape be changed? How is the decision to be made?*

With guidance of these questions, the planners can make decisions in relation to what analytical tools, type of information and what actors to include in the planning process. This structured approach aims to facilitate informed and sustainable decision-making regarding the implementation of solutions within the investigated context, tailored to the specific challenges and conditions encountered.

3.4 Different traditions in transport planning

In planning there are different traditions that can be distinguished by analyzing the main rationalities that structure actions (Friedmann, 1987). Technical instrumental, communicative and strategic rationalities emphasize different logics and reasoning in planning practice (Alexander, 2000; Campbell, 2012; Healey, 1997). These three rationalities, and others, have an influence on transport planning practice (e.g. Alexander, 2000; Löfgren, 2020), and in some contexts they coexist (e.g. Tornberg and Odhage, 2018a).

The technical-instrumental model to planning, which received much attention in the 1950s and 1960s, emphasize the scientific qualities of decision-making processes (Campbell, 2012). These models operate on deductive logic and instrumental reasoning rooted in scientific analysis. It is goal-oriented and strives to achieve specific objectives by optimizing methods, such as transport models (e.g. Alexander, 2000). According to this planning tradition, expert knowledge that is understood from an objectivist point of view is considered factual. The technical instrumental approach to planning has been criticized in several regards, for example, the approach has difficulties with handling complexities, uncertainties, power struggles and value conflicts (Innes and Booher, 2016). It has also been criticized for marginalizing other ways of knowing (Healey, 1997).

The communicative model to planning emphasize, since the 1980s, the planning process, stakeholder involvement, empowerment of citizens and power relations embedded in decision-making processes (Næss et al., 2013). In literature on communicative rationality, knowledge is considered socially

constructed and the social embeddedness of ways of thinking and acting is emphasized (Healey, 1997). Planning procedures should be deliberative and iterative, with strong elements of knowledge-sharing and learning, acknowledging multiple problem definitions (Healey, 2003). However, communicative planning has been criticized for not considering power asymmetries among actors (Flyvbjerg, 1998). The interdependence between actors affects the power relation between them and will thereby affect the 'mutual and deepened understanding' of the problem and objectives of the process; likely in the favor of the powerful actors (Innes and Booher, 2016). Powerful actors are more likely to maintain a balanced relationship, facilitating effective collaboration.

A strategic approach in planning, much like the technical approach, is instrumental in nature as it aims to achieve specific objectives (Alexander, 2000). Unlike the technical approach, strategic planning emphasizes the integration of choice of means, prioritizing objectives and assessing the situation in which decisions are to be taken (Alexander, 2000). In this way, the strategic approach could legitimize individual actors interests, and increase their commitment to the task (Healey, 2007). One major advantage of strategic planning is its ability to account for the reactions and opinions of the actors involved (e.g. Tornberg and Odhage, 2018a).

Traditionally, transport planning has been dominated by technical instrumental rationality (Willson et al., 2003), with a strong believe in the quantitative 'predict and provide' thinking (Owens, 1995). The focus has been on planning activities that optimize the transport system. The planning and budgeting were focused on a specific transport activity often corresponding to the division of tasks between government departments, and transport planning has been the typical example of the sectoral planning tradition (Busscher et al., 2015). Today the technical instrumental approach is still highly influential in transport planning practice (Marsden and Reardon, 2017; Willson, 2001). However, transport planning has been criticized for focusing too much on transport flows and paying too little attention to capturing and valuing place based issues and peoples experience of place (Vigar, 2017). Several researchers suggest that collaborative

approaches need to be strengthened in transport planning, to acknowledge and account for forms of knowledge that may otherwise be neglected as well as to establish cross-connections between sectors and institutional entities (Hrelja et al., 2018; Vigar, 2017). This implies, for example, that planning and implementing efficient transport require collective action of organizations with different responsibilities and driven by different rationalities (Pettersson et al., 2018). At the same time, in contemporary Swedish transport planning and decision-making, logics of project management have strongly influenced planning practice. Stimulating productivity and market competition in transport planning and construction industry has been an explicit and prioritized goal for STA (Ek Österberg and Qvist, 2020). According to Witzell (2019), the strengthening of the project management approach and focus on economic targets is weakening the collaborative planning. Moreover, the decision-making in projects are influenced by the organizational form, which in a strategic phase cause a tension between the logic of openness and the logic of conducting planning in project form (Ek Österberg and Qvist, 2020), i.e. meeting specific objectives.

3.5 Policy integration: Transport and land use

As mentioned in the previous section, cross connections between sectors and institutional entities is a way forward to facilitate collective action of actors for effective transport solutions. This actualizes the concept of policy integration. Transport and land use integration, as one specific form of policy integration, focuses on the reciprocal relationship between the land use system and the transport system, which is addressed in this thesis.

Policy integration aims to establish inter-sectoral and multilevel relationships between interdependent policy actors, and has emerged as a concept to address fragmented policy domains. Traditionally, in many countries, the public sector has been characterized by clearly delineated responsibilities and a hierarchical and sector-oriented division of tasks (Dunleavy and Hood, 1994; van Geet et al., 2021). Over the years, single-purpose organizational units has been developed, with explicit and discrete goals and

responsibilities (Cejudo and Michel, 2017). This has led to policy domains which have their own conception of policy problems, appropriate solutions, ideologies and interests. These circumstances have influenced public policymaking in different ways leading to a fragmented practice (Stead and Meijers, 2009).

Policy integration relates to many research fields, and the terminology varies depending on literature. In the realm of bridging transport and land use planning, concepts such as integration, coordination, cooperation, and collaboration are often used interchangeably. However, the academic literature also engages in discussions regarding the nuanced differences between these concepts (e.g. Geerlings and Stead, 2003; Keast et al., 2007). There are also variations in how the concept integration is presented, for example, Geerlings and Stead (2003) outline the following types of policy integration:

- Vertical integration—policy integration between different levels of government
- Horizontal integration—policy integration between sectors or professions within one organization (i.e., inter-sectoral)
- Inter-territorial integration—policy integration between neighboring authorities or authorities with some shared interest in infrastructure and/or resources
- Intra-sectoral—policy integration between different sections or professions within one department.

Van Geet et al. (2021) defines policy integration along four theory-based principles.

- Policy integration serves as a strategic approach to overcome fragmented government action (Trein et al., 2019).

- Integration is a process where policy actors collectively address to a cross-cutting policy problems or work towards shared objectives by coordinating actions across diverse policy domains and government levels. This process can involve formulating goals and developing a mix of policy instruments (Candel and Biesbroek, 2016).
- Processes of integration are based on establishing interdependent relations as an incentive to cross administrative boundaries (Keast et al., 2007). These dependencies arise because different and specific resources need to be drawn from a broader range of policy actors to make and implement policies.
- Interaction, as in transfer of resources, i.e. financial, production, competency, knowledge and legitimacy resources (Klijn and Koppenjan, 2016), is a key mechanism in policy integration processes. This facilitates overcoming interdependencies and enhances the capacity to achieve shared goals and address complex policy problems (Cejudo and Michel, 2017).

Integration can manifest in different degrees, with policy sectors and levels of government engaging to varying extents. Increased interaction typically corresponds to higher levels of integration (Candel and Biesbroek, 2016). The most advanced form of integration may not be necessary at all times, Candel and Biesbroek (2016) suggest that some cross-cutting issues can be satisfactorily addressed with exchanging information or engaging in coordinated actions. However, by achieving integration in strategy development, goal orientation or visioning, shared policy goals could be established, which would promote mutually reinforcing transport and land use measures (Brömmelstroet and Bertolini, 2010).

A related concept, collaboration, is also used in the literature addressing the interaction between various organizational entities in transport and land use planning. For example, Hrelja et al. (2018) emphasize collaboration among organizations to overcome organizational barriers and sectorial boundaries,

when, for example addressing cross-cutting issues such as sustainability. The concept collaboration should (here) be understood as an attempt to overcome problems with collective action and to transform a situation in which the various organizations operate independently into a situation in which they act in concert to achieve shared objectives (Hrelja et al., 2016). Moreover, planning and implementation of sustainable transport require collaboration between organizations with different responsibilities and budgets, as well as driven by different rationalities (Hrelja et al., 2016; Pettersson et al., 2018). This is a challenging endeavor that can involve clashes between strategic regional transport planning and tensions between local-level priorities and control over land use planning (Pettersson and Hrelja, 2020).

Transport and land use integration is commonly conceptualized by differentiating between strategic and operational level (e.g. Gudmundsson et al., 2016; van Geet et al., 2019). The strategic orientation concern transport and land use policy formulation. It aims to contribute to an optimum spatial organization of activities and a well-balanced transport system linking these activities in an efficient and sustainable way. The operational orientation concern transport and land use policy implementation. This approach focuses on integrating infrastructure development with adjacent land use development into integrated area-development projects (Heeres et al., 2016). According to the typology presented in van Geet et al. (2019), the interface between formation and implementation is called adoption. During the policy adoption phase a gradual shift occurs from a strategic to operational focus. In the process studied by van Geet et al (2019) the adoption phase constitutes of an explorative study including an integrated problem analysis and, development and evaluation of possible solutions, which converge towards a desired alternative. Before the implementation phase begins, the chosen alternative is prepared for realization by formulating responsibilities (including financial), defining a timetable and acquiring permits. This thesis primarily addresses strategic transport and land use integration and its focus is on policy adoption and policy formation rather than policy implementation.

3.6 Instruments for policy integration: Transport and land use

Policy instruments refer to the variety of deliberately designed methods that governments employ to implement their policies (Howlett and Rayner, 2007; van Geet et al., 2021). Mixes of instruments are usually mobilized to attain defined objectives (Howlett and del Rio, 2015). Howlett (2008) distinguishes between two types of policy tools, substantive and procedural. Substantive tools have a command-and-control character, and they make direct use of government resources to induce desired behavior or prohibit undesired behavior, such as subsidies and loans, regulation and licenses as well as advice and training (Howlett, 2000). Procedural instruments influence the processes and procedures involved in policy development by structuring the process of formulating and adopting policy without predefining the outcome (Howlett, 2000). Stead (2021) emphasize that procedural policy tools can foster interaction and consensus building among stakeholders to generate or strengthen support for policy goals or initiatives. Ways in which governments govern interaction and interrelationship between policy actors are, for example, by providing information, devising overarching strategies, creating funding mechanisms and decide for administrative reorganizations. This thesis focus on procedural instruments, i.e. substantive instruments are not handled.

