SCAFFOLDING FOR MULTISTAKEHOLDER DIALOGUE-BASED PROCESSES IN STRATEGIC PLANNING FOR TRANSITIONING TO SUSTAINABLE MOBILITY

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ABSTRACT

There are numerous sustainability challenges related to mobility. One of the main challenges is the necessary reduction of greenhouse gas emissions. The transport sector is one of the main emitters. There are also challenges regarding accessibility, health, equity, and justice that need to be considered. The recent COVID-19 pandemic led to a temporary decrease in emissions (mainly from reduced aviation), at the same time as there were worsening aspects such as social exclusion. These and other complex challenges require urgent, comprehensive change and creative solutions. The urgency for a change adds to the challenge of mobility planning since conventional planning processes are usually slow. Moreover, local planners who plan for transitioning to sustainable mobility need to facilitate participatory processes since mobility planning affects many stakeholders. When engaging with planning practitioners, it was found that there is a lack of tools that can support practitioners when conducting reflective and generative multistakeholder dialogues.

The aim of this research was to develop process-oriented methodological support for multistakeholder dialogues in strategic planning for transitioning to sustainable mobility. A transdisciplinary research approach was used to explore this topic, including the problem space of participatory research modes. Furthermore, a design research approach was used for tool development.

A comprehensive literature review to identify prominent research themes in regional and urban planning for transitioning to sustainable mobility was made. The developments in the field over the past 15 years show a paradigm shift from 'predict-and-provide' to participatory visionary approaches, such as backcasting and SymbioCity. However, this has led to new challenges concerning processes that support reflective and generative stakeholder dialogue in a rapidly changing and highly diversified world. These challenges relate to, among other things, an insufficient diversity in multistakeholder processes, a limited availability of stakeholders to participate in such processes and a lack of tools that can aid with an overview of various sustainability goals from policy and planning documents.

Among participatory research approaches, transdisciplinary research and action research were explored. As these research modes have become prominent, it is important to know more about them. It was found that transdisciplinary research could be particularly useful for advisory reflective contexts, whereas action research could be particularly useful for contexts where action is a priority.

The dissertation presents further forms of methodological support that can help structure participatory multistakeholder dialogue-based processes:

– a framework for analysing the complexity of co-production settings in relation to epistemic communities, linguistic diversities, and culture;
– a rapid scenario planning method to support regional visioning for sustainability transformation; and
– the MUSTS tool that connects sustainability goals at multiple levels with stakeholders who have the power and legitimacy to act upon them.

To conclude, the methodological process-supporting tools that were investigated and those developed in this research offer a form of "scaffolding" that aids facilitators to organise more efficient and effective participatory processes. These scaffolding tools are rooted in transdisciplinary co-production of knowledge research and offer promising elements for a toolbox for strategic planning for transitioning to sustainable mobility.

Keywords: *sustainability, transdisciplinary, co-production of knowledge, mobility, strategic planning, facilitation, dialogue-based process*

LIST OF INCLUDED PAPERS

This compilation dissertation includes an overview part and the following papers. The papers have been reformatted from their original publication to fit the format of the dissertation. The content remains unchanged.

Paper A

Nikulina, V., Simon, D., Ny, H., Baumann, H., 2019. Context-adapted urban planning for rapid transitioning of personal mobility towards sustainability: a systematic literature review. *Sustainability* 11 (4): 1007. https://doi.org/10.3390/su11041007.

Paper B

Nikulina, V., Baumann, H., Simon, D., Sprei, F., 2018. Sustainable Transport Futures: Analysis of the Selected Methodologies Supporting the Planning Process Towards Achieving Goal 11 Sustainable Cities and Communities. In: *Handbook of Sustainability Science and Research*. pp. 473–488.

Paper C

Laycock Pedersen, R., Nikulina, V., Chineme, T., Subroto, S., Robinson, Z., Winkler, K., Luederitz, C., Metson, G., Malmborg, K., Moriggi, A., Lam, D. P. M., Partelow, S., Cockburn, J., Bhurekeni, J., 2023. Distinguishing transdisciplinary (and) action research in sustainability science: a comparative systematic-narrative hybrid literature review. *To be submitted to journal.*

Paper D

Nikulina, V., Lindal, J., Baumann, H., Simon, D., Ny, H., 2018. Lost in translation: a framework for analysing complexity of co-production settings in relation to epistemic communities, linguistic diversities and culture. *Futures* 113 (October): 102442. https://doi.org/10.1016/j.futures.2019.102442.

Paper E

Thomson, G., Ny, H., Nikulina, V., Borén, S., Ayers, J., Bryant., J. 2020. "Rapid Scenario Planning" to Support a Regional Sustainability Transformation Vision: A Case Study from Blekinge, Sweden. *Sustainability* 12 (17): 6928. https://doi.org/10.3390/su12176928.

Paper F

Nikulina, V., Ny, H., Baumann, H., Laycock Pedersen, R., Berger, T., Oginga Martins, J., Wälitalo, L. Grasping multiple sustainability goals (MUSTS): a tool for supporting dialogue-based processes of multi-level governance in transport planning. *Submitted to journal.*

OTHER PUBLICATIONS BY THE AUTHOR

Nikulina, V., Borén, S., Ny, H., Simon, D. (2017, June 18-21). *Gaps in the sustainable mobility planning guidelines from a sustainability principles point of view* [Paper presentation]. 8th International Conference on Sustainability Transitions, Gothenburg, Sweden.

Nikulina, V., 2019. Need for speed: towards urban planning for rapid transitioning to sustainable personal mobility (Blekinge Institute of Technology Licentiate Dissertation Series No 2019:03).

Ny, H., Nikulina, V., Thomson, G., Borén, S., 2019. Scenarios for Blekinge 2050 within the project Strukturbild Blekinge 2.0. (in Swedish). Blekinge Institute of technology. Research Report 2019:01. Karlskrona, Sweden.

Nikulina, V., Larson Lindal, J., Ny, H. (2019, September 10-13). *Contemplating Complexities: Enabling transdisciplinary dialogue in co-production processes* [Paper presentation]. International Transdisciplinary Conference: Join Forces for Change, Gothenburg, Sweden.

Ny, H., Nikulina, V., Thomson, G., Borén, S. (2019, September 10-13). *Sustainability transition scenario planning. A transdisciplinary case study from Blekinge in Southeast Sweden.* [Paper presentation]. International Transdisciplinary Conference: Join Forces for Change, Gothenburg, Sweden.

Nikulina, V., Laycock Pedersen, R. (2021, September 13-17). *Dialogue between transdisciplinary and action research: modus operandi and what we can learn from it* [Paper presentation]. International Transdisciplinary Conference: Creating Spaces and Cultivating Mindsets for Learning and Experimentation, online.

Nikulina, V., Ny, H., Oginga Martins, J., Wälitalo, L., Berger, T. (2021, October 19-20). *Making a jigsaw puzzle: An approach for integrative preliminary sustainability indicators for the transport sector in Blekinge, Sweden* [Paper presentation]. Baltic University Programme Symposium, online.

Berger, T., Nikulina, V., Wälitalo, L., Ny, H. (2021, October 19-20). *The European Green Deal - a systematic approach for integrating sustainability goals in the transport sector: the case of Blekinge region, Sweden* [Paper presentation]. Baltic University Programme Symposium, online.

LIST OF ABBREVIATIONS AND ACRONYMS

CO_2e – carbon dioxide equivalents

IPCC – Intergovernmental Panel on Climate Change

MUSTS - MUltiple SusTainability goalS

OECD – Organisation for Economic Cooperation and Development

RQ – research question

SDGs – Sustainable Development Goals

SUMP – sustainable urban mobility plan

SWOT – strengths, weaknesses, opportunities and threats

UN – United Nations

UN-HABITAT – United Nations Human Settlements Programme

USB – universal serial bus

CONTENTS

1 INTRODUCTION

In this chapter, the general context for the dissertation, the problem and knowledge gap dealt with are described. Given the identified gap, an aim for the research is stated. Finally, the dissertation outline is provided.

1.1 The needs of multistakeholder processes in strategic planning for transitioning to sustainable mobility

Planning for sustainable transport requires a refined, differentiated, contextualised and coherent approach (Elmqvist et al. 2018; Schiller and Kenworthy 2018). It requires balancing different perspectives, such as land use and aspects of urban design, as well as the participation of various actors (Schiller and Kenworthy 2018). On the one hand, planners need to follow bureaucratical processes, and, on the other hand, they need to address urgent sustainability challenges, and they do not always have relevant methodological support to do so.

One way of working with multiple actors is through employing participatory research modes, such as action research or transdisciplinary research. These types of research often focus on finding out what we need to know to solve urgent sustainability problems (e.g., Hasan et al. 2017; Muhar and Penker 2018), where we need to go (e.g., Nicolescu 2002; de Vries et al. 2017), and how we can get there (e.g., Clemens 2009; Ny et al. 2017). Even though there are exceptions (e.g., Wälitalo 2023), less attention has been given to the processes behind the work towards addressing the challenges at hand, that is, when and how to apply certain tools in designing, carrying out and evaluating participatory processes (Lawrence et al. 2022).

Tools for participatory planning are of great importance for planners who follow principles of democracy and inclusion into the processes. These tools are especially important for mobility planners, who need to satisfy the needs of various groups of people, both locally and internationally, by facilitating access to, for example, education, jobs, healthcare and leisure. There are many tools available to support participatory processes. For example, sustainability-related tools, such as life cycle assessment (e.g., Ally 2008) and material-flow analysis (e.g., Hodson et al. 2012); and facilitation tools, such as energisers (e.g., Online Energizers) and ice-breakers (e.g., Rogga and Parisi 2023). There are also tools that are specific for dialogue-based processes. However, most of them focus on fundamental issues of creating and sustaining a dialogue. Some examples of issues are tension for energy

and creativity in the group (Freeth et al. 2019), elements that need to be considered in creating a safe space for dialogue (Durham et al. 2014), and identification and selection of people who need to be part of the dialogue (Mitchell et al. 1997). Moreover, tools for dialogue-based processes are often developed by practitioners and often do not have a scientific grounding (Jordan 2014). Therefore, there is a need for science-based methodological support for planners to organise and facilitate these complex processes to support reflective and generative multistakeholder dialogue in the context of strategic planning for transitioning to sustainable mobility. Such process-supporting tools could provide a sort of scaffolding that helps in the running of those complex processes.

1.2   Aim

Based on the above, the aim of the dissertation is to develop process-oriented methodological support for reflective and generative multistakeholder dialogue in strategic planning for transitioning to sustainable mobility. The target groups for the dissertation are academics and practitioners (including planners, local authorities, project managers, and facilitators).

1.3   Dissertation outline

To develop a thesis for the dissertation, knowledge in the fields of sustainability science, general complex systems theory, strategic sustainable development, sustainability transitions, regional and urban sustainable mobility planning, participatory research modes, project management, and stakeholder facilitation has been obtained. The backgrounds of these fields are introduced in Chapter 2. Further on, to develop the thesis and address the research aim, a research methodology was designed. It is described in Chapter 3. The research methodology required arguments that contribute to the thesis. These arguments were published in scientific papers, a book chapter and provided as manuscripts. Short summaries of publications are presented in Chapter 4. The results are then presented in Chapter 5. Overall reflections upon the results and research limitations are provided in Chapter 6. Finally, a synthesis is given in Chapter 7, where contributions of the dissertation to the body of knowledge and an outlook into possible future studies are also suggested. The dissertation ends with a collection of included papers.

2   BACKGROUND OF THE FIELDS

To address the challenge of insufficient processes to support reflective and generative multistakeholder dialogue in the context of strategic planning for transitioning to sustainable mobility it is important to understand the foundations of a number of research fields. These fields are primarily sustainability science, general complex systems theory, strategic sustainable development, sustainability transitions, regional and urban sustainable mobility planning, participatory research modes, project management, and stakeholder facilitation. In this chapter, an overview of these fields and related key concepts are presented.

2.1   Sustainability science

The term 'sustainability' has existed for a considerable time. Yet, there is no general agreement among researchers or in society in general regarding definitions of sustainability (Pater and Cristea 2016). Some examples of definitions are presented below. Perhaps the most widely known definition of sustainable development comes from the so-called Brundtland report (UN World Commission on Environment and Development, 1987, p. 16), referring to a development that:

> "*meets the needs of the present without compromising the ability of future generations to meet their own needs*".

This definition has been criticised for, for example, being too vague and not operational enough for practical use (Lozano 2008; Chasin 2014; Missimer et al. 2017a). Another attempt to define sustainability is that of John Elkington (1997), who considers sustainability as an intersection of environmental quality (planet), social equity (people) and economic prosperity (profit), captured in the so called Tripple-Bottom-Line concept, see Figure 1.

Figure 1. Tripple-Bottom-Line conceptualisation of sustainability. Based on John Elkington (1997).

However, this definition has been criticised for its vagueness and that this, in turn, might lead to ineffective decision-making and that the approach does not support measuring the social performance systematically (Srivastava et al. 2022). It has also been criticised for promoting/indicating a mindset that the dimensions are interchangeable and can be negotiated against each other (Thurm and Baue 2018). Moreover, John Elkington (2018) has re-evaluated the definition stating that:

> *"It was supposed to provoke deeper thinking about capitalism and its future, but many early adopters understood the concept as a balancing act, adopting a trade-off mentality".*

An alternative view on sustainability is that the social system is part of and depends on the ecological system, and that the economic system is part of and depends on the social system (Gibson 2006; Pryn et al. 2015), see Figure 2.
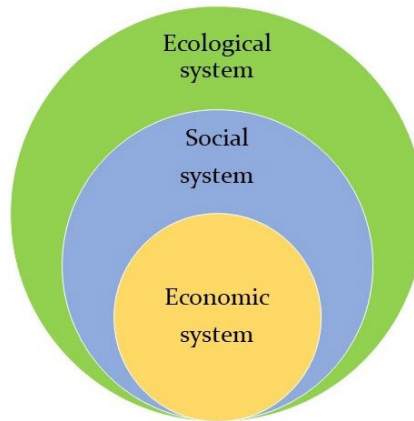
Figure 2. Nested interdependent systems view on sustainability.

Based on this approach to sustainability, an attempt to develop a unifying, operationally applicable definition of sustainability through an international consensus process among academics and practitioners (e.g., Robèrt 1992; 1994; Holmberg 1995; Broman et al. 2000; Robèrt 2000; Robèrt et al. 2002; Ny et al. 2006; Broman and Robèrt 2017; Missimer et al. 2017a; Missimer et al. 2017b) has resulted in the following set of sustainability principles (Broman and Robèrt, 2017, p. 23):

> *"In a sustainable society, nature is not subject to systematically increasing...*
>
> 1. *... concentrations of substances extracted from the Earth's crust [...];*
> 2. *... concentrations of substances produced by society [...];*
> 3. *... degradation by physical means [...];*
>
> *and people are not subject to structural obstacles to...*
>
> 4. *... health [...].*
> 5. *... influence [...].*
> 6. *... competence [...].*
> 7. *... impartiality [...].*
> 8. *... meaning-making [...]".*

This principled definition of sustainability is used in the dissertation as boundary conditions for future visions in mobility planning as it can be operationalised in such planning and assist in including all aspects of sustainability simultaneously, while providing conditions for flexibility and dialogue (Broman and Robèrt, 2017).

Sustainability and sustainable development address a certain type of challenges. Sustainability researchers and practitioners are dealing with *complex* problems (Komiyama and Takeuchi 2006). These problems are often poorly defined, have interdependent causes, are also multi-dimensional, socially constructed and have a moving target (Mowery et al. 2010; Reid et al. 2010; Levin et al. 2012; Ferraro et al. 2015). Such problems typically require emergent solutions, meaning that there is no one-fits-all solution and that suitable solutions would evolve in a process. Furthermore, some researchers call such problems as constituting a sustainability *crisis* (e.g., Komiyama and Takeuchi 2006), emphasising the need for a comprehensive view of sustainability issues. Finally, urban planners often call such problems *wicked* problems (Rittel and Webber 1973), while some researchers go to the extent to call them *super wicked problems* (e.g., Levin et al. 2012), emphasising the need for "comprehensive social change" (Brown 2008, p. 1). These problems have contested knowledge gaps and require joint definitions of the problems as well as the co-production of knowledge to address the problems among scientific and societal actors and stakeholders (United Nations 2019). Some of the key terms used in a previous sentense are presented below. Co-production is one of them. The concept has many definitions coming from different fields. *Co-production of knowledge* (Polk and Kain, 2015, p. 2) could be defined as a

> "*collaboratively based process, where different actors and interest groups come together with researchers to share and create knowledge that can be used to address the sustainability challenges being faced today and increase the research capacity to contribute to societal problem-solving in the future*".

According to Mark Reed and colleagues (2009), *actors* are people or groups of people who act within a system of interest. And according to Ronald Mitchell and colleagues (1997), *stakeholders* are actors who are affected by the problem or can influence the resolution of the problem.

Sustainability challenges are further referred to in the dissertation as complex challenges due to the acceptance of the term in various disciplines and its relation to complex systems theory, which this dissertation builds on.

Work on sustainability and sustainable development led to the development of the sustainability science field. The field can be defined in several ways. One of the most widely accepted definitions (Kates et al. 2001, p. 641) states the following:

> "*sustainability science is [an] emerging [field] that seeks to understand the fundamental character of interactions between nature and society*".

The sustainability science field is characterised by the following features: normativity, urgency, inclusion of non-scientists and collaboration between disciplines (Ziegler and Ott 2011). In sustainability science, *normativity* refers to challenging social norms, outlining beneficiaries, whose interests are considered (or not) and putting a requirement for transparency in the process. *Urgency* in sustainability science underlines that society is running out of time. Moreover, *collaboration with non-scientists* can improve sustainability science in many ways: bringing in local knowledge (that is often not considered scientific); pointing out research bias (e.g., underlying assumptions); encouraging self-criticism among scientists (e.g., about hidden agendas in the hierarchical organisational structures); reinforcing alertness (e.g., help to see outside of the predominant theoretical stance); being open to new conjectures by bringing in unusual ideas and unexpected observations; underlining cautiousness due to care and concerns regarding consequences society is to face; indicating the right timing for elements of research work; bringing a research project to implementation due to upheld power; and disputing values that are brought into research. Finally, the *diversity of disciplines* in sustainability science improves the quality of the results, challenges the hierarchy between disciplines, and enables communication and translation of the results back to the disciplinary contexts.

To deal with complex sustainability problems one needs to understand the basics of general complex systems theory or complexity theory as it is sometimes called. This is briefly described in the next section.

2.2   General complex systems theory

Systems theory started to evolve in the early 1940s as an alternative to "physicalistic unitary science" (Hirsch Hadorn et al. 2008, p. 23). A general definition of complex systems theory is that it is (Rotmans and Loorbach 2009, p. 185):

> *"an interdisciplinary field of science that studies the nature of complex systems in society, nature, science, and technology".*

Different interpretations of systems theory and/or complexity theory come from different disciplines (Hofkirchner and Schafranek 2011). For example: game theory (Von Neumann and Morgenstern 1947), cybernetics (Wiener 1948), information theory (Shannon 1953), biology (Bertalanffy 1968), system dynamics (Randers 1980), sociology (Luhmann 1983), and organisational learning (Senge 2006).

Systems theory works with systems. A system could be defined as (Kim 1999, p. 19):

> *"a group of interacting, interrelated, or interdependent elements forming a complex whole"*.

A system could be complex. There is no single, generally agreed upon definition of what a complex system is. However, some features are often associated with complex systems. Examples are that complex systems interact with their environment, evolve and change over time (Rotmans and Loorbach 2009); that some interactions between the elements of the system are non-linear, and that there are path dependencies.

There are also complex adaptive systems. They are often referred to in sustainability science as special types of complex systems (Folke 2006; Levin et al. 2013). These systems are adaptive as "they have a capacity to change and learn from experience" (Rotmans and Loorbach 2009, p. 186). A distinguishing feature of complex adaptive systems is that their interactions are constantly changing in a non-linear way. Therefore, unique features of such systems are coevolution (interaction between systems affects dynamics of individual systems), emergence (creation of new structures during self-organisation) and self-organisation (internal organisation of a system increases in complexity without external guidance) (Rotmans and Loorbach 2009). An example of a complex adaptive system could be a city, a traffic flow or a social network.

Systems theory has had a great influence on transdisciplinary co-production of knowledge (Hirsch Hadorn et al. 2008), the Framework for Strategic Sustainable Development (Broman and Robèrt 2017), and sustainability transitions (Rotmans and Loorbach 2009), among others. Ways of dealing with or managing complex adaptive systems in different fields are described in subsequent sections.

2.3   Strategic sustainable development

There are several ways of doing intentional directional work involving environmental and societal change. Remigijus Čiegis and Dalia Gineitienė (2008) talk about strategic planning for sustainable development, Rupert Baumgartner and Jouni Korhonen (2010) refer to it as strategic thinking for sustainable development, and the European Commission (EC) talks about a strategy for sustainable development (European Commission 2001). It seems

that a new research area, that does not yet have a single, formal definition, is growing around the term 'strategic sustainable development'.

An approach to strategic planning and action that is particularly developed for sustainability science is the Framework for Strategic Sustainable Development (Broman and Robèrt 2017). It is a methodology for iterative, participatory co-production of strategic plans and their execution towards sustainability, allowing for many possible visions within a principled frame of boundary conditions for sustainability and many possible routes to such visions. In its guidance of participatory innovation the methodology is open to diverse political, cultural, and economic approaches. This framework has been used in various contexts, such as research on product- and service development (Hallstedt et al. 2010; Schulte and Hallstedt 2018; Villamil et al. 2022; Watz and Hallstedt 2022), public procurement (Bratt et al. 2013), education design (Ayers et al. 2020; Bryant et al. 2021), social sustainability (Missimer et al. 2017a; Mesquita and Missimer 2021), governance (Wälitalo et al. 2020) and transport planning (Borén et al. 2017; Ny et al. 2017).

An important part of the Framework for Strategic Sustainable Development is a participatory operational procedure that uses backcasting from visions framed by principles for sustainability and is called the ABCD procedure (Broman and Robèrt 2017). It is used to make plans and roadmaps towards sustainability in complex societal systems. The ABCD procedure emphasises the necessity to reassess and recreate such plans repeatedly as the detailed contextual conditions change. Step A is about creating a vision within sustainability principles as boundary conditions. Step B is about assessing the current state of the system in relation to the vision. Step C focuses on identifying possible actions towards the vision. Finally, step D includes reflective questions to prioritise actions into a strategic plan or roadmap.

The principled definition of sustainability (presented in section 2.1) of the Framework for Strategic Sustainable Development has been developed with the following in mind: to be unifying across disciplines and sectors and thereby operationally applicable for co-ordinated backcasting planning and redesign for sustainability, the principles should be (Broman and Robèrt, 2017, p. 19):

- "**Necessary**, but not more to avoid imposing unnecessary restrictions and to avoid confusion over elements that may be debatable";
- "**Sufficient**, to avoid gaps in the thinking, i.e., to allow elaboration into second and higher orders of principles from a complete base";

-   "**General**, to be applicable on any arena, at any scale, by any member in a team and all stakeholders, regardless of field of expertise, to allow for cross-disciplinary and cross-sector collaboration";
-   "**Concrete**, to actually guide problem solving and innovation, i.e., redesign through step-by-step approaches in real life";
-   "**Non-overlapping**, to enable comprehension and facilitate development of indicators for monitoring of progress".

In any complex endeavour, it is impossible to predict change at a detailed level, implying that *all* detailed plans *will not* be realised in full. Visions that use sustainability principles as boundary conditions and repeated participatory assessment and co-production are then essential elements of strategic planning and action. Such an approach is helpful for including all aspects of sustainability and involving important stakeholders in sustainability transitions (Broman and Robèrt 2017). The field of sustainability transitions is briefly described in the next section.

2.4   Sustainability transitions

The terms of transition and transformation are often used interchangeably in relation to radical change (Hölscher et al. 2018), although they have different origins and may mean different things. It has been suggested (Markard et al. 2012, p. 956) that *sustainability transitions* are

> *"long-term, multi-dimensional, and fundamental [change] processes through which established socio-technical systems shift to more sustainable modes of production and consumption".*

It has also been claimed that such transitions often use disruptive innovation, that they have several dimensions (technological, organisational, institutional, political, and socio-cultural), that they span over 30-50 years, and that they often focus on sectoral changes, for example, transport, energy, or agriculture (Geels 2002; Smith et al. 2010).

According to Johen Markard, Rob Raven and Bernhard Triffer (2012), there are four major schools of thought when it comes to sustainability transitions. The first one focuses on transition management and aims to govern complex societal systems (e.g., Rotmans et al. 2001). The second school of thought is strategic niche management that focuses on the introduction and dissemination of small-scale innovations, such as wind energy or biogas (e.g., Caniels and Romijn 2008). The third school of thought develops further the multi-level perspective that focuses on the understanding of dynamics in

complex socio-technical change (e.g., Geels 2002). Finally, the fourth school of thought works with technological innovation systems, where new technologies emerge, such as renewable energy technology, leading to institutional and organisational changes (e.g., Bergek et al. 2008).

Among the schools of thought of sustainability transitions, transitions management has its roots in complex systems theory. This approach is also used in participatory governance processes and aims to present ways of managing change on a sectoral level, such as transport or energy. Based on the above, the term of transition is used in the dissertation (rather than transformation).

More about sustainability transitions and recent developments in the field are presented in Chapter 5. Sustainability transitions are inherently connected to the context where they (could/should) take place. In this dissertation, it is regional and urban mobility planning, which is described in the next section.

2.5   Regional and urban sustainable mobility planning

Mobility could be defined as *"the ability to move or be moved freely and easily"* (Oxford Dictionaries).

This includes motorised and non-motorised transport of people and walking but excludes transport of goods. The focus of this dissertation is mainly on mobility on land since air and sea transport are often excluded from regional and urban planning. Some scholars, such as Frank Geels (2018), use the term of passenger mobility. However, this seems to imply that people are passengers in vehicles, whereas mobility also includes walking.

Current regional and urban mobility is a significant contributor to society's sustainability challenges and considering current trends of population growth and ongoing urbanisation, sustainability challenges are further pronounced.