Van Geet et al. (2021) present procedural instruments related to transport and land use planning in two groups. The first group, technical decision support instruments (data and knowledge), aim to provide information to decision makers. Some argue that technical decision support tools developed for integrating transport and land use are overly technical, inflexible and complex for practical application in planning (e.g. Brömmelstroet, 2010). However, there are various strategies associated with how to develop decision support instruments for different purposes. For example, Gudmundsson et al. (2016) suggest loosely structured frameworks for organizing (sustainability) indicators in the early planning phases. This allows participants in the planning process to address problems that are not well defined, with support of the instrument. The second group of procedural instruments is those, which aim to span boundaries between

transport and land use planning domains (creates links between different processes). Examples of this type of instruments, given by van Geet et al. (2021), are cross-departmental budgeting schemes (Stead, 2008), the Dutch sustainable urbanization ladder (Duffhues and Bertolini, 2016) and the Swedish four-step principle (Johansson et al., 2018). These types of procedural instruments can be further divided into three groups, namely, those employed to facilitate the formation (strategic), adoption (strategic/operational) and the implementation (operational) of policies (van Geet et al., 2021). Stead (2021), among others, point out that softer tools related to e.g. citizen engagement have been put forward in practice, whereas the use of harder financial and regulatory tools such as EIA, have been scaled back.

In this thesis, the typology for policy instrument presented in van Geet et al. (2021) have been applied to understand features of the SCM process as well as the studied Nordic planning approaches.

3.7 A transformative capacity framework and organizational learning

A theoretical concept with links to collaborative planning and governance capacity, as well as resilience and systems thinking is transformative capacity (Hölscher, 2019). The concept serves as a framework for analyzing how effectively governance settings and organizations are adapting to evolving environments (Gupta et al., 2010). The framework has been developed with the ambition to identify transformative action, often in urban and local settings, that contributes to the capability of partnerships and networks of public and private actors to steer developments towards sustainability (Wolfram et al., 2018). The concept primarily originates from urban climate governance literature but has also been influenced by broader literature on institutional and governance capacity (González and Healey, 2005; Healey, 1997; Innes and Booher, 2003) as well as by sustainable transitions literature, transformative climate governance, resilience and systems thinking (e.g. Berkes et al., 2003). While much of the existing literature on transformative capacity has primarily focused on urban contexts (e.g. Hölscher et al., 2019;

Koop et al., 2017; Wolfram et al., 2018), it can be applied in many different governance contexts. For example, Witzell et al. (2022) considers transformative capacity as a “framework of relevance for exploring various types of complex governance situations where the need for change is evident, but also difficult to realize due to power structures, path-dependencies and complex institutional and political conditions.”

Transformative capacity highlights skills, resources, capacities and practices that can help to promote transformation of a particular context, e.g. cities. The literature illuminates, for example, systematic thinking, strategies to prioritize social learning and reflexive action, civic engagement as well as the ability to collaborate with a variety of actors and stakeholders (Wolfram et al. 2018). Hölscher (2019) propose a framework that outlines four types of governance capacities that address four different transformative purposes. The capacities are stewarding, unlocking, transforming and orchestrating.

Stewarding address the purpose of societies ability to anticipate and respond to long-term change, uncertainty and risk. This is done through self-organization, monitoring, and continuous learning (Hölscher, 2019). This capacity relates to resilience approaches’ notions of adaptability and adaptive governance that help governing complex systems when knowledge is incomplete and surprise is likely (e.g. Folke et al., 2005). Due to the high levels of complexity and uncertainty, stewarding is not a search for one optimal solution but requires monitoring and continuous learning through on-going and iterative knowledge acquisition and incorporation of learning outcomes into actions and policies (Berkes, 2017). This requires fostering learning partnerships and a collective social memory for linking past experiences with the present and future (Koop et al., 2017). Relevant for this thesis is also organizations continues learning and improvement, including their capacity to share and integrate knowledge across the organization (Silva et al., 2013). Organizational learning is the process by which an organization acquires, assimilates, and applies knowledge and information to improve its performance and achieve its goals. It involves the continuous adaptation and development of an organization's knowledge, skills, and processes through individual experience and feedback (Silva et al.,

2013). The adaptation of administrative and government organizations responsible for transport and land use planning is essential for effectively addressing and managing prevailing social and environmental challenges through decision-making, planning and implementation processes. Organizational learning can be of single-loop character, i.e. more technical by identifying alternative strategies or actions for addressing or improving specific problems or challenges. It can also have double-loop character, which involve questioning and transforming values, norms and structures (Argyris, 1976; Silva et al., 2013).

The purpose of Unlocking is recognizing and dismantling unsustainable path-dependencies and maladaptation. It focuses on revealing and phasing out or breaking down existing structures and path-dependencies (Turnheim and Geels, 2012). The revelation of unsustainable path-dependencies and mal-adaptation help identify root causes and drivers of undesirable lock-in that need to be strategically phased out (Kivimaa and Kern, 2016). The Transforming capacity concerns creating and embedding novelties while anchoring them in context (e.g. new ways of organizing, producing, consuming and thinking through social, technological and governance innovations). Integrating long-term and multi-scale perspectives into political, financial, and institutional incentives and decision-making creates opportunities for cooperation and win-win solutions that align with long-term objectives (e.g. Loorbach et al., 2015). Related to this is the suggestion made by Heeres et al. (2017) to institutionalize ‘design thinking’ in transport and land use planning, where design thinking is assumed to support the process of identifying innovative solutions to integrated, transport related problems.

The purpose of the fourth and final capacity, Orchestrating, is coordinating multi-actor governance processes across scales and sectors in alignment with common goals and to create synergies (Hölscher, 2019). The strategic alignment of the multiple actors and networks towards long-term goals for sustainability and resilience provides common reference points for concerted action that create synergies and avoid trade-offs across sectors, scales and times (Loorbach et al., 2015). The mediation of knowledge,

resources, contacts, ideas etc. across sectors and scales creates opportunities for collaboration and supports resource synergies, knowledge and resources dissemination, diffusion of new technologies and practices and conflicts resolutions (Frantzeskaki et al., 2014). Similarly, governmental policy instruments that aim to close the gap between transport and land use planning could count as (formal) boundary spanning activities that create and instigate learning processes by gathering, processing, combining and distributing knowledge (cf. Kivimaa, 2014). Related to the orchestrating capacity, is the presence of so-called change agents i.e. persons that are critical for efforts of mobilization in different key stages (Healey, 1998; Wretling, 2022). It concerns, in an institutional context, government officials that can advocate and persuade actors regarding their need for implementation of certain policies and measures. However, these individuals can only push efforts to a certain extent until it will be dependent upon a broader institutional capacity in order to overcome the constraints of administrative structures (cf. Bulkeley and Kern, 2006).

This thesis examines how to strengthen environmental considerations and sustainability perspectives in Strategic Choice of Measures (SCM). The transformative capacity framework contributes with insights into what elements should characterize the planning practice in order to pave the way for transformative change and sustainable development in transport planning. In relation to this, organizational learning is an important element linked to the transformative capacities.

4 METHODOLOGY AND RESEARCH DESIGN

This chapter describe the methodological considerations and how empirical material has been gathered and analyzed throughout the research process. At the end of the chapter, the limitations of the study are discussed.

4.1 Approach to research

The research design has been developed to fit in an interdisciplinary field of research, where knowledge, methods and terminology developed in various fields of research occur (cf. Silva et al., 2014). The research is based on a qualitative research approach using a combination of different qualitative methods in order to collect empirical material (Table 2), an approach often applied by research that seek to holistically describe a studied phenomenon, situation or system (Bryman, 2016). This can be favorable in situations where it is considered especially difficult to achieve information that are independent of the observer's subjective interpretation and/or self-interest of the studied phenomenon. Societal processes are simultaneous processes, which cannot be isolated and need to be understood in their context (Flyvbjerg, 2006). Therefore, the research of this thesis was grounded within the object of study rather than being distanced from it. Parts of the data collection has been inspired by the ethnographic tradition (e.g. Hay, 2000), which emphasize a deep understanding of context as important to be able to identify relevant problems and to generate relevant interpretations in relation to the studied phenomenon.

This thesis focus on Swedish strategic transport planning practice conducted by the Swedish Transport Administration (STA). The study analyzed how STA interact and coordinate their work with other actors (Regional Public Transport Administration, RPTA, and municipalities), and also how environmental aspects and sustainability perspectives have been addressed and handled, from various perspectives, in strategic transport planning processes by STA and others.

It is important to mention that the qualitatively derived empirical material to some extent include subjective interpretation, both by the researcher (me, the author) and in the collected material. This includes assumptions and ideas that have formed the research problems and the methods used to collect the empirical material (Alvesson and Sköldbberg, 2020), for example, material have been collected with close involvement with the STA and the civil servants working there. One effect of individuals' assumptions and ideas influencing the material is that if others were involved, the result would be different. To reduce such errors as much as possible, multiple sources of information and different methods have been used to collect the material (triangulation).

Concerning details on how the methods were applied, it is referred to the separate papers. Below is given an overview.

Method	Paper 1	Paper 2	Paper 3	Paper 4
Case study				
Observations and informal interviews				
Semi-structured interviews				
Focus group interview				
Document study				
Literature study				
Thematic analysis				

Table 2: Methods and analysis applied in the different papers. Concerning details on how the methods were applied, it is referred to the separate papers.

4.2 Strategic Choice of Measures in Stockholm as a case study

The case study approach (Paper 2 and 4) was useful when studying the contemporary phenomenon of the SCM process within its real-life context (cf. Yin, 2014), and the case study facilitated the understanding of patterns and relationships in the complexity that characterized each case (Stake, 1995). The strength of the qualitative single case study is its detailed character, which aims to understand different processes, structures and implications. It has the potential for data collection of multiple sources, and

can create insights and understandings concerning peoples experiences and social phenomena, including its multiple interpretations (Bryman, 2016). Moreover, the case study approach develop knowledge about the multiple realities that inform robust research (Flyvbjerg, 2006).

Yin (2014) and Stake (1995) represent two divergent schools of thought on how to conduct a case study. While Yin's method prioritizes creating a detailed design early in the research process with minimal changes later on, the Stake method advocates for flexibility and a progressive approach, acknowledging that the study's trajectory cannot be fully mapped out in advance.

In this thesis, the two approaches has been combined, supported by the discussion in Yazan (2015). Tools and guidance for gathering and analyzing data were provided initially to steer the research process. However, flexibility in the method was allowed as the process progressed.

The study of the three cases (Papers 2 and 4) provided empirical material on the SCM planning practice. The SCM processes were comprehensive and involved many stakeholders, and addressed several different challenges, which is typical for SCM's conducted in the Stockholm region (i.e. urban and peri-urban areas). The rationale for the choice of cases in Paper 2 was that they were rich in information and provided examples representing two different perspectives to SCM, local and regional perspectives respectively. The case in Paper 4 was chosen because the Integrated Landscape Character Assessment was applied in the SCM process. The planning work carried out in SCM processes, as analyzed in this thesis, serves as cases that can enhance the understanding of how environmental and sustainability considerations in strategic transport and land use planning are taken into account along with multi-actor coordination in societal development. The three comprehensive case studies. The three comprehensive case studies represent an in-depth analysis of a (three) comprehensive case that include many aspects of transport planning, thereby contributing to the understanding of the relations and complexities that characterize planning (cf. Flyvbjerg, 2006).

4.3 Collection of empirical material and analysis

4.3.1 *Observations and informal interviews*

In Paper 2 and 4, observations have been used as a method to gather material related to the three case studies. The purpose of the observations was to gain an insight into the actual interactions between actors (cf. Kearns, 2016). Observations can be participant and non-participant. Non-participant observation, or shadowing, is when the researcher closely follows key actors and their practices, which provide an opportunity to witness everyday work activities in the specific context (Czarniawska, 2007; Eneqvist, 2022; Håkansson, 2014).

Non-participant observation was conducted during SCM meetings and workshops, where attendance was as a passive observer. Being present in the meeting room but not participating in interactive activities allowed for observation of interactions between individuals and their responses to statements in face-to-face situations. Discussions were listened to, and notes were taken (i.e., the collected data), without recording. The meetings continued without participation in the discussions. Observations were conducted for a period of approximately five years (from January 2018 through May 2023). Additionally, informal interviews were conducted with the participants, enabling further clarification of questions that arose during meetings and workshops. Observing SCM process activities provided insights into the dynamics of procedures at the STA and the behaviors of other participating actors, i.e., municipalities and RPTA, in relation to that.

4.3.2 *Semi-structured interviews*

Empirical material from semi-structured interviews were gathered in Paper 1, 3 and 4 to gain insight into various perspectives in strategic transport planning.

The interviews focused on interviewing key practitioners with experience of contemporary strategic transport planning practice. The interviews content was influenced by the interests that the respondent represented in their role (e.g. official at a municipality or STA). The interviews were conducted in

order to obtain (through conversations) descriptions of the interviewee's professional life, which then were analyzed to interpret the meaning of how they described the planning practice (cf. Brinkmann, 2015). Semi-structured interviews were conducted to allow the respondents to develop the answers to the interview questions by adding perspectives and topics that they believed were important (Bryman, 2016).

Before the interviews, an interview guide was prepared with themes and suggested questions. During the interview, the guides were used as a reminder to cover all the desired themes in a conversation with the respondents. This allowed for clarification and follow-up on interesting answers, and for respondents to describe their understandings and experiences in their own terms. (Gill et al., 2008). Some of the respondents were contacted again after the interview to clarify statements. The analysis was further structured with themes, which were identified based on the content of the transcripts.

The interviews were recorded and generated transcripts as empirical data to comprehend the perspectives of the respondents. Through answering questions about their work and motivations, the interview provided them with an opportunity to reflect and articulate their interpretations of planning practices.

Papers 1 and 4 focus on strategic transport and land use planning in a Swedish context (in total 18 individuals were interviewed), and Paper 3 include interviews with respondents working with transport planning in the other Nordic countries, that is Iceland, Norway, Denmark and Finland (in total 14 individuals were interviewed).

4.3.3 Focus group interview

The focus group interviews explored specific topics and identified qualitative similarities and differences among participants (Cameron, 2010). The interactive aspect of focus group interviews provide an opportunity for people to explore different points of view and to formulate and reconsider their ideas and understandings (Bryman, 2016). The composition of the

focus groups, the intrapersonal influence and environmental factors are elements that affect the interaction between the members of the group (Löfgren, 2020a; Stewart et al., 2007). For example, the group should meet in a setting where participants feel comfortable enough to engage in discussion and they should share some common identity or context. The synergistic effect of the interaction among participants within the group generate valuable information (Stewart et al., 2007), that, in this research, complemented the other methods applied in the respective studies.

The aim of conducting focus group interviews differed between Paper 1, 3 and 4. In paper 1, the aim was to learn from STA officials' understanding of the SCM process, and how they responded to each other's perspectives. In paper 3, practitioners in transport planning in the Nordic countries were gathered at two occasions to discuss topics related to coordination and sustainability in strategic transport planning. In paper 4, a focus group interview was held with participants in the studied SCM process, to reflect on the role of the ILCA in the conducted SCM. The empirical material consisted of written notes (taken by one of the authors to the respective Papers).

4.3.4 Document study

A document study was used as a complement to the other methods (cf. Bryman, 2016). The documents, that are 'social facts', had been produced, shared and used in socially organized ways (cf. Bowen, 2009). Compared to the oral sources, the documents were stable over time, which made it possible to review them at any time. They gave details of events as well as enabled an overview of broader contexts (cf. Yin, 2014).

The production of documents are an important part of the work conducted by public administrations, such as STA, RPTA and municipalities. The documents gathered were both official and unofficial. Unofficial documents were used for compilation of background, context, and process description for the three studied cases in Paper 2 and 4. The case descriptions relied on documents with information about events, contexts, and situations that were relevant to the research objectives. Official documents such as policy

documents, manuals and reports, were used in studies of the official meaning and intention of e.g. the SCM process, the ILCA approach etc. as well as to capture the organizations (Swedish and Nordic transport authorities) strategic mission and intentions. Different types of documents were used for different purposes (cf. Yin, 2014). In addition to their role as descriptive sources, the documents revealed topics worthy of further investigation (Yin, 2014) and identified sources and reports to check for further information.

4.3.5 *Literature study*

Literature studies were used to gain knowledge of the research topic, of important concepts and theories in the field, and to frame the research (cf. Bryman, 2016). Initially, scientific literature was reviewed to achieve an overview of contemporary practice related to the strategic planning of transport infrastructure projects. Literature collection involved searching for relevant articles in databases like Web of Science, Science Direct, and Google Scholar. This was followed up by an iterative review process (cf. Lavallée et al., 2014) to facilitate an explorative approach. Furthermore, non-peer reviewed literature, such as internal policy documents, manuals, and reports from the STA, were reviewed with specifications related to the studied topics (e.g. environmental considerations in strategic transport planning).

In Paper 1 literature on planning theory, transport planning practice, and environmental aspects in Swedish planning practice was reviewed, Paper 2 focused on literature on systems perspective in planning and planning projects, frameworks, and tools applied in planning projects. Paper 3 focused on literature on transport and land use integration, policy instruments and collaborative planning. Paper 4 focused on literature on landscape analysis, transport planning and transformative capacity.

4.3.6 *Analysis of the collected data*

The empirical material gathered through different methods (Table 2) in this thesis was analyzed in different stages of the research process. The approach used for analysis was ‘thematic analysis’, which is one of the most common approaches used to analyze qualitative data. The data were, as typically for qualitative data, a large corpus of unstructured textual material that was not amenable to a straightforward analysis. Hence, there were no clear-cut rules about how analysis should be carried out, so, following the approach discussed in Bryman (2016), a framework with themes and subthemes was developed and applied to the material. A theme captured ‘something important’ about the data in relation to the research question(s) and represents some level of patterned response or meaning within the dataset (cf. Braun and Clarke, 2006), detailed description of analysis can be found in the appended Papers. Ryan and Bernard (2003) outline several strategies for searching for themes in material. In this thesis three strategies were used; repetition of topics in the material (1) similarities and differences in how respondents discussed a topic (2), and theoretical concepts used as springboards for identifying themes (3). A manual interpretation of the data, in terms of dominant themes, was conducted by reading the material several times and making notes before deciding on specific themes. This involved an iterative process of dividing and merging themes represented in the collected data. The themes were reviewed multiple times to improve consistency within each theme and to separate them from each other (cf. Braun and Clarke, 2006).

5 RESULTS

Altogether the four papers contribute to a greater understanding of the consideration of environmental aspects and sustainability considerations in strategic transport planning, and of the procedures to integrate transport and land use planning. A brief summary of all four papers are presented in this chapter.

5.1 Paper 1:

Challenges and Opportunities in Early Stage Planning of Transport Infrastructure Projects: Environmental Aspects in the Strategic Choice of Measures Approach

In this paper, the investigation focuses on the consideration of environmental aspects in strategic transport planning in Sweden, specifically the Strategic Choice of Measures process (SCM). The investigation includes an analysis of the official SCM guidelines and the perspective of practitioners engaged in SCM practices. The aim was to identify challenges and opportunities associated with incorporating environmental aspects into the SCM process.

Following the restructuring of the transport planning system in Sweden, the SCM process was introduced to enhance coordination and collaboration among stakeholders in strategic transport planning. This shift altered the prerequisites for addressing environmental aspects in strategic transport planning. The SCM guidelines aim to guide the transport planning process, and the results show that the practitioners sought guidance from the guidelines, particularly regarding the consideration of environmental aspects. However, the guidelines lacked detailed information on the specific environmental considerations, instead referring to information in the STA's guiding documents regarding the environmental impact assessment of investments. Sustainability aspects within SCM are addressed by referring to information from the Sustainability rating system framework for National Road Administrations (SUNRA) project (Sowerby et al., 2014). Despite the reference to SUNRA and environmental assessment procedures, no new

routines had been established (within STA) for practitioners regarding the inclusion of environmental aspects in the SCM process. Respondents indicated that many environmental considerations were only subject to formal environmental assessment in later planning stages, post SCM process, which potentially had little impact on the decisions made during the SCM process. Additionally, a general idea among the interviewed practitioners was that the SCM failed to ensure the inclusion of perspectives (e.g. environmental and sustainability) beyond the explicit focus of the planning process.

The study identified various challenges and opportunities in managing environmental aspects within the SCM process (Table 3). While the introduction of the SCM increased coordination among actors in strategic transport planning, opportunities to address complex problems were perceived as limited, especially in urban areas with existing infrastructure and concurrent construction projects. Divergent opinions also emerged (in the interview material) regarding the ability to propose measures within the SCM process. Furthermore, challenges arose when merging different perceptions of the planning context and reaching consensus on the problems to address or measures to implement. Respondents emphasized the importance of creative dialogue in the SCM to illustrate the collective benefits associated with proposed measures. They also discussed difficulties in agreeing on responsibilities to apply measures to mitigate environmental impacts, particularly concerning existing infrastructure. Respondents expressed challenges related to specific environmental aspects. Issues related to public health, noise, and toxic materials received widespread awareness and interest among municipalities involved in SCM, placing these concerns higher on the agenda. Landscape-related aspects were considered abstract, often falling outside the SCM's scope and risking neglect in projects. Addressing air pollution and greenhouse gas emissions within SCM boundaries proved challenging, and water-related aspects interfered with planning at various spatial levels. Moreover, according to respondents, conditions for addressing environmental aspects changed throughout the planning process, from the SCM stage to subsequent planning and

implementation stages. Extensive specifications from previous planning stages reduced flexibility in later stages, sometimes leading to conflicts between environmental values. Despite these challenges, respondents noted that the knowledge and guidelines produced in the SCM facilitated dialogue in later stages of the planning process.