For example, the Special Report of the Intergovernmental Panel on Climate Change (IPCC, 2018, p. 17) states that:

"Pathways limiting global warming to 1.5°C with no or limited overshoot would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems (high confidence)".

For decades, scientists have collected increasing evidence suggesting that anthropogenic impact is one of the largest contributors to climate change and a recent example of this is the synthesis report produced by the Intergovernmental Panel on Climate Change (Pachauri et al. 2015). Also, according to Eurostat (European Commission 2017), 23,5 % of the greenhouse gas emissions in the 28 European Union (EU) countries, expressed as carbon dioxide equivalents (CO_2e), come from the transport sector. There are further ecological challenges related to transport, for example, human-fixed nitrogen (Galloway et al. 2004), the flow of metals and minerals (Klee and Graedel 2004), and noise (Proost and Van Dender 2012). Additionally, there are social sustainability challenges. For example, in development processes, often only certain categories of people benefit, while the rest are left behind. For example, when decision-makers incentivise motorised public transport development to increase accessibility to the cities in the countries of the global South, the non-motorised mobility of the poorest of the poor becomes more difficult (Parnell 2016; Simon 2016). Addressing these aspects in a coordinated and strategic way forms part of the complex challenge related to sustainable mobility.

A study on global trends showed that consistently negative trends of land-based transportation are related to car ownership and use, which is often related to proximity to places and services (Kenworthy 2013). The magnitude of mobility led to the creation of a new term – *hypermobility* (Adams 1998), which emphasises sustainability challenges related to, for example, social equity, land use, urban form, and environmental, economic and cultural impacts (Schiller and Kenworthy 2018). The concept of automobile dependence further emphasises the challenge (Newman and Kenworthy 1999).

Mobility is typically an important subject for urban and regional planners, but it is also an outcome of urban planning, which deals with policy demands and transport management (Hull 2005). Urban planning is typically done with regard to two elements: map development outlining zones, and conceptual planning that indicates factors, such as land use, density, road infrastructure (Schiller and Kenworthy 2018). Much of mobility planning takes place in the context of urban planning, but it is also affected by national policies, such as policies on transport, land use, and spatial planning. In different countries, different stakeholders might have the power to influence the planning, but typically it is planners at the regional and local levels that have most of the influence. Therefore, mobility planning is a complex process that involves many influential actors and issues that need to be taken into consideration. Sustainability considerations add to the complexity.

Regional mobility planning adds to the complexity in terms of capacity to transport people, costs, the speed of travel and right-of-way issues (Schiller and Kenworthy 2018). Additionally, regional mobility solutions need to be well connected to urban mobility solutions, requiring extended coordination and cooperation of the respective stakeholders at all levels.

Planning for mobility is an emerging field (UN-HABITAT 2013). Different scholars have shifted to mobility planning from transport planning at different times. For example, for the research group led by David Banister, this shift happened when the sustainable mobility paradigm was published (Banister 2008), which underlines the importance of combining transport and land use in planning. It also raises other aspects important for planning, such as technological advancement, regulation of prices, land-use development, and behavioural change through the means of information. These aspects show that actors other than transport planners need to be involved in the process, which makes the concept of mobility more complex than that of transport. Some researchers use the terms 'mobility planning' and 'transport(ation) planning' interchangeably, as, for example, a research group led by Kay Axhausen (Future Cities Laboratory 2018). Based on UN-HABITAT (n.d.), *mobility planning* is in this dissertation defined as:

> "*resident-centred planning that brings people together locally, providing accessibility and reducing the need to travel*".

Further developments in sustainable mobility definitions show that there has been a shift in approaches too, namely from people being moved by means of transport to the movement of people (where people become the central focus). This creates a question of the organisation of mobility planning. Is it still the same organisational structure and the same authority (for transport planning) that should be responsible for mobility planning? And how is this reflected in the organisation of mobility planning research? At this stage, it is difficult to answer these questions.

Furthermore, the European Commission plays an important role in urban mobility planning in Europe. In September 2009, they adopted guidelines for an action plan on urban mobility, which later became widely known as the Sustainable Urban Mobility Plan (SUMP). These guidelines were meant to be of support for local, regional, and national authorities that work towards the achievement of their sustainable urban mobility goals. The main feature of this approach is that it focuses on planning for people. One of the critiques of the approach is that it is not clear how challenges of climate change and societal issues are accounted for in the SUMP (Arsenio et al. 2016). Other researchers suggest using the SUMP as a process guideline and to complement it with a multilevel transport system model (Okraszewska et al.

2018). It is considered reasonable to conclude, however, that the SUMP can be used as an initial guideline for mobility planning.

The literature shows that there has been a paradigm shift in planning approaches that has allowed for participatory, innovative, and flexible solutions to address the challenges of today and the future. Planning processes changed from forecasting and planning from scenarios (Kenworthy 2006; Drličiak and Čelko 2016; Taylor and Letham 2018) where past trends have a great influence on the outcomes, to participatory backcasting and planning from a desired future (Dreborg 1996; Holmberg and Robert 2000; Robinson et al. 2011), where relevant stakeholders together define a desired future and possible pathways to get there.

However, the participatory approaches used in planning are considered insufficient when it comes to addressing complex sustainability challenges (Moallemi et al. 2020). It is not uncommon to have collaborative projects together with academia on transitioning to sustainable mobility. These projects often run as transdisciplinary or action research projects (e.g., Von Knorring 2019; Olson et al. 2021; Becker et al. 2022; Kesselring et al. 2023). Yet, there is limited information on the usefulness of such research modes in relation to the purpose of the work they are applied in. Two of them, action research and transdisciplinary research, are presented below.

2.6   Participatory research modes

There are many research modes (some researchers call them approaches or traditions) available in sustainability science, where participatory methodologies are employed. Some examples are citizen science (Silvertown 2009), scholar activism (Blomley 1994), action research (Reason and Bradbury 2001), transdisciplinary research (Hirsch Hadorn et al. 2008), and transdisciplinary action research (Stokols 2006). There are researchers who advocate for action research (Wittmayer and Schäpke 2014; Egmose 2015) and transdisciplinary research (Komiyama and Takeuchi 2006; Brandt et al. 2013). These two approaches are briefly described below.

Action research was developed in the 1940s before sustainability science was introduced. Action research has a methodology that is called the action research spiral. There are several versions of this spiral (see Figure 3 a-c). However, three versions are used the most: Constructing - Planning action - Taking action – Evaluating (Coghlan 2019), Look - Think – Act (Stringer 2013), and Observe - Reflect - Plan – Act (O'Leary et al. 2004).
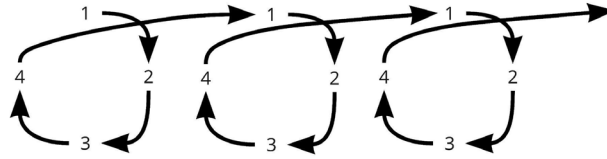
Figure 3a. The action research spiral, depicting three cycles of action and reflection.
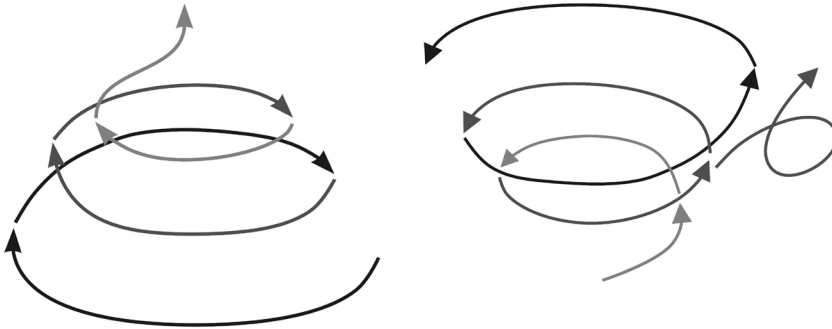
Figure 3b. The action research spiral depicted with a wider base and narrower top, representing more specific understandings and targeted actions over time.

Figure 3c. The action research spiral depicted with a narrower base and wider top, representing more complex and nuanced understandings over time which create offshoot spirals addressing questions that arise from the process (adapted from McNiff 2013).

Due to the focus on solving sustainability problems collaboratively together with non-academic stakeholders, action research is recommended as a methodology for sustainability science (Wittmayer and Schäpke 2014; Egmose 2015).

Transdisciplinary research is another widely used research mode in sustainability science. It was introduced in the 1970s in the context of interdisciplinary research. Like many other research concepts, interdisciplinary research has many definitions. However, the common thread is that it focuses on solving a problem with researchers collaborating from at least two disciplines (Aboelela et al. 2007). Transdisciplinarity takes it a step further by combining efforts to solve a sustainability problem, not only through efforts of researchers from different disciplines, but also,

through collaboration with non-academic stakeholders (Jahn et al. 2012). Such collaboration is called co-production or co-creation of knowledge, depending on the level of engagement of stakeholders outside of academia (Simon et al. 2018), where co-creation means close collaboration at all four stages of the transdisciplinary process (conceptualisation, design, production and analysis of research), whereas co-production usually takes place in the last two stages.

Christoph Woiwode and Olivia Bina (2021) suggest that transdisciplinarity can be used in three different ways: as a methodology – solving problems; as an epistemology – in relation to transcending boundaries in knowledge production; and as a philosophy – placing ourselves in a larger context of existence. To address problem-solving, several versions of the 'ideal type' of transdisciplinary research process were developed (e.g., Scholz et al. 2006; Jahn et al. 2012; Lang et al. 2012; Pohl and Hadorn 2017; Hoffmann et al. 2019). Out of these, the one developed by Daniel Lang and colleagues (2012) is the most cited.

In recent years, transdisciplinary research has gained considerable attention among researchers and practitioners (Simon 2016; OECD 2020; Fokdal 2021; Hemström et al. 2021). It has even been suggested as the underpinning research approach for sustainability science (Komiyama and Takeuchi 2006; Scholz et al. 2006; Brandt et al. 2013).

Significant attention in transdisciplinary research is given to knowledge production. There is no agreement among researchers about what knowledge is and in what way it is different from information. In this dissertation, the definition of *knowledge* by Marco te Brömmelstroet and Luca Bertolini (2008, p. 252) is used:

> *"a meaningful collection of information, such that it can be used in a specific context".*

Transdisciplinary researchers (e.g., Hirsch Hadorn et al. 2006; Kueffer et al. 2019) distinguish between three types of knowledge (systems knowledge, target knowledge and transformation knowledge) necessary to be engaged for research to be considered transdisciplinary (see Figure 4).

Systems knowledge describes the system in focus. It is often descriptive and analytical and answers the question "what is?". Critical thinking is the key to producing this type of knowledge. An example of this knowledge might be a systems analysis with casual loop diagramming of the environmental system.

Target knowledge represents the desired future. It is based on deliberative processes by diverse societal actors, engaging with values and norms, to formulate the future direction. This knowledge addresses the question "what ought to be?". Ethical reasoning, self-reflection and a culture of responsibility and environmental virtues are important for the reflection of people upon their values and for entering participatory processes prepared for a dialogue (Kueffer et al. 2019). An example of target knowledge could be a policy document that has a set of goals.

Transformation knowledge is about bridging the gap between the current system's state and the desired future. It is comprised of strategies and concrete steps that need to be taken. This type of knowledge addresses the question "how to?". Empowerment and agency are important elements of transformation knowledge. An example of transformation knowledge could be that which comes out of the creation of a roadmap or strategic plan done by a regional planner.

Additionally, Mark Lawrence and colleagues (2022) argue for another type of knowledge, *process knowledge*, that helps to design and carry out transdisciplinary research. An example of process knowledge could be an ideal type of process on how transdisciplinary research could be conducted (Lang et al. 2012). This is illustrated in Figure 4 by adding connections of process knowledge to the initial illustration of systems, target and transformation knowledge by Mark Lawrence and colleagues (2022).
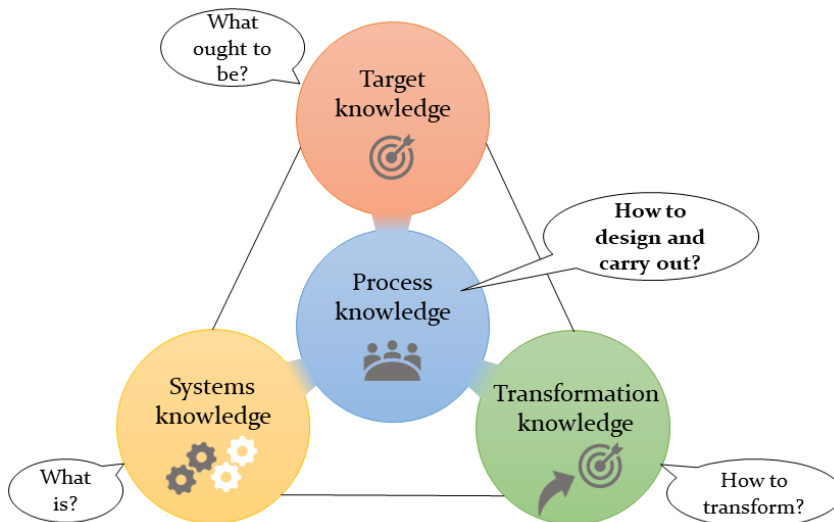
Figure 4. Four types of knowledge and their main questions. Adapted from the figure by Mark Lawrence and colleagues (2022).