The SCM process...

- ...increased coordination between actors in the early planning stages.
- ...provided potential for collaboratively find solutions to integrated transport problems in complex planning contexts.
- ...plays a role in preserving and creating links between local and regional transport and land use planning.
- ...should be flexible concerning what perspectives and competencies that need to be included.
- ...need to strengthen its consideration of environmental aspects.
- ...had difficulties providing agreements on responsibilities concerning measures to mitigate the environmental impacts.
- ...focused on environmental aspects related to direct impacts on human well-being, such as noise, while aspects related to landscape received less attention.
- ...provided a risk that the environmental aspects on the border between two adjacent projects were neglected.
- ...had difficulties finding applicable mitigation measures for air pollution and greenhouse gas emissions within the boundaries of the SCM and the administrative boundaries of the municipalities.
- ...provided extensive specifications from previous planning stages that reduced opportunities to develop measures that promote sustainability.

Table 3: Highlights from the results of investigating the practitioners' perspective of the SCM planning practice in the Stockholm region, and the consideration of environmental aspects in the process.

In conclusion, the study revealed that within the SCM process, environmental aspects like noise and air pollution from urban road traffic actively involve the participating actors, whereas aspects related to landscape and water receive inadequate attention and are perceived as poorly addressed. Furthermore, the consideration of environmental aspects in the SCM process is influenced by the varying perspectives and competencies of local and national authorities involved. To effectively integrate environmental aspects into strategic transport planning, the findings suggest that these aspects should be explicitly addressed in the instructions provided to the SCM project management. Additionally, there is a need to strengthen the link between the SCM and preceding, following, and potentially parallel planning stages. This would facilitate a more comprehensive and cohesive approach to environmental considerations throughout the entire planning process.

5.2 Paper 2:

Inclusion and exclusion of environmental aspects in early-stage planning of transport infrastructure projects: A Swedish case study

In this paper, two cases of Strategic Choice of Measure (SCM) processes conducted in the Stockholm region (Case A: European Route E4/E20 Hallunda-Vårby Backe, and Case B: the National Road 73) were studied in order to illuminate consequences of systems boundaries on how environmental aspects are considered and what aspects are included or excluded. The aim was that this will provide a deeper understanding of what factors influence the consideration of environmental aspects in SCM.

The empirical material gathered from the cases were analyzed with respect to territorial (geographical area included in the project) and participation (the actors involved) defined boundaries (Verweij et al., 2014). The findings indicate a common trend in the studied cases, where the spread of noise and air pollution from the road (as calculated) influenced the definition of the territorial boundaries of the SCM. In these cases, the spatial distribution of other environmental aspects, such as water, climate, landscape and health that extended beyond the territorial boundaries, was disregarded as concern

the definition of boundaries. The SCM working group encountered challenges in dealing with water, climate, landscape, and health aspects due to the constraints posed by the boundaries. The effects of these boundary constraints were evaluated by studying two cases; case A allowing for specific calculations of pollutions from the road and case B utilizing estimations from previous calculations for the entire region. The scale difference between the two SCMs imparted distinct characteristics of the boundary issues. The SCM in Case A was delimited to a local geographical area, allowing for specific calculations of air and noise pollution from the road. This facilitated detailed discussions on mitigation measures within that particular area, revealing whether the involved actors shared a consensus on the design of these measures. On the other hand, the SCM in case B, defined as a sub-regional geographical area, did not involve specific calculations regarding noise and air pollution, resulting in less detailed discussions on mitigation measures. However, Case B incorporated a risk analysis for surface and groundwater, as well as a landscape analysis, which was assumed irrelevant in Case A due to its limited geographical boundaries. The landscape analysis in Case B provided insights into the interplay between various aspects along the road corridor, such as ecological, cultural and current development trends, although, not offering the desired systems perspective, as it primarily focused on road users rather than the road's role in the landscape. In case A, the boundaries were temporarily extended when addressing the connectivity issue between two nature reserves. The working group then collaborated with other adjacent infrastructure projects dealing with the same area and issue. This collaborative approach extended the SCM boundaries beyond their primary limits in Case A, highlighting the effect of a flexible approach to addressing problems spanning larger geographical areas.

The participatory boundaries were defined by which actors were involved in the SCM. In SCM processes, the national planning of the STA meets regional and local transport and land use planning, leading to conflicts of interest between different administrative levels. For instance, in Case B, Stockholm municipality envisions the northern parts of National Road 73 as

a future urban space, while the STA asserts the road's status as part of the national road network, emphasizing prioritizing accessibility for road traffic. This disparity exemplifies the conflicting national and local interests that might arise in the SCM process.

The recommendations of measures in the SCM process are significantly influenced by the actors' mandates (see Figure 8 for measures). In Case A, although the working group identified and recommended measures such as improved public transport, cycling, and walking to mitigate air pollution, noise pollution, and greenhouse gas (GHG) emissions, they deemed them insufficient to adequately address the severe environmental issues within the SCM geographical boundaries. The road traffic generating air and noise pollution was regarded to primarily be of national and international responsibilities (not local traffic), through measures such as congestion charges and the use of sustainable fuel which fell outside the actors' mandates. Following these arguments, no measures were identified to locally reduce air pollution to desirable levels.

Another example of how the mandate of the actors affected the recommended measures concerned the reduction of barrier effects. In Case B, a wildlife passage plan to reduce barrier effects was recommended, with the STA designated to implement it. Conversely, in Case A, a similar measure to reduce barrier effects between Nature Reserve Gömmaren and Sättra Forest could not be recommended because the STA's representative lacked the mandate to address these measures within the SCM. This implied that decisions on capacity increasing investments were made without decisions on implementing countermeasures for barrier effects. However, to overcome this, the SCM suggested an investigation to explore the feasibility of an ecoduct or alternative solutions to enhance connectivity between the green areas. In summary, involving the right actors to ensure the recommendation of optimal solutions within the SCM process proves challenging. This is in line with Verweij et al. (2014) who claim that many actors are part of the complex urban system and influence it. Therefore, a single project may only partially address that complexity.

Environmental aspects related to transport and land use changes are intricately connected, requiring a systems perspective for understanding these interconnections. However, addressing environmental aspects in context-specific planning processes, such as the SCM, involves delimitation and categorization of overall systems. Consequently, various tools are employed to analyze environmental aspects, leading to the exclusion and prioritization of specific elements. The tools used in analyzing environmental problems in Cases A and B differed to some extent (Paper 2 -Table 2), influenced by the scope, geographical boundaries, and available information at the initiation of the SCM processes. In both cases, a combination of qualitative and quantitative tools was utilized to collect and organize information regarding environmental problems. Noise and air pollution were examined through calculations of current and projected future pollution levels in the project area. Analyses of other aspects, including water, climate, landscape, and health, adopted a qualitative approach or involved summarizing information derived from both quantitative and qualitative sources provided by the STA, RPTA, and municipalities. The information gathered from these analyses was then used in working group discussions and workshops to prioritize problems and identify potential solutions. The participants in these discussions played a crucial role in aggregating information on environmental problems. Recognition of the interconnections and potential synergies between aspects, which could lead to identifying multifunctional solutions, relied on the participants' knowledge. Despite these efforts, participants in the working groups felt that the SCMs did not fully address the raised environmental problems. One possible reason for this shortfall could be the lack of a clearly structured approach within the SCM processes for generating knowledge on the connections between transport, land use, and environmental concerns, along with a deficiency in competence on how to effectively utilize such knowledge.

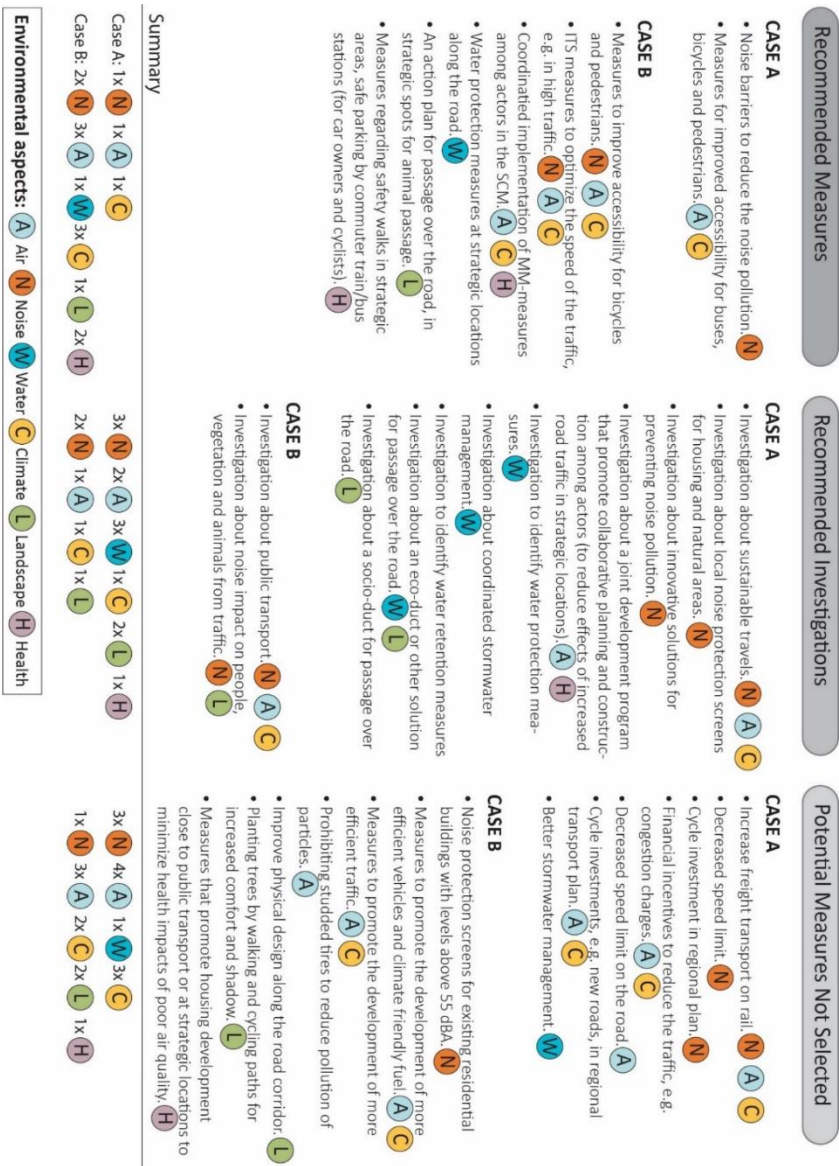


Figure 8: The figure shows Recommended measures, Recommended investigations, and Potential measures not recommended by the SCM in cases A (European route E4/E20 Hallunda- Vårby Backe) and B (Road 73), respectively. The environmental aspect associated with each measure or investigation is marked with a letter in a colored circle.

This paper concludes that a landscape analysis can have the potential to provide a systems perspective and account for ecological, functional and cultural interconnections between different landscape elements. However, a landscape perspective alone is insufficient; it needs to be complemented by an open process facilitating knowledge sharing, creating an arena for combining insights from diverse realms of knowledge.

























5.3 Paper 3:

Exploring practices for facilitating integrated strategic land use and transport planning in the Nordic countries

This paper explores the practical application of strategic policy and planning instruments and approaches applied in the Nordic countries. The focus is on how these methods facilitated the integration of land use and transport planning, fostering sustainable measures through collaborative efforts among stakeholders spanning different governance levels. The paper presents an overview of the countries' planning structures, including institutions that govern land use and transport planning. The study is limited to examining strategic land use and transport policy and planning conducted solely by authorities at the national, regional and local levels.

The Nordic transport planning systems are to a high degree structured hierarchically to establish a unified framework encompassing multiple transport modes, see figure 9 for an overview of regulatory planning instruments. In terms of transport goals, the national transport plans in the Nordic countries share significant commonalities by focusing on efficiency, accessibility, safety, and sustainable mobility, although with distinct emphases in their specific goals. These plans typically span a time frame of 12-15 years and undergo regular updates. At the national level, a Ministry holds the political responsibility for transport and infrastructure, supported by one or more national authorities working under the ministry. However, a noteworthy distinction among the Nordic countries lies in the degree of independence afforded to national transport authorities. In the public administration models of Denmark, Norway and Iceland, these authorities have less autonomy from the transport ministry compared to their

counterparts in Sweden and Finland. Across all Nordic countries, regional councils play a crucial role, with diverse responsibilities that include regional development planning and public transportation. Meanwhile, municipalities are entrusted with local land use planning and may also be tasked with responsibilities related to transport infrastructure, such as local roads, public transport at the local level, as well as management of ports and airports. This hierarchical approach fosters vertical integration within the transport sector. National transport policy documents also have implications for other policy areas, for instance, in Denmark and Sweden, where municipal land use plans are expected to facilitate the implementation of future transport projects of national significance. This fosters coordination between land use and transport planning, while at the same time it also highlights the asymmetric relationship between municipal land use planning and national transport planning.

	National (the State)	Regional (e.g. Regional councils)	Local (Municipalities)
Finland	<ul style="list-style-type: none">  National land use guidelines  National transport system plan 	<ul style="list-style-type: none">  Regional plans  Regional transport system plans 	<ul style="list-style-type: none">  Master plan and detailed plans (local transport is in general included in these plans)
Norway	<ul style="list-style-type: none">   National land use plan and guidelines  National transport plan 	<ul style="list-style-type: none">  Regional plans 	<ul style="list-style-type: none">  Master plan and detailed plans (local transport is in general included in these plans)
Iceland	<ul style="list-style-type: none">  National planning strategy  National transport plan 	<ul style="list-style-type: none">  Regional plan in the capital area is mandatory 	<ul style="list-style-type: none">  Master plan and detailed plans (local transport is in general included in these plans)
Denmark	<ul style="list-style-type: none">  National planning directives and land use guidelines   National transport plan and planning directives 	<ul style="list-style-type: none">  Regional mobility strategies 	<ul style="list-style-type: none">  Master plan and detailed plans (local transport is in general included in these plans)
Sweden	<ul style="list-style-type: none">  National interests of nationally significant areas  Transport infrastructure investment plan 	<ul style="list-style-type: none">  Regional development strategies  Regional transport plans 	<ul style="list-style-type: none">  Comprehensive plan and detailed plans (local transport is in general included in these plans)



 Land use/Transport plans
  Land use/Transport guidelines/strategies

Figure 9: An overview of transport and land use plans at the national, regional and local level in the Nordic countries.

Regarding policy instruments the Finger Plan in Denmark stands out as a formal and top-down policy instrument, where the national government establishes overarching principles for the development of the Greater Copenhagen region. This includes considerations for urban green structures, transport infrastructure, and business development. The Finger Plan exhibits explicit political guidance from the national government, similar to regional plans in Finland and Norway, although with a more pronounced governmental influence.

Other identified policy instruments in the study operate within national regulatory frameworks and primarily aim to facilitate multi-actor collaboration to address complex cross-sectoral challenges within city-regions or projects. Examples include MAL (land use, housing and transport) agreements in Finland, Urban Growth Agreements (UGA) and Concept Studies (CS) in Norway, as well as Urban Environment Agreements (UEA) and Strategic Choice of Measures (SCM) in Sweden. UGA in Norway, UEA in Sweden, and MAL agreements in Finland share similarities as policy instruments through which local, regional, and national authorities seek agreement on urban regional development. These agreements align with a shared vision, outlining policy measures and actions for integrated land use and transport planning in accordance with anticipated development. The Finnish MAL provides a flexible framework for voluntary cooperation in city regions, allowing authorities to identify common issues and prepare a joint vision for land use, housing, and infrastructure development. This vision serves as a basis for discussions with national authorities to link transport infrastructure investments and subsidized housing development to the integrated MAL plan. Moreover, UGAs in Norway are positioned as tools to achieve the Zero-Growth Goal through shared political commitments fostering compact land use, sustainable transport, and toll schemes. Meanwhile, the Swedish UEA, inspired by Norwegian experiences, focuses on cost sharing for investments in public transport, walking, and biking facilities. In addition to UEAs, agreements between national, regional, and municipal authorities have been established in Sweden following negotiations in Stockholm and nationally.

These agreements, similar to Norwegian UGAs, involve significant investments and political commitment, with the primary goal of increasing housing in exchange for transport infrastructure investments. Finally, the Norwegian CS and the Swedish SCM operate at the interface between strategic and operational phases, falling under the category policy adoption (van Geet et al., 2019). Both instruments assess potential measures and interventions in the interplay between land use and transport before project implementation. However, the distinction between different classifications of policy instruments may not always be clear.

These policy instruments share a common feature – aiming to align the perspectives of various authorities on the needs and potentials of a specific region, leading to a commitment to a shared vision for its strategic development. Thus, they serve as examples of strategic policy instruments for integrated land use and transport planning. Figure 10 illustrate the integration of the strategic policy instruments in the Nordic planning, as well as their connections with authorities and regulatory instruments.

In summary, this study highlights a diverse mix of strategic policy instruments in the Nordic countries, all aiming to promote integrated land use and transport planning through multi-actor engagement. MAL and UGA serve as representative examples of collaborative approaches that work towards establishing a shared vision and selecting policy measures, especially in city regions. On the other hand, SCM and CS function as policy instruments employing collaborative approaches before project implementation, facilitating discussions on combinations of measures to minimize environmental impacts. These instruments create informal arenas for seeking consensus, fostering commitment to enforce policy measures and interventions through regulatory planning processes. While a consensus may be reached through an agreement, the consensus remains informal until authorities formally incorporate the agreed policy measures into their regulatory instruments, such as municipal master plans or national policy plans.

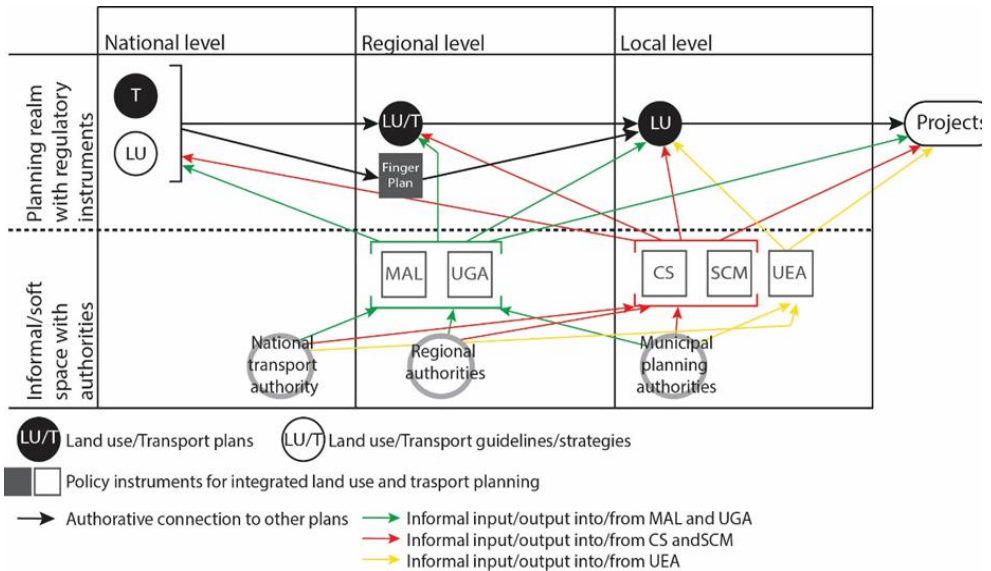


Figure 10: The integration of several strategic instruments in Nordic planning, and their connections with authorities and regulatory instruments. The instruments are: Finger Plan in Denmark, MAL (M:land use, A:housing, L:transport) agreement in Finland, Urban Growth Agreement (UGA) and Concept Studies (CS) in Norway, Urban Environment Agreement (UEA) and Strategic Choice of Measures (SCM) in Sweden. The figure is reworked from Figure 4 in Paper 3.

5.4 Paper 4:

The integrated landscape character assessment as a tool to bridge the gap between strategic transport and land use planning

This paper aims to investigate whether and how the application of a landscape approach contributes to informing decisions on strategic choices of measures in transport and land use planning practice. The study involves a case study conducted in Stockholm, Sweden, where the Integrated Landscape Character Assessment (ILCA) is carried out in conjunction with a Strategic Choice of Measures (SCM) process. To analyze the impact of ILCA on making sustainable strategic choices in Swedish transport planning, the study applies an analytical framework inspired by the

Transformative Capacity framework developed by Hölscher (2019), as previously described in this thesis.