There is a considerable amount of research done on the first three types of knowledge (e.g., Klein et al. 2001; Bergmann et al. 2005; Pohl and Hirsch Hadorn 2007; Hirsch Hadorn et al. 2008; Jahn et al. 2012; Brandt et al. 2013), whereas there is a limited amount of research done on process knowledge (e.g., Hirsch Hadorn et al. 2008; Lawrence et al. 2022). The lack is especially noticeable in process-oriented tools that can help creating appropriate conditions for co-production of knowledge.

To develop process-oriented tools it is necessary to understand what a process is and what its stages could look like. In this dissertation, one of the interpretations of a process, coming from project management, will be used, and this is described below.

2.7   Project management

Project management is a broad field that focuses on managing projects. A project can be defined in many ways. However, a simplified accepted definition states that a *project* is a task with a beginning and an end (Maylor 2010, p. 4). A project has a process related to it. More broadly, a *process* can be defined as (Oxford Advanced Learner's Dictionary):

> *"a series of things that are done in order to achieve a particular result".*

In project management, similarly, a *process* is defined as a system of implementation of a project, considering the nature of the task and the means of delivery (Maylor 2010).

One of the basic models for a project process is presented by Harvey Maylor – the 4-D model (Maylor 2010). It starts with making sense of the project context. The model itself consists of four phases: define it, design it, do it, and develop it (Figure 5). Each stage is briefly described below.
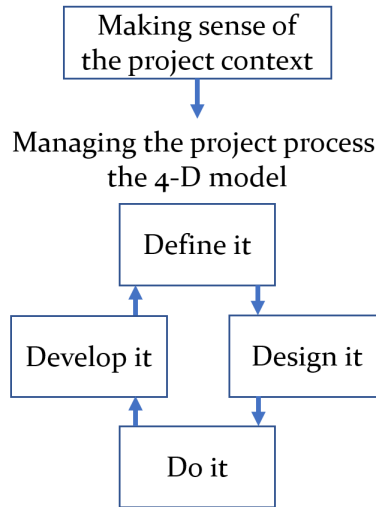
Figure 5. Phases of a process. Re-created from the figure by Harvey Maylor (2010, p. 74).

Making sense of the project context

This stage deals with an introduction to the context of the project, its purpose, intended process and the 'language of strategy' (Maylor 2010, p. 50) to the people involved in the project. This is necessary for creating a common platform for people to efficiently work throughout the process. It is followed by identification and agreement upon or co-creation of the system's structures and managerial frameworks that enable the constructing of mental models of the complex systems that human activity represents. Finally, the project is positioned in relation to other projects and organisations.

Define it [the project]

The key issue in this stage is to define the goals of the project and organisational strategy. The main questions being asked are: 'Why are we doing this?' and 'What needs to be done?'. As part of this stage, stakeholders are also identified.

Design it [the project process]

The main planning happens in this phase. The main alternatives for fulfilling the project goals are outlined, evaluated, and selected focusing on risk minimisation. The questions that could be helpful to ask are: 'How can we

implement the project?', 'Who will be involved in different parts?' and 'What is the timeline?'.

Do it [deliver the project]

This phase focuses on implementing the project following the prepared plan. The two questions being asked are: 'How can we manage the project on a day-to-day basis?' and 'How can we address unforeseen changes?'.

Develop it [the process]

In this phase, review and evaluation take place. The phase is meant to improve the process of the project for the future, based on the learnings gained throughout the timeline of the project. The main question asked is: 'How can we improve the process?'.

The model could be relevant for various contexts of project management, including regional and urban planning. Contemporary regional and urban mobility planning often happens in projects (Walter and Scholz 2006; King and Fischer 2016; Mottee et al. 2020). However, some researchers argue that strategic and comprehensive approaches to planning could be more efficient compared to project-based planning approaches (Odendaal 2007).

Transdisciplinary research project processes often require someone who can lead and/or facilitate them. Sometimes it is someone from the research team (trained or untrained), and sometimes it is an external person. Thus, there is a need to know what facilitation is and what needs to be considered when facilitating. Therefore, the following section describes the basics of facilitation.

2.8   Stakeholder facilitation

The term of *stakeholder* has already been defined in section 2.1. *Facilitation* could be defined as a process that is (Hogan 2002, p. 10):

> *"concerned with encouraging open dialogue among individuals with different perspectives so that diverse assumptions and options may be explored".*

This concept became widely used in the second half of the 20th century in the context of business, education, and development studies. Facilitation is often done by facilitators.

There are many tools in the toolbox available for facilitators. Using Figure 4 as a structure for characterising the tools, one could say that there are tools for producing systems knowledge, such as participatory causal loop diagrams (Coletta et al. 2021); tools for producing target knowledge, such as scenario planning (Miller 2007); and tools for producing transformation knowledge, such as the ABCD procedure of the Framework for Strategic Sustainable Development (Broman and Robèrt 2017). However, relating to Mark Lawrence and colleagues (2022), there seems to be a lack of tools supporting transdisciplinary processes.

An important element of running a process is facilitation. Based on the definition above, facilitation is about creating a space for dialogue. *Dialogue* could be understood as a formal discussion among several people (Oxford Advanced Learner's Dictionary). Rebecca Freeth and colleagues (2019) identify four types of dialogue:

- *serial monologue,* where people take turns to present their perspectives;
- *engaged monologue,* where an exchange of perspectives takes place;
- *reflective dialogue,* where participants of the dialogue pursue learning about each other's perspectives and attempt to find common ground; and
- *generative dialogue,* where people build on a common ground to deal with misunderstandings and disagreements, and create new ideas.

The latter two types of dialogue could be useful for participatory planning approaches, including those in mobility planning. Since dialogues, by definition, often happen among several people, a *dialogue-based process* term could also be used (de Roo et al. 2021). It emphasises that such processes require planning and preparation.

In dialogue-based processes, diversity is often seen as a key to learning among stakeholders (Cuppen 2012). The diversity can be analysed in relation to epistemic community, community of practice, languages spoken in the group, culture and stakeholders' power, legitimacy, and urgency, among other aspects. These terms are defined below.

An *epistemic community* could be understood as a group of recognised professionals with knowledge in a certain domain (Haas 1992, p. 3). Example of epistemic communities in academia could be a group of engineers and a group of social scientists. A *community of practice,* on the other hand, could be defined as a group of practitioners that share some knowledge (McCauley

et al. 2006, p. 642). Languages spoken in a group could be defined as *linguistic diversity* (Sullivan 2004, p. 991). Furthermore, people in a group bring their traditions, procedures, and perspectives to the group. This could be referred to as *culture* (Leslie and Storey 2003, pp. 122-127). Additionally, there are several attributes related to stakeholders that need to be defined. *Stakeholder power* could be understood as a relationship, where one stakeholder can get another one to do something that they would not have done otherwise (Mitchell et al. 1997, p. 869). *A stakeholder's legitimacy* could be defined as an assumption of desirability and appropriateness of a stakeholder's actions in a *"socially constructed system of norms, values, beliefs, definitions"* (Mitchell et al. 1997, p. 869). Finally, *stakeholder urgency* could be defined as a degree of stakeholder involvement in a call for immediate attention (Mitchell et al. 1997, p. 869). These aspects of diversity could be analysed within a *stakeholder analysis* method, such as that recommended by Mark Reed and colleagues (2009).

Designs of dialogue-based processes that take into consideration the above-mentioned aspects of diversity often require situationally appropriate tools (Palmer et al. 2020; de Roo et al. 2021; Palmer et al. 2022). Some suggest a particular type of support that is called scaffolding. *Scaffolding* could here be defined as a structured method and/or experienced facilitation as a form of support for running the process (Wood et al. 1976; Jordan 2014). The term originates from studies of learning and acquisition of skills, particularly in children's development. The term is often used as a metaphor to describe external support, for example, when creating a solution to a complex problem (Jordan 2014). Scaffolding may have different functions depending on the needs. For example, to generate a list of creative solutions (such as in step C of the ABCD procedure of the Framework for Strategic Sustainable Development (Broman and Robèrt 2017)), creativity might need some assistance to develop innovative ideas (instead of listing trivial ones) and it can be done with a help of tools that scaffold a creative process.

What facilitators consider in relation to learning in dialogue-based processes are a set of rules that all participants will co-create and/or agree to, the provision of a safe space, where participants can speak openly and freely, with accurate documentation that encourages transparency (Escobar 2011). In participatory processes, such as action research or transdisciplinary research, some additional aspects that are considered by facilitators for dialogue-based processes have been identified. The list below is a synthesis based on the work by other researchers (Wiek 2007; Escobar 2009; Jordan 2014; Ernst et al. 2017):

- conditions for reflective dialogue, open exchange, curiosity, empowerment and creativity;

- the dominant conversational mode is inquiry;
- support to keep attention;
- attitudes and feelings;
- appropriate facilitation, there is even a special term 'epistemediator' for someone who facilitates such processes (Wiek 2007);
- emergent facilitation, meaning that there is no prepared script and the facilitator reacts to the discussion, coordinates action and enables decision-making;
- (re-)establishment of trust and improvement of understanding among stakeholders;
- relationships among stakeholders;
- active listening, listening to understand; and
- reflection upon multiple ways of knowing in the group.

As Thomas Jordan (2014) points out, methods and tools for facilitation (including scaffolding) are often developed by the practitioners based on their needs. Therefore there is a need for methods and tools that have theoretical underpinnings.

Zooming in on mobility planning, despite the general recommendation for people-centred planning (Elmqvist et al. 2018; Gómez-Álvarez et al. 2018) and participatory approaches in planning (Smith et al. 2017), there is limited research on dialogue-processes and this is particularly emphasised in strategic mobility planning to sustainability. Furthermore, Marco te Brömmelstroet and Luca Bertolini (2008) point out that the lack of 'common language' in dialogue-based processes between land use and transport planners is one of the key barriers in integrated transport planning. Other researchers suggest that such processes can have additional benefits to conflict resolution, when appropriate facilitation is in place and conditions for that are created (Cuppen 2012), creating a feeling of dynamics in the process (te Brömmelstroet and Bertolini 2008), and a possibility to influence decision making when stakeholders with power take part in the process (Ernst et al. 2017). At the same time, it is suggested that identification of skills and capacities for development of scaffolding is required (Palmer et al. 2020).

2.9 Summarising the knowledge need

There are many tools for participatory planning that can aid planners and facilitators in these processes. Among these tools there are few that deal with process support.

In the context of strategic planning for transitioning to sustainable mobility there are special considerations to be taken. Because of sustainability challenges an urgent transition is necessary. Also, mobility is a matter for everyone and, therefore, it involves numerous stakeholders. Process supporting tools need to be able to handle these considerations.

3   RESEARCH METHODOLOGY

This chapter describes the research approach to achieve the aim and my personal journey of working towards the dissertation.

3.1   Research design

Doing research that addresses urgent complex problems together with multiple stakeholders (such as transdisciplinary research) does not always have a clear approach from the beginning (Mitchell and Willetts 2009). For this, Cynthia Mitchell and Juliet Willets (2009) found it useful to conceptualise such research in relation to a domain, a problem space and a problem. By domain they mean a sector or aspects of practice, problem space further specifies context within the domain, and the problem is where the research contributes to the body of knowledge. They also suggest that some aspects of research methodology will emerge during the research work.

To fulfil the aim of developing process-oriented methodological support for reflective and generative multistakeholder dialogue in strategic planning for transitioning to sustainable mobility, the domain of strategic sustainable development in mobility planning was explored. Through participation in the problem space of collaborative research projects, the problem of insufficient processes of multistakeholder dialogue was identified and addressed (see Figure 6 and 7).

RESEARCH DESIGN
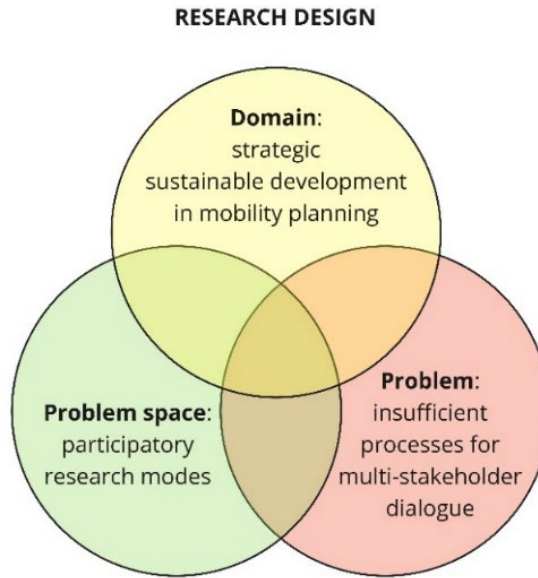
Figure 6. The domain, the problem space, and the problem of research.

Some terminology is frequently used in this research: approach, framework, method, tool, scaffolding, scaffolding tool, process support. The term *tool* is here used in an encompassing way and covers both approaches, frameworks, and methods. Here, *process* refers to the process of running a transdisciplinary research engagement. A number of tools is used in this process. Many of them refer to the system knowledge, target knowledge and transformation knowledge (Figure 4). When speaking about process-supporting tools, this dissertation refers to tools that relate to the process knowledge in Figure 4. These process-supporting tools have the task to aid in obtaining a reflective and generative multistakeholder dialogue – this can metaphorically be called *scaffolding*. The *scaffolding tools* are thus the support tools that support this process.