The results indicate that the application of the ILCA contributed with systematic approach for addressing environmental aspects and sustainability perspectives within the SCM process. The ILCA played a key role in assembling knowledge about social, natural, and cultural aspects both within the SCM project area and beyond its boundaries to establish baseline information. This knowledge assembly facilitated the anticipation of emerging risks and uncertainties, essential for making informed decisions aligned with sustainable development principles. Additionally, the ILCA contributed to raising awareness among participants regarding how the identified problems in the investigation area were connected to the surrounding landscape and its characteristics. By systematizing and contextualizing the analysis of various aspects, the ILCA helped streamline the evaluation process, accommodating the diverse interests of the involved actors.

The application of the ILCA played a pivotal role in recognizing practices within the Swedish Transport Administration (STA) that cause unsustainable living and land use patterns. For instance, it shed light on the challenges faced by STA officials in handling measures related to perceived noise and those aimed at improving conditions for users of sustainable transport modes in cities. The attention to these unsustainable practices exerted pressure on organizations like STA, potentially creating opportunities and raising awareness for alternative approaches to address such issues. The measures identified in the ILCA, further developed by the project management group, were grounded in assessments considering the relationship between transport and land use infrastructure and their respective societal purposes. While land use planning in general is directly connected to societal development, transport planning serves as a means to fulfill specific societal functions, such as ensuring people's accessibility to different locations. The ILCA, proved valuable in identifying measures originating from societal development issues. However, some of these measures (e.g. eoducts, socioducts and noise reduction measures) were

perceived as challenging to implement as they were expensive and/or required funding from several of the actors within the SCM. Yet, the SCM project management strategically used these measures to advance sustainability in transport and land use planning. In addition, the respective missions of organizations influenced the actions they were willing to fund, which, in turn, is linked to the distinct purposes of transport and land use planning.

The ILCA not only contributed to unveiling unsustainable path-dependencies but also provided an opportunity to advocate for transdisciplinary and multidisciplinary collaboration. The SCM process itself facilitated the co-production of knowledge involving multiple stakeholders rooted in different disciplines, both in the working group and workshops. Such collaborative processes are known to be crucial for developing innovative solutions and achieving sustainability goals (e.g. Heeres et al., 2017; Hölscher, 2019). The results indicate that the ILCA has the potential to support the SCM process by strengthening the co-production efforts and facilitate opportunities for transdisciplinary and multidisciplinary collaboration. However, the full potential of the ILCA in this regard was not considered to be fully utilized in the studied process, partly due to issues like miscommunication with procured consultants.

To orchestrate change of practice to long-term goals, multi-actor coordination and strategic alignment towards such goals are crucial. The SCM, in this study, served as a platform for such coordination where issues related to responsibilities, incentives, costs, and benefits were clarified. It also created an opportunity to mediate across scales and sectors, facilitated by the ILCA. However, practical implementation faced challenges, such as mismatches in scale (regional RPTA) and difficulties in engaging actors across sectors (environmental experts at the municipality). Overcoming these challenges is essential for effective collaboration and achieving sustainable outcomes.

In the collaborative process, the ILCA played a crucial role in broadening perspectives, enabling different actors to recognize and understand the

relevance of each other's viewpoints. For instance, officials from the STA became more aware of aspects important to the municipalities. This openness to diverse perspectives is deemed crucial for learning across professional boundaries, as the comprehensive complexity of urban conditions and potentials surpasses the capacity of any individual professional category.

The ILCA contributed to bringing actors together to address challenges related to achieving sustainable development in the SCM project area. The ILCA materials were collaboratively used in problem-solving and coordinating inputs from different actors. Furthermore, the ILCA served as a tool in communication and negotiation between actors and with practitioners handling the planning stages following the SCM process. While Sarlöv Herlin et al. (2018) note that the ILCA was developed to establish the landscape as a regional platform for cooperation between national and regional authorities, Clemetson and Schibbye (2015) argue that, due to the poorly developed state of integrated regional planning in Sweden, it is a 'gift without a receiver'. This study indicates that the application of ILCA in the SCM process not yet has reached its full potential as a regional platform for cooperation between actors. However, ILCA has shown to serve as a facilitator for coordination and collaboration among actors concerning sub-regional to regional-scale issues.

In conclusion, the application of the ILCA in the SCM process demonstrates a potential to merit Swedish transport planning in terms of making strategic choices of sustainable measures. The ILCA operationalizes the landscape perspective and offers an opportunity to integrate a holistic approach into planning practices. While the use of the tool in strategic planning has shown promising, there is room for further development and broader adoption to the governance contexts associated to complex sustainable transport systems.

Table 4: Key findings from the four Papers presented in Chapter 5.

<p>Paper 1</p>	<ul style="list-style-type: none"> - Nearby environmental aspects like noise and air pollution from urban road traffic actively involve actors in SCM, whereas landscape (including ecological and some social aspects) and water related issues received less attention. -Consideration of environmental aspects in the SCM process is influenced by the varying perspectives and competencies of the local and national authorities involved -There us a need to strengthen the link between the SCM and preceding and following planning stages.
<p>Paper 2</p>	<ul style="list-style-type: none"> -Landscape analysis has the potential to provide a systems perspective and account for ecological and social aspects of landscapes, including interconnections between different landscape elements. -Landscape perspective needs to be complemented by an open process facilitating knowledge sharing and creating an arena for combining insights from diverse realms of knowledge.
<p>Paper 3</p>	<ul style="list-style-type: none"> -There is a diverse mix of strategic policy instruments in the Nordic countries for integrated land use and transport planning through multi-actor engagement -MAL (Finland) and Urban Growth Agreement (UGA, Norway) are collaborative approaches that work towards establishing a shared vision and selecting policy measures, especially in city regions -Strategic Choice of Measures (SCM, Sweden) and Concept Studies (CS, Norway) employ collaborative approaches before project implementation, facilitating discussions on combinations of measures to minimize environmental impacts. -In all Nordic countries, the instruments create informal arenas for seeking consensus, fostering commitment to enforce policy measures and interventions through regulatory planning processes.
<p>Paper 4</p>	<ul style="list-style-type: none"> -Integrated Landscape Character Assessment (ILCA) can improve SCM's ability to make strategic choices of sustainable measures -ILCA operationalizes the landscape perspective -ILCA offers an opportunity to integrate a holistic approach into planning practices

6 ANALYSIS AND DISCUSSION

The thesis examines the integration of environmental considerations and sustainability perspectives in transport planning in terms of addressing three main research tasks; (i) how SCM facilitate the coordination of Swedish transport and land use planning in order to enhance a sustainable transport system, (ii) lessons that can be learned from Nordic practices of integrating transport and land use planning, and (iii) how landscape character assessment contribute to integrating environmental considerations and sustainability perspectives in transport planning. The findings shed light on the multifaceted nature of environmental and sustainability considerations in the planning process, and in the Strategic Choice of Measures (SCM) process particularly. The papers 1 to 4 (table 4) contribute with valuable insights, emphasizing the dynamic interplay of environmental considerations, sustainability perspectives, transport and land use planning, and collaborative strategies.

In Paper 1, a distinction is made between environmental aspects that were deemed engaging or non-engaging. Landscape and water emerged as less engaging aspects (in the case study), pointing at the necessity for targeted attention to these issues to integrate them into the planning process. Moreover, the paper underscored the importance of coherent approaches for environmental consideration in strategic transport planning, suggesting links between SCM and preceding and following planning stages to be strengthened.

The results of Paper 2, in line with those of Paper 1, advocates for a systems perspective in the SCM planning process. A landscape analysis was proposed as a means to grasp ecological, social, and cultural interconnections between different elements in the transport and land use planning context. In addition, the paper acknowledged the need for an open process that facilitates knowledge sharing and integration of insights from diverse knowledge realms.

Paper 3 enriched the discussion on policy instruments targeted for transport and land use planning by introducing a variety of instruments applied in the Nordic countries. For example, MAL in Finland and UGA in Norway promote integrated transport and land use planning through multi-actor engagement. SCM in Sweden and CS in Norway were highlighted for their collaborative approaches before project implementation. These instruments not only fostered consensus but also created informal arenas for commitment. The results of the paper underscores that consensus remains informal until formally incorporated into regulatory instruments.

In the context of a specific SCM process analyzed in Paper 4, the Integrated Landscape Character Assessment (ILCA) emerged as a tool that have the potential to foster sustainable strategic choices. By operationalizing the landscape perspective, ILCA provided a means to integrate holistic approaches into the planning practices. Additionally, the systems perspective applied to the planning practice (through ILCA) revealed elements aligned with Hölischer's (2019) four transformative capacities (stewarding, unlocking, transformative and orchestrating), indicating the potential for positive transformative impacts.

In the discussion below (after methodological reflections), key findings from all papers are analyzed in the context of the theoretical framework presented in Chapter 3 above. As concern strategic transport and land use planning, the environmental and sustainability considerations, policy instruments as well as the operationalization of collaborative governance, are discussed. At last, the contribution of these practices to transforming society towards sustainable development is discussed.

6.1 Methodological reflections

Generally, reliability of a research process and its results relate to the repeatability of the studies (Bryman, 2016). To achieve repeatability in this study, complete records of data have been kept for all phases of the research process, when possible, including the selection of interviewees, interview guides, recordings, interview transcripts, observation notes, collected

documents, and data analysis. The major challenge was to collect records on the dynamic nature of the planning process. For example, the way these processes were conducted were frequently changed, as practitioners learned from good and bad experiences during the processes.

A central quality aspect of the research results is how consistent the findings are with reality (credibility, internal validity, Merriam, 1998; Yin, 2014). Techniques used to increase the credibility of the study included respondent validation and triangulation (cf. Bryman, 2016). Triangulation was applied by using several methods and sources of information collected from literature, documents, and interviews. The validity of the respondents responses was examined, when possible, through follow-up interviews and informal interviews. In addition, the cases were studied in depth, which added to the credibility of the study.

Another quality aspect is the external validity (Bryman, 2016) generally evaluated in terms of transferability, which concerns potential application of the findings to another context. The conditions for strategic transport planning differed between countries as well as within Sweden. To facilitate the transferability of the methodology and results, international scientific literature (i.e. the theoretical framework in Chapter 3) was used to frame the research, and, when possible, the findings were compared to results of other studies. Also, the technique of studying multiple cases (cf. Stake, 1995) was used to get an impression of variations among cases. This study may then provide learning examples for other contexts, especially in urban and peri-urban areas.

Finally, one last quality aspect is the question of researchers' subjectivism that might cause results to be biased, usually towards verification (Flyvbjerg, 2006). A way to deal with pre-understandings based on subjective factors could be to let the researcher get involved in critical reflections on how one's own position may affect the gathering and interpretation of data (Alvesson and Sköldberg, 2020). In this thesis, discussions with researchers and practitioners in seminars, academic, and non-academic conferences provided input on various perspectives to the authors of Papers 1-4. In,

addition, constructive feedback, received during internal reviews and the paper submission processes to peer-reviewed academic journals facilitated critical reflections on the work.