To operationalise the research, some research questions (RQs) were formulated. The needed domain knowledge revolved around how strategic planning for transitioning to sustainable mobility could be done in theory and practice. It led to the following question:

> **RQ1** What are prominent research themes, research gaps and practice needs in strategic planning for transitioning to sustainable mobility?

Participatory approaches (such as action research and transdisciplinary research) are common in sustainable mobility efforts, and it became necessary to learn more about these. This led to the following question:

> **RQ2** What could action research and transdisciplinary research, respectively, be used for in terms of creating support for transitioning to sustainable mobility?

Finally, to guide the work on closing the research gap and address needs in practice, the following question was asked:

> **RQ3** What could scaffolding that supports multistakeholder dialogue in strategic planning for transitioning to sustainable mobility look like?

Figure 7 shows how the research questions relate to elements of research design, and how the included papers, in turn, relate to the research questions.
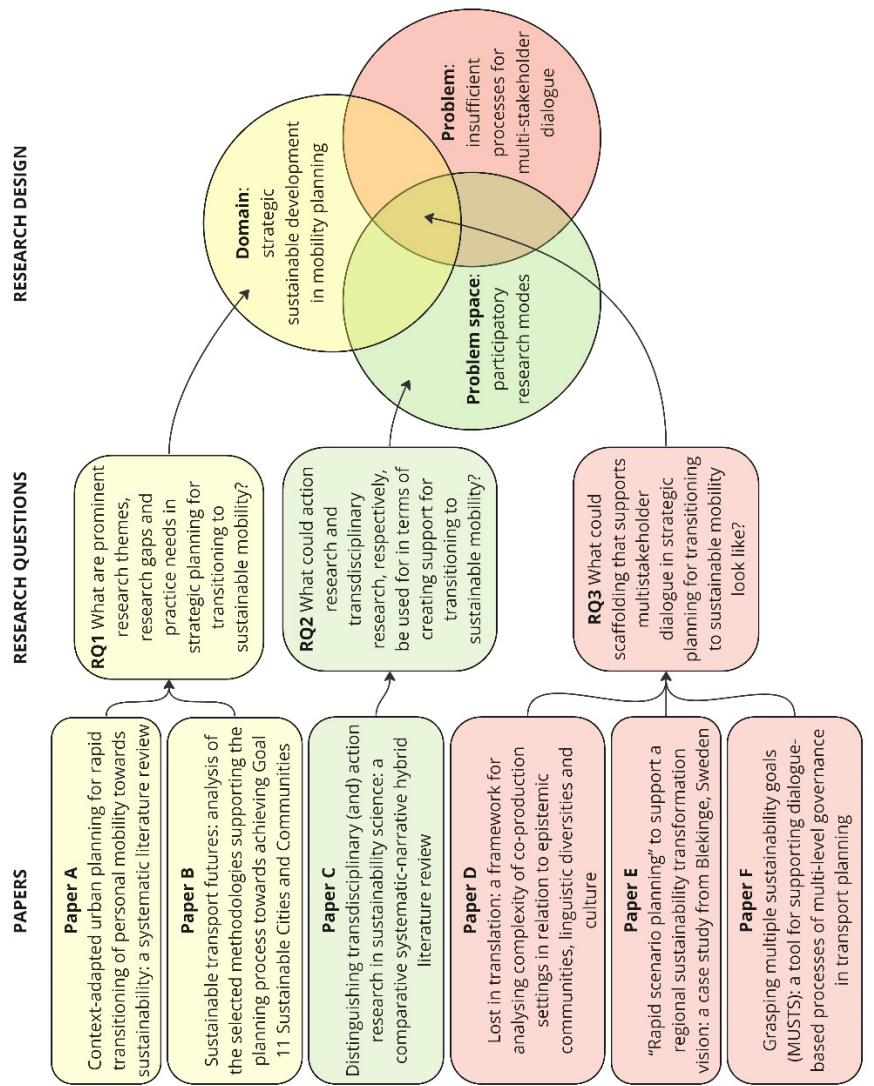
Figure 7. Overview of the research: relationships between papers, research questions, and research design.

To answer RQ1, theoretical knowledge was sought through a systematic literature review following method described by Mark Petticrew and Helen Roberts (2006) (Paper A). In addition, empirical knowledge about transport systems and planning in two localities was sought (Paper B).

To answer RQ2, theoretical knowledge about the problem space, i.e., the many different forms of participatory research modes, was sought. To do

that systematically, a combination of a systematic and narrative literature review (Petticrew and Roberts 2006; Moher et al. 2009; Pickering and Byrne 2014; Xiao and Watson 2019; Page et al. 2021; Turnbull et al. 2023) and bibliometric studies (Chai and Xiao 2012; Chappin and Ligtvoet 2014; Yu et al. 2014; Liu et al. 2015; Donthu et al. 2021) was conducted.

To address RQ3, a design research approach was used to enable the development of (abstract) artefacts, here, various tools that can help structure various aspects of multistakeholder dialogue processes (Hevner et al. 2004) that allows for development of artefacts that could add to the knowledge base and be used in an appropriate environment. The tool design and development was triggered by needs perceived in the projects. This research was part of several projects. These projects are briefly presented in section 3.1.1.

The research also requires strategies to deal with validity concerns. Validity strategies applied in this dissertation are described in section 3.1.2.

3.1.1   Projects

The way of learning more about the practice of strategic planning for transitioning to sustainable mobility in this research was through the participation in four projects:

1. Sustainable urban transportation system in Kisumu, Kenya, as a step towards a resilient city;
2. Interconnect;
3. Structural picture 2.0 (translated from the Swedish, original name Strukturbild 2.0); and
4. Roadmapper.

These projects are briefly described below and references to the included papers where the results of the studies were published are given. Throughout the dissertation, these projects are referred to as the projects.

Sustainable urban transportation system in Kisumu, Kenya, as a step towards a resilient city

This project was designed together with my supervisors during the master's studies at Chalmers University of Technology in Sweden in 2015. The main aim of the project was to investigate current sustainability challenges

regarding transportation and mobility in Kisumu, more specifically to identify strategies useful in transitioning to a sustainable transportation system. My role in the project was to conduct field studies and other studies to address the aim, as well as to analyse and interpret the results and based on that write a master's thesis and present the results at a conference. To get an understanding of the context, a field study, a feasibility study, a SWOT analysis, semi-structured interviews, and questionnaires were conducted. The results were published in Paper B (that was conceptualised and written at the beginning of the PhD studies), which focuses on analysing selected methodologies that could support the planning process towards achieving the Sustainable Development Goal 11 (SDG11): Sustainable Cities and Communities.

Interconnect

Interconnect was a project focusing on public transport planning within and between countries in the Southern Baltic region. The project had 9 main partners and 11 associated partners. The project took place between 2017 and 2020. One of the work packages in the project was led by the SustainTrans research team at Blekinge Institute of Technology[1]. At that time, the team consisted of three people. Of those, a senior researcher was a leader of the work package. My role in the project was to support the design of the three participatory backcasting workshops focused on public transport planning and to facilitate these workshops. To get an understanding of transdisciplinary co-production processes, these workshops were also observed and analysed in relation to epistemic communities, linguistic diversities, and culture. These studies took place in Karlskrona, Sweden, Tricity (Gdynia, Gdansk, Sopot), Poland and Klaipeda, Lithuania. The outcomes of the study were published in Paper D, which presents a conceptual framework for analysing complexity of co-production settings in relation to epistemic communities, linguistic diversities, and culture.

Structural picture 2.0

Structural picture 2.0 was a project run by Region Blekinge, Sweden, which aimed to address challenges of coordination and to co-define strategic policy direction in regional planning. The SustainTrans research team was invited to design and carry out participatory scenario planning workshops. At that time, the team comprised four researchers, of those a senior researcher had the lead. My role in the project was to support the development of a scenario planning workshop and to facilitate it. To address the problem of insufficient processes for enabling reflective and generative stakeholder dialogue, this

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[1] https://a.bth.se/sustaintrans/

workshop was designed, facilitated, observed, and evaluated. The results were published in Paper E, which presents a Rapid Scenario Planning method that could be used to support building a regional sustainability vision.

Roadmapper

The Roadmapper project is focused on decision support for sustainability transitioning of an entire regional transport system. The project uses the Blekinge region as a first case study to build decision support tools for transport planners to keep the focus on the long-term and multi-level sustainability goals while navigating around short-term challenges like the Covid-19 pandemic. The project utilises 30 years of experience in research and practice around the Framework for Strategic Sustainable Development and ten years of close collaboration with regional stakeholders on fossil-free and sustainable mobility. The project was set up with 24 partners, including academia and experts, national, regional, and municipal authorities, and businesses. The project was developed by a senior researcher of the SustainTrans research team and all the other researchers in the team had a supporting role in carrying out of the project. I was responsible for the first work package in the project that focused on the future image of regional transport in Blekinge. Some preliminary results from this project are outlined in Paper F, which presents a tool that could be helpful to support dialogue-based processes of multi-level governance in transport planning.

3.1.2   Validity of the research

The validity of research is described differently by different researchers. For example, when using literature review as a research methodology, Robert Palmatier and colleagues (2018) write about *depth* and *rigour*, referring to a clear strategy of data collection and interpretation, as well as novelty of produced results. They also write about *replicability*, meaning that the method should be described in a way that another researcher could follow it and reach similar results. Additionally, they write about *usefulness* for the results for researchers and practitioners.

In the dissertation, the following strategies to address validity concerns of literature review as a research methodology by Hannah Snyder (2019) were implemented. When designing the literature reviews, the following aspects were considered: the need for such studies and their appropriateness in relation to the research problems, outline of the research questions and their motivation, inclusion of relevant literature and search for previous similar

reviews, and clear and detailed descriptions of the methodologies. At the stage of conducting the reviews, the following considerations were made: appropriateness of the search processes, accurate and detailed descriptions of the search processes, and appropriateness of the final samples of the publications to the purposes of the overviews. During the data abstraction and analysis the following strategies were implemented: data appropriate for the purposes of the overviews was extracted, the processes of data abstraction and analysis were described, reflection upon the appropriateness of the data analysis techniques was done. Finally, at the stage of structuring and writing the reviews, the following strategies were implemented: coherent and sufficient descriptions of the usable results were provided, the findings were synthesised in clear and valuable contributions to the fields of the studies, and the further research questions were provided.

Another way of validating research is suggested by John Creswell (2014), in relation to qualitative studies. He writes about *true* and *reliable* results, meaning that selection and application of methods to address the aim and RQs need to be trustworthy. Additionally, Joseph Maxwell (2013) writes about *correctness* and *credibility* referring to truthfulness of the contextualised results and generalisability of the results outside of the research scope.

Several strategies suggested by John Creswell (2014) were used to ensure the validity of the results. They are described below. The research results were presented to the colleagues, as well as at the international conference and they were submitted to peer-reviewed book as a book chapter. John Creswell (2014) refers to such things as further strategies to ensure quality (*peer debriefing* and *external audit*).

In design science, particular attention to research validation is given to *efficacy* and *usefulness* of the produced artefacts (Larsen et al. 2020). The strategies used in the dissertation are described below.

The need for developed tools came from practice, in the contexts of the projects. For tool development and prototyping, a design research approach was used. These tools were then tested in the projects and evaluated with regard to feasibility, usefulness and efficacy. The proposed tools achieved the intended outcomes and they were useful in the contexts of the studies (presented in the individual papers). The usefulness of these tools outside of the scope of this dissertation is discussed in the discussion section.

When participating in an empirical domain, such as described above, it is important to be ethical and reflect upon personal stance, ones own research

practice, and positionality. The applied strategies to relate to this are presented below.

3.2   Research approach

In this section, ethical considerations made in the work are described. Personal stance, reflexivity strategies and positionality in this dissertation are also presented.

3.2.1   Ethical considerations

When working with people, ethical conduct is important (Savin-Baden and Major 2012). In relation to the projects and tool development, the following ethical considerations were taken into account:

- Signed informed consent forms were collected for each project.
- The participants in the projects were carefully selected. They were all adults and experts in their fields.
- Information about individual participants and actors remained anonymous in the publications unless information about them (e.g., their professional background) was important for understanding the content of the paper.
- Interview recordings were accessible to the authors of the respective articles only. The audio files have been archived and stored on an external USB drive for further access on demand.
- The empirical materials were stored only in a way that can be used to extract quotations or information on demand.
- Interactions with people were based on mutual respect, justice, and beneficence.
- The processes were designed to show transparency in terms of relationships with participants, self-disclosure, and relationship with data.

3.2.2   Personal stance, reflexivity, and positionality

Personal stance

A personal stance is a position taken towards the research case, based on the researcher's beliefs and views of the world (Savin-Baden and Major 2012). Being a young woman in transport research and practice is not an easy task. In several geographical locations of empirical studies it generated both advantages and disadvantages. On the one hand, it created constraints on being taken seriously. Careful preparation was required to overcome this challenge as well as a thorough explanation of the intent of the inquiries to the participants. On the other hand, being a 'neutral' investigator implied some power and opened doors. Additionally, being the only junior woman researcher in a research team was not easy, which led to struggles of being acknowledged. These experiences helped focus the research on inclusiveness in the co-production of knowledge.

This research has been seeking to solve certain problems in relation to the participatory planning processes. The focus of problem solving has been on multistakeholder processes, particularly how to improve their quality, consider different dimensions of complexity and include some aspects of diverse planning documents.

Several biases should be recognised in the dissertation work. They are related to human nature. There is a risk of agreeing more with people just because they hold similar worldviews (Savin-Baden and Major 2012). Reflecting on that helps to isolate the investigator (researcher) from the context of the study and to assess the situation more objectively. Being situated in various projects assisted in getting a better understanding of the contexts and the domain. However, there was a risk of being affected by pre-formulated assumptions of the expected results. This is where peer-review helps counter such biases. Also, work on the projects allowed for the testing of such assumptions as they unfolded in real-life practice (Flyvbjerg 2011; Yin 2014; George 2019).

Reflexivity

Reflexivity is a process of reflecting on oneself as a researcher (Denzin and Lincoln 2005; Savin-Baden and Major 2012; May and Perry 2017). It is not only about the choices one makes regarding research questions, methods and collaborators, but also who one is and the identities that constitute the fluid self in the research environment. Reflexivity looks at the evaluation of the

foundations of interpretative frameworks (May and Perry 2017, pp. 4-5) and has three main imperatives:

- Self-awareness is necessary to understand one's obligations and expectations;
- Our everyday practices require monitoring due to the dynamic environment we live in and interactions with other people who might have different practices;
- Deliberation and action are necessary as the guidelines for action might be conflicting with each other.

Having a reflexive research process enables one to embrace the complexity of the dynamics within us and in the world around us. However, there are several risks related to such an approach: one can become non-relational and take complex forms in writing and self-representation.

Throughout the work towards this dissertation, reflexivity was used in the following ways, as suggested by Maggi Savin-Baden and Claire Major (2012): free writing ideas and biases as well as visualising them in various ways. This was done through keeping a diary, where ideas, understandings and questions were outlined. Moreover, some of these ideas were visualised in, for example, Power Point presentations, Miro and other digital tools, or drawn by hand on a paper. Additionally, there were formal and informal conversations with the supervisors, colleagues, and peers.

Positionality

Thinking about positionality is one example of how reflexivity can be applied in research (Agar 1996). Being an outsider (Herr and Anderson 2014) in all contexts of empirical studies, I was a "stranger" who had a possibility of coming and going (comparable to a character that has been described by Georg Simmel (1950)). In social sciences, it is called *outsider fieldwork* (Savin-Baden and Major 2012) when a researcher attempts to understand the unfamiliar or makes the familiar strange. This concept was helpful for my dissertation work in terms of reflecting upon my positionality in the context of the projects.

The typology of researchers' roles described by Julia Wittmayer and Niko Schäpke (2014) was helpful to reflect upon the changes in positionality throughout my work. I could see myself becoming a *reflective scientist*, the one who analyses actors, dynamics, and outcomes, observes and reflects, as well as the one who provides knowledge. This role was taken during the data collection and analysis. I was a *process facilitator* when I facilitated local and

international workshops. On several occasions I was a *knowledge broker*, mediating different perspectives and attempting to make sustainability meaningful in the context of my empirical studies. Finally, towards the end, I took a role of a *self-reflexive scientist*, assessing and challenging my normative orientation.

The above sums up how this dissertation should be seen in relation to my personal stance, reflexivity and positionality. Finally, I will below further clarify how this research has evolved from a personal perspective due to its emerging quality, as described by Cynthia Mitchell and Juliet Willets (2009). This is presented as my personal research journey.

3.3   My research journey

As Cynthia Mitchell and Juliet Willets (2009) suggested, transdisciplinary PhD studies often do not go as planned, instead they emerge as a response to learning. So it was with my research: the starting point was quite different from where it ended due to engagement in projects that triggered the need for research.

At the beginning of my research journey in strategic planning for transitioning to sustainable mobility, I wanted to get to know the intersection of the fields I was walking into. The fields were sustainability, transitions, mobility, and strategic planning. For that, I conducted a systematic literature review and completed a book chapter based on the results of my master's thesis, where I managed to collect some data on the status of this intersection. Particularly, I found that there is a lot of literature on transport planning (e.g., da Silva et al. 2008a; Danoh et al. 2010), with some of it focusing specifically on approaches to planning, such as backcasting (e.g., Robinson et al. 2011; Soria-Lara and Banister 2017) and foresighting (e.g., Berkhout and Hertin 2002), but little is being said about the processes that these approaches entail. These findings are similar to those in transdisciplinary studies, where significant attention is given to systems knowledge, target knowledge and transformation knowledge (see Figure 4), and very few publications focus on the process knowledge (Lawrence et al. 2022). Instead, the discussion focuses on why alternative methods to conventional planning are necessary (e.g., Soria-Lara and Banister 2018), what their different variations could be (e.g., Dreborg 1996; Phdungsilp 2011; Holmberg and Robèrt 2000), and what results they have given so far (e.g., Quist and Vergragt 2006).

The turning point was my observation in one of the projects, where I led the design and the running of the backcasting workshops. My previous experience as a facilitator kept me wondering why things that I considered common practice, such as reflection upon and accommodation to needs and expectations of the participants of the workshops, constant monitoring of group dynamics, necessary adjustments to the plan and creating conditions for inclusiveness, were not always considered in participatory processes of mobility planning. Therefore, I decided to explore some of these questions from the research perspective together with a practitioner in a PhD course. I could not find any scaffolding that considered epistemic communities, linguistic diversities, and culture simultaneously in transdisciplinary processes. This led me to develop a framework for the analysis of complexity in co-production settings. This framework was meant to be useful for facilitators who plan such transdisciplinary processes.

Later, I continued with my passion for the design and the running of participatory workshops in the next project. The challenge there was to accommodate a usually long process of participatory scenario planning (e.g., Vermote et al. 2014) into a short workshop due to the inability of stakeholders to devote more time to it. The team of researchers in collaboration with practitioners spent six months on thorough preparation for a one-day workshop. This work resulted in the development of a rapid scenario planning method.

Meanwhile, my findings from the systematic literature review kept 'digesting'. When I was offered to work with the visionary stage of backcasting, I saw a chance to attempt to address the gap I found in the review, namely, that there is a lack of methods that could aid contextualisation and integration of diverse goals (Hrelja 2011; Elmqvist et al. 2018). Additionally, to support participatory planning in relation to these goals, it seemed important to identify the stakeholders who have the power and legitimacy to act upon them. This resulted in a tool that connects goals at various levels with 'responsible' stakeholders.

Finally, having continuous conversations with colleagues and peers about socially engaged research led to the idea of attempting to clarify differences in aims and methods used in action research and transdisciplinary research in sustainability science. Together with a colleague, I decided to take a systematic approach and conducted a comparative systematic-narrative hybrid literature review (together with 12 other co-authors). We managed to identify some differences (such as action research emphasising action-for-knowledge and transdisciplinary research emphasising knowledge-for-action) and even make some recommendations for researchers and

practitioners who want to make an informed choice about research modes in sustainability science.

Reflecting on the whole journey, I noticed the following. When I started my research journey, I joined a research group that works in the domain of sustainable transport and energy. This became my domain, and I spent a lot of time trying to understand how it is organised, how it works and what research gaps there are. However, my inner facilitator kept pulling me astray and asking questions related to the domain, but not specifically about it. I felt that I walked alongside my colleagues.

When I started writing the dissertation, I started from the beginning, describing the research gap in the domain. However, as I progressed in my writing, I realised that my contribution could be valid in other domains too. This led to a complete rethinking of my dissertation and multiple versions of its interpretation.

My crossroad did not look so simple anymore. Instead of four, I needed eight fields to describe what I have done: sustainability science, general complex systems theory, strategic sustainable development, sustainability transitions, regional and urban sustainable mobility planning, participatory research modes, project management, and stakeholder facilitation. And instead of contributing only to support for planning for transitioning to sustainable mobility (transformation knowledge in Figure 4), I contributed more broadly to support for facilitation of multistakeholder dialogue-based processes, with application in planning for transitioning to sustainable mobility (process knowledge in Figure 4).

4 SUMMARIES OF INCLUDED PAPERS

In this chapter summaries of the included papers are provided. The chapter also clarifies how these papers relate to the dissertation and what my contributions to the papers were.

4.1 Paper A

Published as

Summary

Despite the widely discussed urgency for change towards sustainability, there is no general agreement on the best way to pursue such change. Therefore, the main aim of this paper was to provide a systematic inquiry into relevant publications in the fields of urban planning, mobility, and transition studies and their overlap in the cited literature, as well as to identify the main themes that have been discussed in the selected literature, and to make a science mapping. Using a systematic literature review and bibliometric studies, several prominent research themes in and between the outlined fields were identified. They were also mapped in relation to the goal of urban planning for rapid transitioning to sustainable mobility. The identified prominent themes were planning and policy for sustainable mobility and accessibility, backcasting and scenario planning, indicators in planning, modes of transport, decision-making, and studies of the global North and the global South. Additionally, overarching themes of equity, equality and justice, roles of institutions, and co-production of knowledge were also outlined in the literature. Moreover, the development of these themes in the past decade was described. The article also discussed the use of the temporal dimension in the selected publications. Furthermore, the main bodies of literature and the science mapping were outlined. Finally, a research gap in strategic planning for transitioning to sustainable mobility was identified.

Relation to dissertation

This paper provides a basis for the dissertation and future work. It combines academic and non-academic publications and identifies a research gap. An important identified gap is a lack of research that focuses on the *how* in planning: how to prioritise actions and how to encourage inclusiveness of relevant stakeholders in participatory processes. Different aspects of the research gap are dealt with in the following papers. Finally, elements of the findings are used as guidance for possible future research directions.

My contribution

I co-designed the study with another co-author, performed the systematic literature review and additional quantitative and qualitative analyses, and proposed the original design for the study. Moreover, I performed an interpretation and analysis of the results, created a first draft of the paper, and led the whole writing process.

4.2   Paper B

Published as

Summary

Mobility planning for transitioning towards sustainability often requires participatory processes. There are many processes available, and it is not always clear which one is the most appropriate in a given context. This paper analysed the usefulness of three futures methodologies – backcasting, foresighting and the SymbioCity approach in relation to the planning processes of the bus park and railway station in Kisumu, Kenya, as well as Centralen (railway station) in Gothenburg, Sweden. The advantages and challenges of each methodology were described. Moreover, the study

examined the application of futures methodologies in multisectoral urban transitions apart from transport and concluded what can be learnt from it. Based on interviews, questionnaires, feasibility studies and field studies, it was concluded that backcasting, even though it is included in SymbioCity, could in itself be enough and the most suitable in both locations despite their sharply contrasting contexts. The main reasons are its applicability both on large and small scales, the possibility to develop creative solutions, and the possibility of a high level of integration of stakeholders. Moreover, the study showed that the application of futures methodologies can be beneficial in tackling complex challenges and addressing several goals and targets at the same time, such as the SDGs. The study also brought in the perspective of the time perception by the participants of the planning process: "in Kenya tomorrow is already [the] future" (Eising 2015).

Relation to dissertation

This paper contributes to the methodological discussion on mobility planning approaches, specifically, through a comparison of backcasting, foresighting and SymbioCity approaches. It provides additional justification for the application of backcasting approach in the projects.

My contribution

Together with co-authors, I designed the study and carried out critical thinking for the paper, conducted a literature review, analysis of methodologies, field studies, feasibility studies and interviews both in Kenya and Sweden, as well as a questionnaire in Kisumu. Moreover, I produced the first draft of the paper and led the whole writing process.

4.3   Paper C

Manuscript

Laycock Pedersen, R., Nikulina, V., Chineme, T., Subroto, S., Robinson, Z., Winkler, K., Luederitz, C., Metson, G., Malmborg, K., Moriggi, A., Lam, D. P. M., Partelow, S., Cockburn, J., Bhurekeni, J. Distinguishing transdisciplinary (and) action research in sustainability science: a comparative systematic-narrative hybrid literature review. *To be submitted to journal.*

Summary

Planning for sustainable mobility requires participation of diverse stakeholders. There are many socially engaged research modes in sustainability science. The main ones are action research and transdisciplinary research. There is also transdisciplinary action research, a growing field that seems to combine the two. This paper aimed to identify and compare characteristics of these research modes. The intention was to help researchers and practitioners choose one of the research modes or to combine them, depending on their purposes. A comparative systematic-narrative hybrid literature review was conducted. An in-depth analysis of 1487 articles was completed, of those 633 were found to have used action research, 787 transdisciplinary research and 67 transdisciplinary action research. The findings showed that there are many similarities between the studied research modes. This includes that they address similar sustainability issues, they use the same methods (but to a varying extent), and they engage with the same stakeholder types (but to a varying degree). However, there are also some indications that these research modes are used for different aims. Researchers employing action research seem to be more intent on achieving action in the practice domain and knowledge from that action for both practitioners and researchers (*action-for-knowledge*). In contrast, researchers employing transdisciplinary research rather seem to be more intent on producing new, relevant and shared knowledge for an action that is later undertaken in the practice domain (*knowledge-for-action*). Although this might be a premature conclusion, researchers employing transdisciplinary action research seem to be more intent on achieving action based on integrative knowledge (*integrative knowledge-for-action*). Finally, some advice regarding the choice of the research mode for a particular purpose was presented. To exemplify, action research could be useful when studying a particular intervention, transdisciplinary research could be useful

when a challenge cannot be addressed within one discipline only, and transdisciplinary action research could be useful when addressing sustainability challenges on a large scale by going beyond scientific disciplines.