6.2 Environmental and sustainability considerations

All papers revolve around strategic transport planning practice where the core activity is to adopt already formulated transport and land use policies in an informal setting (cf. van Geet et al., 2019). In the studied practices, demands for considerations of environmental aspects and sustainability perspectives were not clear. In the SCM process, no regulatory environmental assessment, such as the Strategic Environmental Assessment or the Environmental Impact Assessment, was formally required (by law) or applied. As discussed in Paper 1, the SCM guidelines referred to environmental assessment of road and railways (e.g. STA, 2022) regarding what aspects to consider and how. Consequently, the informal planning process was flexible to what extent environmental aspects and sustainability perspectives were considered (Paper 2). This implied that actors' interest in certain environmental aspects affected what the planning process focused on. For example, municipalities (with land use responsibilities) advocated for consideration of aspects closely related to public health, i.e. noise and air pollution. This appeared to hamper a holistic approach to the interplay between the transport infrastructure and its surroundings.

In addition, the extensive and diverse ecological effects of the transport system (Coffin, 2007; Forman and Alexander, 1998) were not captured by the approach provided by the SCM guidelines Paper 1 and 2). A possible reason for this might be that municipalities promoted priorities they believed to be crucial for the specific project area, in alignment with their municipal land use development strategies. In one way, this might reflect that the planning process was rooted in the relevant societal issues. Nevertheless, the fragmented consideration of environmental aspects and sustainability perspectives in the SCM process could negatively affect cross-cutting issues like climate change and biodiversity loss. Additionally, the SCM cases suggest that problem solving in transport planning need to adopt

a broader societal perspective. This requires a deeper, shared understanding of the challenges and solutions among all stakeholders. Previous studies (Heeres et al., 2017; Löfgren, 2020b) indicate that integrating technical and relational expertise in planning and design processes can significantly enhance the outcomes.

Based on the observed challenges with addressing environmental aspects and sustainability perspectives in strategic transport planning (Paper 1, 2 and 4), there is reason to believe that the planning process would benefit from applying a systems perspective (cf. Bai et al., 2017). The benefit of an integrated systems approach would be that it emphasizes the interplay between ecological, social and technical systems (e.g. Berkes et al., 2003; Sharifi, 2023), which would facilitate a holistic perspective to the investigated problems. However, the operationalization of a systems perspective in planning and decision-making is known to be challenging. One major challenge would be to fit the system perspective to the project-based approaches often applied to manage the complexity in planning (Verweij et al., 2014). In the studied SCM projects (paper 2 and 4), the planning was delineated according to the specific requirements of the issue at hand, and that decisions were made regarding which elements, relationships and operations that were included or excluded in the project. The projects' territorial and participation boundaries did not align with the optimal inclusion of environmental aspects or the pinpointing of effective measures, as elaborated in Paper 2. Consequently, ways need to be identified to bridge the problem of combining a systems perspective and project planning approaches. The results showed that the project management, the capacity of the individuals participating in the project and the application of tools when analyzing problems and finding solutions, are decisive elements in how the planning process play out. If well executed, it would be possible to integrate the systems perspective in strategic planning processes. Acknowledging the interplay between transport and its surroundings, new approaches and solutions could open up, like for example enhanced identification and execution of nature-based solutions, which are regarded as key to fostering urban resilience (Frantzeskaki, 2019; Heeres et al., 2017).

Furthermore, the challenges as regard addressing the environmental aspects and sustainability perspectives in SCM (identified in Paper 1 and 2), show how closely related these issues are with the issues of fragmented transport and land use planning practices (cf. Heeres et al., 2017, 2016; van Geet et al., 2021, 2019). The results of this thesis show that enhanced integration between the two practices could be greatly facilitated through the application of a systems perspective. This would allow practitioners to identify and understand the interconnections between transport and land use issues, enabling more effective coordination. For example, in the studied Norwegian (ZGG, UGA,CS) and Finish (MAL) practices the reaching of climate targets were emphasized, and a systems perspective to transport and land use planning helped in that regard (Paper 3). Moreover, there was a growing interest to employ landscape analytical approaches in various contexts as a means to effectively integrate the complex web of environmental factors. This approach was demonstrated to enable a thorough examination of multiple aspects and the resolution of conflicts between goals. The incorporation of landscape considerations in transport planning goes beyond minimizing or mitigating negative effects; it also emphasizes the creation of positive ecological, aesthetic, and social qualities (cf Löfgren, 2020a), and assist to capture the systems perspective of all the issues addressed. In Sweden, the STA plays an active role in advancing landscape-oriented approaches within transport planning (Sjölund et al., 2016) which is also interconnected with the development of green infrastructure in line with EU policies.

6.3 Bridging transport and land use

When it comes to the integration of transport and land use planning, policy instruments that create opportunities for multi-actor collaborations are central. Sweden's transport planning system is hierarchical (like many other European and Nordic countries), creating a unified framework that integrates multiple modes of transport (e.g. Witzell, 2021). According to Geerlings and Stead's typology (2003), this hierarchical approach fosters vertical integration within the transport sector at the national level, setting broad goals that shape interventions at all levels. The national transport

policies affect other sectors than the transport sector, for example by assuming that municipal land use plans will support the development of nationally significant transport projects. This vertical alignment enhances the coordination between transport and land use planning, but also highlights the asymmetric power dynamics between municipal land use planning and national transport planning, influencing how these policy areas interact.

The Danish Finger Plan was identified as an effective policy instrument for coordinating transport and land use planning. Under national directives, the Danish government formulated broad principles for developing the Greater Copenhagen region, focusing specifically on urban green structures, transport infrastructure, and business development sites (Danish Ministry of Environment, 2015). The plan shared similarities with regional strategies in Finland and Norway, which also have adopted an integrated approach to regional development. However, the Finger Plan in Denmark was distinguished by more direct political guidance from the national government. Beyond formal coordination through top-down governance, this thesis identified additional practices designed to improve the integration of transport and land use planning. These practices include policy instruments embedded within national regulatory frameworks, mainly used to encourage multi-actor collaboration in tackling complex cross-sectoral challenges within city-regions or specific projects (Paper 3).

6.4 Operationalize collaborative governance

Within the SCM processes, a primary goal was to collaboratively identify solutions to problems, with an expectation that all involved parties would contribute to the implementation of the identified measures. However, this collaborative effort often faced challenges due to the differing levels of engagement among the actors, the manner in which they were represented, the different professions involved, as well as their formal responsibilities and mandate to e.g. finance measures.

The issue of fragmented transport and land use planning was present in all the studies. The fragmentation has been shown to be caused by the tradition

of sectoral planning practices, with the division of transport and land use responsibilities between different organizations and planning systems (Cejudo and Michel, 2017; Dunleavy and Hood, 1994; Stead and Meijers, 2009). The collaborative 'instruments' presented in this thesis (cf. van Geet et al., 2021), were used to bridge gaps between the divided practices when addressing cross-cutting policy issues. The instruments concerned the practice where overarching policies (transport policies, land use policies and environmental policies) were adopted. The categorization of instruments aligns with the typology proposed by van Geet et al. (2017) for policy instruments. The adoption phase included integrated problem analysis as well as development and evaluation of possible solutions. In the SCM for example, multiple policy objectives were merged and specific project objectives were developed. The shared project objectives promoted, to some extent, coordination between the actors and a mutually reinforcing of transport and land use measures (cf. Brömmelstroet and Bertolini, 2010; Duffhues and Bertolini, 2016). However, the interviewed practitioners (paper 1 and 4) claimed that the shared visions developed within the project was difficult to hold on to when the SCM project had been finalized, and other people were to take care of the next stages of planning. The Urban Growth Agreement (UGA, Paper 3) in Norway had a clear purpose in fulfilling the Zero Growth Goal, which makes a good example of effective planning towards a shared goal (or at least overarching/national goal). The UGA was preceded by Concept Studies (CS; similar to SCM) in order to make room for deeper analysis of integrated problems.

Ansell and Gash (2008) point out three factors that determine the starting conditions for collaboration: (i) the incentives to collaborate, (ii) power differences among stakeholders, and (iii) past history of cooperation. These factors also apply to the collaborative approaches examined in this study (Paper 3). First (i), the main reason actors collaborate is to achieve effective policy results that can't be reached otherwise (Ansell and Gash, 2008). Financial benefits, especially from government-(co-)funded infrastructure projects, are a key incentive. Examples from the result of this thesis include agreements like the MAL, UGAs, and UEAs (see section 5.3). Collaboration

also allowed local actors, such as those in Iceland, to jointly advocate for regional issues to national authorities. This collective effort was seen as a way to create sustainable benefits for the whole area. This is a sentiment supported by Thomas and Bertolini (2015) who noted that Dutch municipalities, limited by their ability to act alone, often partner with neighbors to meet their objectives. Second (ii), in the Nordic institutional context, nationally funded transport infrastructure investments must align with national transport policies, which limits the scope of interventions approved by authorities like the STA. However, local adjustments often fall outside STA's jurisdiction, and municipal representatives argued that changes prompted by national transport plans should be financed by the STA. This sometimes created challenges in aligning specific project goals with broader transport policies. In some cases, project coordinators avoided setting definitive goals initially, instead they waited to see the outcomes of the SCM process. This strategic vs. operational level disparity underscores SCM's vital role in enhancing project planning by integrating local and regional perspectives, making the approach more holistic. This aligns with Duffhues and Bertolini (2016), who point out that the most critical phases in the planning process are those in which goals are translated into actions. Third (iii), some of the results indicated a negative attitude towards collaboration, which may stem from past experiences, e.g. a municipality that refused to collaborate on issues raised by STA. However, the result mainly reflected positive experiences and suggestions for strengthening collaborative planning approaches. Respondents emphasized the importance of systematically involving multiple perspectives, simplifying processes through prioritization, and recognizing key actors' roles in integrating various perspectives. This commitment to multi-actor coordination aimed to effectively bridge gaps between transport and land use planning.

Furthermore, the findings from Papers 1, 2, and 4 also indicate that the involvement of actors (RPTA and municipalities) in the SCM process was complex. Interviews showed that while some officials were eager to collaborate, share information, and participate in joint efforts, others were less inclined. The difference in engagement seemed to be linked to the

officials' individual interpretation of their professional role and how strict they thought they should follow set policies and internal strategic documents. A significant issue was that municipalities did not always contribute with the most relevant environmental expertise and resources to the collaborative process, which influenced both the definition of problems and the identification of potential solutions. The effectiveness of actors' contributions was also influenced by their capacity and specific professional roles, such as municipal strategists, environmental specialists and traffic planners. It was also influenced by the extent to which these individuals could dedicate time to the planning process. However, in case the collaboration was effective, then the sharing of knowledge among the STA, municipalities, and RPTA proved highly beneficial, particularly in terms of addressing environmental aspects (Paper 4).