Relation to dissertation

This paper provides with an orientation on transdisciplinary and action research and contributes to a discussion about their use for transitioning to sustainable mobility.

My contribution

I co-designed the study with another co-author, made a part of the analysis of the articles (that are considered as empirical data in this paper) including the interpretation and analysis of them, co-created a first draft of the paper and co-led the whole writing process.

4.4 Paper D

Published as:

Nikulina, V., Lindal, J., Baumann, H., Simon, D., Ny, H., 2019. Lost in translation: a framework for analysing complexity of co-production settings in relation to epistemic communities, linguistic diversities and culture. *Futures* 113 (October): 102442.
https://doi.org/10.1016/j.futures.2019.102442.

Summary

Transdisciplinary co-production of knowledge and backcasting are increasingly recommended in the planning literature for facilitating major changes in complex systems, such as a transport system. A complication for co-production is that many contemporary urban areas are multilingual and multicultural, which makes conditions for diverse participatory processes even more complex. Additionally, there might be diverse epistemic communities that need to find a common language, reach a consensus, or agree to disagree. Even within the same epistemic communities, challenges

may occur depending on the local context, such as the linguistic diversities of participants and their cultures. That is why thorough preparation for participatory processes is required. This paper presented a conceptual framework for analysing complexity in multilingual, multicultural, and multi-stakeholder co-production settings. Concepts of linguistic diversities, epistemic communities and culture were used for the framework development. The framework was tested in three participatory workshops focused on sustainable public transport planning in and between the regions in the Southern Baltic region, namely in Karlskrona, Sweden, Tricity (Gdynia, Gdansk, Sopot), Poland and Klaipeda, Lithuania. The framework was then critically assessed based on several aspects inherent in co-production: inclusivity, cross-sectoral understanding and applicability in different contexts and time perspectives. In addition, the framework was compared to other frameworks. Finally, based on the framework application, several elements that are recommended to be taken into consideration for effective co-production were outlined. These elements are linguistic equality among participants, disciplinary integrity, a working culture of mutual respect, and simultaneous mitigation and informed facilitation.

Relation to dissertation

This paper provides the conceptual discussion on participatory processes in contemporary mobility planning, such as transdisciplinary co-production of knowledge and backcasting and presents a framework. This framework can be used to analyse groups of participants from different perspectives - epistemic communities, culture, and linguistic diversities. Additionally, it can be used to prepare process leaders (or facilitators) for effective events in the ongoing work. Finally, this paper contributes to a basis for continued research on transdisciplinary co-production of knowledge and backcasting.

My contribution

I came up with the initial idea for the study. The idea was further developed together with a practitioner in a co-production manner, making it a transdisciplinary process on its own. I performed empirical studies. Later the paper was developed together with all the co-authors.

4.5   Paper E

Published as

Summary

Participatory planning approaches include not only backcasting but also, for example, scenario development. The complex challenges of today are multidimensional, path-dependent and unpredictable in nature. Planners and city authorities who address these challenges in their work often do not have a place for reflection to consider the implications of their decisions. Moreover, to achieve the SDGs, and fulfil the Agenda 2030 and the Paris Agreement, sustainability transformations are necessary, and they require collaborations across sectors and spheres of influence. To work in these complex conditions, methods that support the creation of visions of desired or possible futures are necessary. Scenario planning is an example of such a method and is considered to be useful in policy development. A case study on scenario planning in Blekinge, Sweden, was presented in this paper. Three objectives were defined for the paper: (i) to describe the role of the transdisciplinary approach in policy development in Blekinge; (ii) to evaluate the efficiency of the rapid scenario planning method; and (iii) to provide recommendations to those seeking to create a similar process. Three phases of the rapid scenario planning method were described in the paper as well as their results. Finally, the process is finalised in the flow diagram that shows the collaborative process among everyone involved. A reflection upon the required time was made for collaborative processes: from the organisers' side thorough preparation is required, and from the participants' side a seven-hour workshop of intensive work followed by the questionnaire has proven to be sufficient.

Relation to dissertation

This paper provides a methodological discussion on regional planning approaches, looking in detail into the scenario planning approach applied in

the Blekinge region, Sweden. The paper proposes a 'rapid' approach to scenario planning that is recommended when there is time pressure for the participants of the workshop, and it discusses what preparation is necessary. The paper creates an outlook for future studies.

My contribution

I led the process of workshop preparation, particularly the designing of the process for the workshop, and facilitated all the preparatory meetings. Additionally, I facilitated the workshop and contributed to the report that the paper is based on. I also contributed to the writing, reviewing and editing of the paper.

4.6   Paper F

Submitted as

Nikulina, V., Ny, H., Baumann, H., Laycock Pedersen, R., Berger, T., Oginga Martins, J., Wälitalo, L. Grasping multiple sustainability goals (MUSTS): a tool for supporting dialogue-based processes of multi-level governance in transport planning. *Submitted for journal publication.*

Summary

Modern planners encounter not only multiple stakeholders in their work but also have to deal with multiple goals at various levels. These goals come from various documents: policies and agreements at the international level and strategies and plans at the local level that are a response to the complex challenges of sustainability. Each of these documents comes with a set of explicit or embedded goals. To reach these goals there is a need for dialogue-based processes among multi-level governance actors. However, it is not always clear who needs to be part of such dialogue-based processes and how to address goals, when there are so many of them and they are at different levels. Therefore, this study proposed a tool that provides an organised overview of sustainability goals for relevant stakeholders at different levels. The MUSTS tool was developed and prototyped, then tested in a multistakeholder collaborative project for sustainable transport planning in Sweden. By applying the tool, the study managed to sort and organise 169

goals in 30 documents at five levels into 109 goal categories, in an attempt to help stakeholders identify the goals relevant to their work with transport planning. One exemplification of the results from the tool showed that different aspects of 'health' are aimed for by the goals in the various policy and planning documents; it also showed the different stakeholders with mandate and legitimacy to act on the different goals. The usefulness of the tool for various contexts was discussed (both geographically and disciplinary) and for other purposes, such as for sustainability assessment of the goals in policy and planning documents, monitoring and reporting of the goals, and supporting dialogue-based processes in multi-level governance. For further refinement of the tool, it should be applied and tested in various contexts. The study foresees the development of a digital version of the tool that can be used to support dialogue-based processes of multi-level governance to achieve better alignment of goals in planning towards sustainability.

Relation to dissertation

This paper provides the methodological discussion on dialogue-based processes within multi-level governance and proposes the MUSTS tool. The tool is grounded in knowledge about transdisciplinary processes and uses the sustainability principles of the Framework for Strategic Sustainable Development as the target aspects, which is one of the features of the tool. The paper gives an example application of the tool relating to transport planning in Sweden. It connects the sustainability goals to stakeholders who have the power and legitimacy to act upon them. The tool provides a procedure that supports transport planning.

My contribution

The idea for the tool originated in a project, where I was responsible for one part. It was then improved together with the other co-authors into the present form. I did part of the testing of the tool, created the first draft of the paper and led the whole writing process.

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5 MAIN FINDINGS

In this chapter, the main research findings of the papers are interpreted and integrated into synthesised results. Aligning with the general systems theory that this research builds on, it is important to note that all the findings are interconnected. However, for practical reasons they are presented as responses to the research questions, and these responses can be theoretical or practical in their nature.

5.1 Prominent research themes, research gap and practice needs in strategic planning for transitioning to sustainable mobility

What are prominent research themes, research gaps and practice needs in strategic planning for transitioning to sustainable mobility?

The identified prominent research themes are presented in Figure 8, illustrated as a jigsaw puzzle. Each piece of the puzzle represents a theme and colours represent the field of studies or categories of themes.
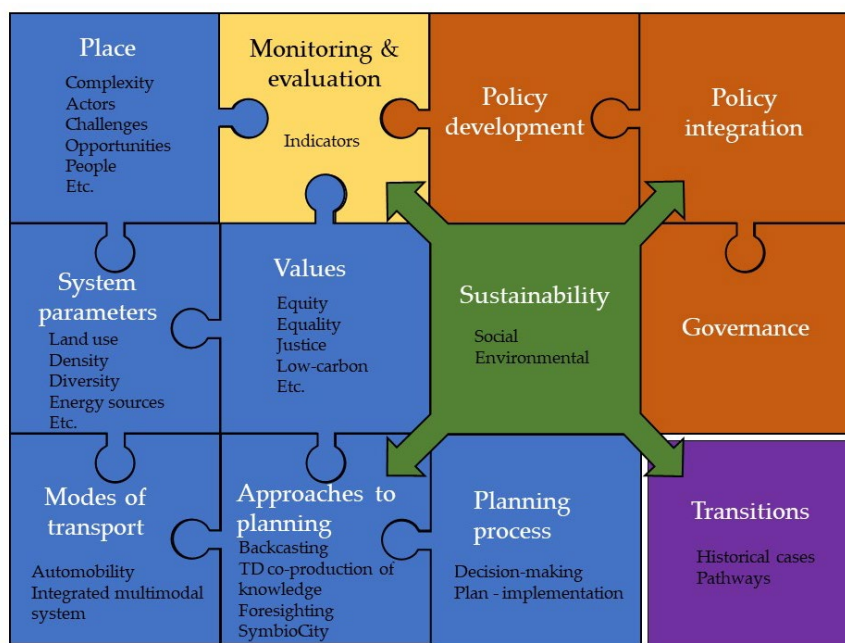
Figure 8. Research themes for transitions to sustainable mobility. Five categories – planning (blue), process monitoring and evaluation (yellow), policy development and governance (orange), sustainability (green) and transitions (purple).

Five categories of themes are identified: planning (blue in Figure 8), process monitoring and evaluation (yellow), policy development and governance (orange), transitions (purple) and sustainability (green). Each of these categories is briefly described in the subsections below.

One can see in Figure 8 that sustainability (green) informs the other four fields (illustrated by the arrows). The connections between the pieces of the jigsaw puzzle represent the interconnectedness of the categories and themes (they do not represent causality, though). A jigsaw puzzle in this case is used as a metaphor. Moreover, the systematic literature review (Paper A) showed that transition studies seem to stand alone whereas the other categories are interrelated. A similar observation was made by Wolfram (2018), who suggests that transition management stands beside urban planning due to differences in approaches. The urgency of change does not appear as any of the main themes in this figure. However, this became more apparent and explicit with the IPCC reports and press releases (2018; 2021; 2022).

5.1.1 Planning

The systematic literature review (Paper A) revealed that the planning towards sustainable mobility category is much larger than the other categories in terms of the number of publications. In that literature, six themes were discussed: planning process, approaches to planning, modes of transport, system parameters, place, and values.

The planning process literature (e.g., Emberger et al. 2008; da Silva et al. 2008b; Danoh et al. 2010; Zhao 2010) is focused on decision-making, its challenges and opportunities as well as different methods supporting it. Moreover, the discrepancy between plans and their implementation is widely discussed.

Multistakeholder
dialogue-based process
e.g. in mobility
planning

In this dissertation, four different approaches sometimes used in relation to planning for sustainable mobility are covered: backcasting, transdisciplinary co-production of knowledge, foresighting and the SymbioCity approach. All except for foresighting are participatory approaches to planning, which means that various stakeholders are involved in the dialogue-based planning processes. Backcasting (e.g., te Brömmelstroet and Bertolini 2010; Borén et al. 2017; Robèrt et al. 2017) is briefly discussed in Papers A and B, while transdisciplinary co-production of knowledge (Simon 2016; Song 2016; Elmqvist et al. 2018; Simon et al. 2018) is discussed briefly in Papers A, C, D, E and F. These two approaches are identified as trends in planning in the past decade. The other two approaches, foresighting and SymbioCity, are analysed in Paper B. They were not identified in the systematic search in Paper A, but they have played a significant role in planning in different places. Moreover, backcasting is often used as part of the SymbioCity approach.

One of the methods that is often used in planning, including some variations of backcasting, is scenario planning (Miller 2007; Vergragt and Quist 2011; Quist 2013). For this method to give the most useful outcome, one needs to consider the needs and time pressures of both the multistakeholder participants of the process and its organisers – process leader(s) or facilitator(s). These aspects, as well as the role of transdisciplinary research in regional planning in Sweden, are discussed in Paper E.

Process
leadership

Facilitation

The literature focusing on modes of transport (e.g., Hull 2005; Geels 2012; Newman and Kenworthy 2015) is to a large extent related to the negative impacts of private cars on the environment. A parallel discourse in the literature related to the modes of transport focuses on integrated multimodal systems. Other modes of transport, such as water, rail and air are often excluded from the urban mobility discourse. This might be due to the complexity of actor groups and regulations related to these means of transport.

Different elements of the mobility system are discussed in relation to system parameters in the literature (e.g., Cervero 2002; Bertolini et al. 2008; Banister 2011; Hickman 2013). Examples of these parameters are land use, density, diversity, and energy sources, among others. Place or local context are mentioned in the literature as important for planning (e.g., Han 2010; Imran 2010; Elmqvist et al. 2018). Complexity, actors, challenges, opportunities, and people who travel are also emphasised in the reviewed publications.