One part of the collaborative efforts in SCM, MAL and CS (Sweden, Finland and Norway, Paper 3) was to transfer knowledge resources between actors, and to integrate different knowledge domains (cf. Klijn and Koppenjan, 2016). Professionals with different expertise participated in the planning processes. The interviews of Swedish and Nordic practices showed that there were mostly positive experiences of sharing knowledge with each other. According to Arts et al. (2017) for a successful interdisciplinary collaboration, professionals need to be experts in their own field and at the same time possess competencies to work together with other experts and integrate different knowledge domains. Additionally, Oskam (2009) states that to be a good collaboration partner you need to have a basic knowledge of connecting fields as well as an openness to inputs from outside one's own expertise and an enthusiasm to try out new angles. In these regards, mentioned by Arts et al. (2017) and Oskam (2009), at least the SCM process (among the cases studied in this thesis) provided an environment that fostered a 'safe space' to explore the connections between knowledge domains (cf. Löfgren, 2020c).

The role of the project manager or management team was crucial in steering the collaborative efforts within the SCM process. The leadership style and the priorities set by the project manager significantly influenced the

outcomes of the SCM. The capacity of the project manager to foster coproduction and innovation became vital in driving societal transformation, emphasizing the importance of creating a collaborative environment that encourages synthesis and collective learning. When the project managers were highly ambitious, in the cases studied, they acted as 'change agents' and contributed to capacity building by spurring change and innovation (cf. Bulkeley and Kern, 2006; Wretling, 2022). For instance, the follow-up on the recommended measures from case A in Paper 2 (the E4/E20) demonstrated an example on how proactive steps taken to move away from unsustainable practices, can promote the development towards new multifunctional solutions. In this case this concerned mitigating the negative impacts of the road on public health (AFRY, 2022). This showed how dedicated leadership can mobilize efforts to address environmental and societal challenges effectively.

The informal collaborative practices discussed above fall under a concept that Allmendinger and Haughton (2009) describe as 'soft spaces' of planning, which has emerged across various administrative and political contexts. Soft planning instruments play a key role in strategic planning efforts, unleashing the creative potential of urban regions and mixing regulatory frameworks with visionary strategies (Mäntysalo and Bäcklund, 2017). However, these soft planning approaches are inherently tied to their broader institutional context, including statutory planning procedures, legal requirements, and existing planning hierarchies, which influence the outcomes of strategic policy instruments. Furthermore, the informal nature and lack of transparency of these collaborative processes present challenges to the democratic quality of decision-making, and its legitimacy (Mäntysalo et al., 2022). For example, there might be conflicts between the idea of an open a democratic process, and a process in which a strong process leader has a lot of influence.

In summary as regards operationalize collaborative governance of the planning process, the presence of several strategically minded actors, each with their own set of interests, calls for a process that can retain high relevance for different goals and policies. This means that while a

comprehensive perspective is necessary for a holistic understanding, there is simultaneously a need to selectively focus on specific issues that align with the strategic interests of the involved parties (cf. Tornberg and Odhage, 2021). Balancing this broad palette of focused issues is a delicate task, requiring the above mentioned factors for successful collaboration, to facilitate a productive and innovative planning environment.

6.5 Innovations for sustainability

The SCM introduced a new way for fostering a more adaptable process facilitating creative, innovative, and sustainable solutions to transport-related problems. The emphasis on dialogue and the co-creation of knowledge enhanced the capability to address complex societal problems. However, planners reported difficulties in conceptualizing innovative and multifunctional solutions, struggling to find feasible options for the issues at hand. Despite the assembly of diverse expertise and basically good conditions for collaborative innovation, participants felt that brainstorming solutions was not a productive use of their time, possibly due to that they did not see themselves as innovators. Instead, following their established roles they appeared to identify themselves more as coordinators managing various organizational tasks. The organizations' established roles and underlying tensions between them further dampened the innovative atmosphere. For instance, municipalities took the opportunity during the workshops, to urge the STA to acknowledge and mitigate the environmental and social effects of urban infrastructure projects, as explored in Paper 2.

In Paper 4 the Integrated Landscape Character Assessment (ILCA) was applied to aid identify potential measures. Conducted by landscape architects engaged by the STA, the ILCA process leveraged 'design thinking,' a skill inherent to the landscape architecture profession and known for its ability to identify innovative and multifunctional solutions (Heeres et al., 2016). The ILCA provided multifunctional solutions to the SCM process, however, the results also showed that there was room for improvement of the communication with professionals skilled in 'design thinking', particularly regarding the type of solutions sought by the SCM

project. This underscores, as previously mentioned, the importance of deep expertise in one's domain to be coupled with the ability to collaborate across disciplines, in order to integrate diverse knowledge areas. Heeres (2017) argue that creative dialogue is crucial in planning to avoid communication to be limited to policy issues alone and to prevent the entrenchment of polarized positions. An effective planning process requires that participants are able to explore a broad 'solution space'. Hence, to promote innovative solutions within a SCM project, there is a need to stimulate a creative dialogue through a strategic staffing of the project with individuals that can collaborate across disciplines.

Throughout this thesis, there has been a focus on exploring ways to improve transport planning practices to support the sustainable development of both the transport system and society as a whole. In paper 4, the evaluation of whether the application of ILCA in SCM added features that would contribute to the transformation into sustainable cities and societies, was inspired by the transformative capacity framework as formulated by Hölscher (2019). Several elements in this framework have already been addressed in the discussion above, for example, continuous learning through on-going and iterative knowledge acquisition and the incorporation of learning outcomes into actions and policies (cf. Berkes, 2017). Another example of organizations' continuous learning and improvement. This includes their capacity to share and integrate knowledge across the organization, for example through 'change agents' as well as learning of single- and double-loop character (see theoretical framework, section 3.7 and Healey, 1998; Silva et al., 2013, Argyris, 1976). The latter type of organizational learning was identified in the SCM process, where practitioners at STA exchanged assessments of noise effects from transport infrastructure in terms of estimated perceived noise. Additionally, the ILCA approach provides flexibility and a less formal structure (as compared to formal environmental assessments), making it well-suited for strategic planning contexts.

In summary, the application of ILCA to SCM showed potential to identify innovative solutions to cross-cutting policy issues. I also showed the

potential to identify approaches that might lead to unwanted unsustainable solutions or hinder the implementation of measures that would contribute to the development of a sustainable transport system. Finally, the instruments used to bridge gaps between transport and land use planning (Paper 4), demonstrated the potential to fulfill the criteria of the transformative capacity framework emphasizing the coordination of multi-actor governance (i.e. orchestrating capacity) (Hölscher, 2019).

7 CONCLUSIONS

The aim of this thesis is to develop knowledge and understanding to enhance the integration of environmental considerations and sustainability perspectives in transport planning, in order to foster the development of a sustainable transport system.

The research highlights the complexities and challenges inherent in aligning transport system development with land use policy and sustainability objectives. The findings underscore the effects of fragmented planning practices, which is particularly evident when it comes to addressing cross-cutting policy issues (e.g. various environmental considerations and sustainability perspectives). However, the results show that the SCM process can facilitate the coordination of Swedish transport and land use planning by creating informal collaborative arenas for multi-actor involvement. These spaces allow various stakeholders, including municipalities as well as national and regional authorities, to discuss and agree on policy measures before formal project implementation. This collaborative approach can facilitate the alignment of local and national priorities, and thereby fostering a shared vision for sustainable transport systems.

Lessons from planning practices in the other Nordic countries highlight the importance of multi-actor collaborations and the use of strategic policy instruments to integrate transport and land use planning effectively. Approaches like MAL (Finland) and UGA (Norway) in major city regions emphasize the value of forming shared visions and selecting policy measures through collaborative efforts. These practices demonstrate the benefits of informal collaborative spaces that precede formal project implementation, allowing for thorough discussion and alignment of priorities. However, in the Swedish SCM, the consideration of environmental aspects is unclear, and the process falls short of fostering a comprehensive understanding of the interplay between the transport infrastructure and its impacts. One way to deal with this is through integrating landscape analytical approaches into

the planning process, as seen in Sweden and Norway, which holistically considered ecological, aesthetic, and social factors.

The landscape character assessment approach provides a structured and yet a flexible method for evaluating and incorporating environmental, cultural and social issues in planning. The application of Integrated Landscape Character Assessment (ILCA) in the SCM process, leverage 'design thinking' to identify innovative and multifunctional solutions. ILCA shows potential to enable planners to address the complex ecological, cultural and social effects of transport projects in a systems perspective. By fostering a creative dialogue among diverse experts and facilitating the exploration of a broad 'solution space', the ILCA contributes to a planning process that not only focuses on minimizing negative environmental effects, but also enhance positive ecological, aesthetic, and social qualities. This holistic perspective supports the development of sustainable transport systems that align with land use policy and sustainability objectives.

To sum up, the path towards developing a sustainable transport system is laden with challenges that demand reimagining of planning practices. Continuous learning, dismantling approaches that lead to unsustainable solutions, fostering innovation and multi-actor coordination, are elements that could enhance the planning process in these endeavors. This thesis concludes that fostering transformative change by bridging gaps between transport and land use planning, adopting a systems perspective through ILCA, and committing to collaborative governance and innovation are critical factors for realizing the vision of more sustainable and resilient transport systems.

7.1 Future research

- There is a need to study how to expand the use of ILCA within the transport planning practice to achieve more innovative and effective strategies. This involves identifying ways in which ILCA can be adopted across various planning contexts to fully leverage its capabilities, which is linked to work by Loupa- Ramos and Pinto-Correia (2018).
- Detailed analysis on how tools similar to ILCA can enhance the consideration of various environmental aspects, such as water issues, and to understand the implications of their applications in transport planning.
- Investigate how to encourage the application of a systems perspective in planning projects. This could involve demonstrating the long-term benefits of a holistic planning approach, such as increased efficiency, sustainability, and stakeholder satisfaction. Demonstrating clear advantages for embracing this perspective can motivate more planners to integrate it into their projects.
- Strengthening collaboration between the Nordic countries to further develop planning approaches for bridging gaps between transport and land use planning. This can enhance the exchange of knowledge and practical experience to increase the effectiveness of coordinated transport and land use planning in the Nordic countries.

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