Different forms of complexity were encountered in the research. Three particular aspects of complexity concerning epistemic communities, language and culture in co-production settings are addressed in Paper D. In Paper B empirical studies show the complexity of the organisation of bus and railway stations in Kisumu and Centralen in Gothenburg. In Paper F complexity regarding the number of planning documents, related sustainability goals and stakeholders involved is addressed (Paper F).

In the local context of the Nordic countries, local authorities have the responsibility to develop actions to address goals at various levels due to the governmental structures (Baldersheim and Ståhlberg 2002). However, goals in policy documents are often not contextualised, which often leads to some goals being prioritised over others by various stakeholders (Valencia et al. 2019). Therefore, there is a practical need for getting an overview of various sustainability goals in relation to transport planning, as well as of stakeholders who have the power and legitimacy to act upon them. This need is addressed in Paper F.

Finally, overarching values of equality, equity, justice and low carbon are the themes that the literature shows as being important to account for in the planning processes (e.g., Parnell 2016; Simon 2016; Bakker et al. 2017). These values often relate to sustainability; however, they sometimes also appear individually in the literature and not in relation to sustainability.

5.1.2   Process monitoring and evaluation

The literature in the process monitoring and evaluation category focuses mainly on different types of indicators based on their purpose. Some indicators are used in diverse methodologies to assess sustainability in urban transport (e.g., Youssef and Mohmoud 2011; De Gruyter et al. 2017; Jain and Tiwari 2017). Another set of indicators is used for comparative studies in urban mobility planning (e.g., Haghshenas and Vaziri, 2012), and strategy development (e.g., Shiau and Liu, 2013). Finally, three generations of indicators are identified for monitoring and evaluation of urban development (Elmqvist et al. 2018; Gómez-Álvarez et al. 2018).

5.1.3   Policy development and governance

Another category identified in Paper A is related to policy development and governance (e.g., Bertolini et al. 2005; Hull 2008; Buehler and Pucher 2011). In the literature in this category, different context-specific policies are discussed and their potential usefulness in other places. Another focus of these studies is on policy integration at different levels (e.g., Hull 2008; 2010; Curtis and Low 2012). Finally, the role of governance in planning is underlined in the literature (e.g., Hull 2008; Haarstad 2016).

5.1.4   Transitions

In the reviewed publications for Paper A, the category of transition studies comprises a small number of papers. The transitions literature on mobility mostly studies historical cases (e.g., Hickman et al. 2011; Gössling 2013) and identifies pathways for the future (e.g., Figueroa et al. 2013; Cohen et al. 2016; Ny et al. 2017).

Accelerating transitions became an interesting question for scholars in the past several years. Several studies have been done in the energy sector (e.g., Bento and Wilson, 2016; Kern and Rogge, 2016; Sovacool, 2016; Sovacool and Geels, 2016). In this literature, transport systems are used as an example of energy applications, in terms of different power sources for vehicles. In this dissertation, the main focus is on mobility, where energy becomes a secondary concern, related to the sources of power for vehicles. Studies in the energy sector can be seen as complementing the findings in the dissertation. These articles go into detail in the discussion around fuel-

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transitioning to sustainable mobility

powered vehicles, their emissions and how they contribute to a larger energy system.

5.1.5   Sustainability

The final category of prominent research themes in relation to regional and urban strategic planning for transitioning to sustainable mobility was sustainability. It was found in the systematic literature review (Paper A) that sustainability is understood differently by different actors. It was seen as a policy end-point (e.g., Goldman and Gorham, 2006), as a vision (e.g., Kenworthy, 2006), as a pathway (e.g., WBCSD, 2004), and as a lens to look through at the social reality, also arguing that planners cannot achieve sustainability fully, but only approximately (e.g., Carr et al., 2015). This shows the ambiguity of the term in current research and practice.

Reflecting on the findings to RQ1, it became noticeable that participatory approaches for regional and urban mobility planning increased in popularity in the 2010s. That created a need for methodological support to aid these processes, to ensure that multistakeholder processes are run more smoothly and effectively given the urgency of sustainability challenges. Participatory research modes, such as action research and transdisciplinary research can function as a form of scaffolding for these processes. This leads to a question about their usefulness for processes in co-production settings that work towards a transition to sustainable mobility.

5.2   The transdisciplinary research and action research modes in sustainable mobility transitions

What could action research and transdisciplinary research, respectively, be used for in terms of creating support for transitioning to sustainable mobility?

The three regional projects on mobility planning in Blekinge (described in section 3.1.1) employed a transdisciplinary mode of engagement with stakeholders, but the choice to go with a transdisciplinary approach was made without much consideration of alternative participatory research modes – it was perceived as a matter of course. Even though the comparative systematic-narrative hybrid literature review (Paper C) was conducted later, it was helpful as it provided support for the choice of going with a

transdisciplinary research mode. Learnings made through the literature review on participatory research modes helped to form a reflection upon past projects and can also help with more informed choices on scaffolding different future multi-stakeholders projects.

In the field of transitioning to sustainable mobility (where the projects took place) work is typically done towards environmental and societal change at a sectoral level (as described in section 2.4). It requires a certain flexibility in the planning processes (Broman and Robèrt 2017). To ensure flexibility there is a need for reflection – to (re-)evaluate the current state of planning, note learnings, and improve the process. Many research modes could be useful in such a context, however, there are two that are widely used in sustainability science (action research and transdisciplinary research), and it is not clear when either of them could be most useful.

In transdisciplinary research, significant attention is given to reflection and reflexivity (e.g., Polk, 2015; Popa et al., 2015; Steger et al., 2021). Therefore, it might seem like a natural choice of research mode for planning processes. However, the comparative systematic-narrative hybrid literature review (Paper C) showed that the concept of reflexivity is mainly used in the definitions of transdisciplinary research and not so much in the utilised methods. This might indicate that work with reflexivity in transdisciplinary research is not very well described in the literature. Additionally, it might demonstrate that reflexivity is not used for data collection, but instead as a principled approach to work. In contrast, analysed articles utilising action research used twice as many reflective/reflexive and participatory methods than what was found in the transdisciplinary articles. This could, for example, indicate the particular needs of action researchers and practitioners who work with education and social policy problems. Based on the above, both approaches could be useful for work on sustainable mobility to reflect upon the processes, where transdisciplinary research could be useful to reflect upon work approaches, whereas action research could be useful to reflect upon a particular action.

The conducted projects have further aspects that align with patterns in the theoretical study in Paper C. They all utilised the general systems theory to understand the structure of the bus park system (Paper B), to analyse complexity in relation to epistemic communities, linguistic diversities, and culture (Paper D), to create scenarios (Paper E), and to identify policy and planning documents (Paper F). Also, each of the papers addresses a particular challenge in the respective context within transitioning to sustainable mobility. The learnings from the theoretical study, similarly, show that the field of transdisciplinarity has been highly influenced by the general systems theory (Hirsch Hadorn et al. 2008), among other theories.

Moreover, one of the discourses of transdisciplinarity, called *problem-solving*, stems from environmental sciences and specifically focuses on challenges related to climate change and its effects on society (Klein 2014). The transdisciplinary mode of research is even advocated as an underpinning research mode for sustainability science (Komiyama and Takeuchi 2006; Scholz et al. 2006; Stauffacher et al. 2006; Barth and Michelsen 2013; Brandt et al. 2013; Scholz 2020). Action research, conversely, was not influenced by the general systems theory to the same extent as transdisciplinary research. However, it similarly focuses on solving problems by creating useful and actionable knowledge (Johansson and Lindhult 2008).

Furthermore, the projects addressed gaps in the domain and problem knowledge (see Figure 6 for reference). The literature review showed that transdisciplinary research gives more attention to understanding the domain, for example, sustainability assessment (e.g., Ostrom 2009; Rockström et al. 2009), learning for contextualised problem-solving (e.g., Scholz et al. 2006; Stauffacher et al. 2006), transitions (e.g., Loorbach 2010; Frantzeskaki and Rok 2018), whereas the primary focus of action research is on the problem space, for example, participation (e.g., Moller et al. 2009; Wittmayer and Schäpke 2014) and education (e.g., Eilks 2013; Aznar et al. 2018). Nevertheless, both research modes utilise traditional qualitative social science research methods (such as interviews, workshops, questionnaires, and participant observation), but to a different extent.

When it comes to stakeholder engagement, the projects engaged with professionals (e.g., transport planners) and government departments (e.g., representatives of county administrative boards). The literature review showed that researchers who utilise a transdisciplinary research mode work primarily with professionals (incl. workers and trade unions), government departments (incl. politicians, policymakers, and advisers), and local communities. Researchers utilising action research mode engage with the same types of stakeholders, but to a different extent, preferring local communities over governmental departments.

Comparing the designs of the projects with the insights from the literature review, it seems that the designs of the projects are aligned with the transdisciplinary research mode more than with action research. Also, the field of strategic planning for transitioning to sustainable mobility (the domain of this dissertation) aligns with transdisciplinary research mode because there is a focus on knowledge co-production intended for actions to be implemented by the respective planning departments of the local authorities.

If these projects were designed using the action research mode, they could have looked like this: The main focus of the projects would have been on creating a change or making an intervention to improve welfare of society (i.e., creating *action-for-knowledge*). The purpose of the projects would have been to find a practical solution to a sustainability problem in the local context. The projects' main stakeholder would have been the local organisation that provides transport services. Finally, in-depth knowledge on the problem and its solution would have been produced during the course of these projects.

To conclude, transdisciplinary and action research could both be useful for work on transitioning to sustainable mobility. However, the decision upon one of them (or their combination, transdisciplinary action research) would lead to different designs of the projects. Such a decision could be seen as a higher level of scaffolding for work on transitioning to sustainable mobility. When looking at a lower level of scaffolding, there is a need for structural support for the design and facilitation of participatory processes in strategic planning for transitioning to sustainable mobility. Some elements of such scaffolding, triggered by practical needs, are presented below.

5.3 Scaffolding for multistakeholder dialogue-based processes in strategic planning for transitioning to sustainable mobility

What could scaffolding that supports multistakeholder dialogue in strategic planning for transitioning to sustainable mobility look like?

Two types of scaffolding were investigated throughout the research and three more types were produced:

- The two investigated are transdisciplinary research and action research (Paper C);
- Framework for analysing complexity of co-production settings in relation to epistemic communities, linguistic diversities and culture (Paper D);
- Rapid scenario planning method to support a regional sustainability transformation vision (Paper E);
- The MUSTS tool for supporting dialogue-based processes of multi-level governance in transport planning (Paper F).

The findings from Papers A and B presented in section 5.1 suggest that strategic planning could have great benefit from participatory processes, meaning that all the important stakeholders need to be involved. Running such a process could be considered a project, and regional and urban mobility planning is often done in projects as described in section 2.7. Running a transdisciplinary research process could also be considered a project with phases like in the 4-D model (presented in section 2.7). This model can be used to illustrate the process phases of a project. This is here used to present where in the process different types of scaffolding apply (see Figure 9).
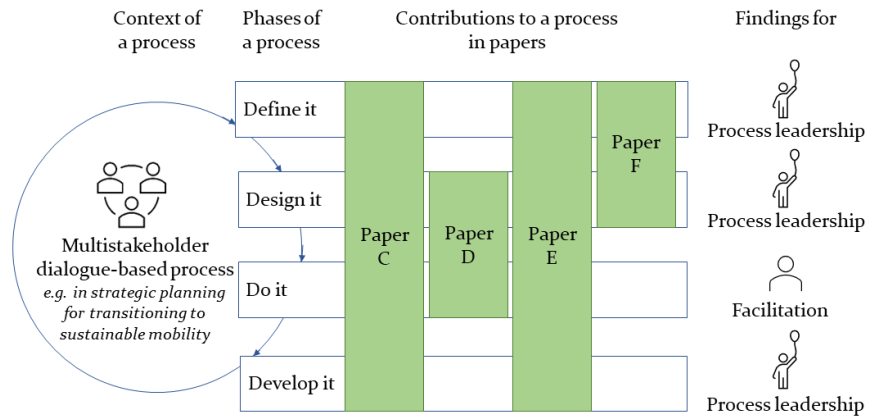
Figure 9. Different types of scaffolding for multistakeholder dialogue-based processes in strategic planning for transitioning to sustainable mobility: relation of findings of individual papers to phases of a process and potential beneficiaries of these findings. Paper C – transdisciplinary research and action research; Paper D – framework for analysing complexity of co-production settings in relation to epistemic communities, linguistic diversities and culture; Paper E - rapid scenario planning method; and Paper F - the MUSTS tool.

For each phase of a project process, some recommendations of methodological support based on the findings from the papers are presented. In Figure 9, one can see that the scaffolding tools in Papers C and E contributed to all four phases, whereas the scaffolding tool in Paper D contributed to the *design it* and *do it* phases, and the scaffolding tool in Paper F contributed to the *define it* and *design it* phases. It varies who makes use of each scaffolding tool. Sometime it is the facilitator and/or the process leader, and sometimes it is the project team (with the same function), depending on the set-up of the project process. In some cases, a person or people who take the role of process leadership might facilitate the process in the *do it* (implementation) phase or might invite another facilitator for it. It could also be beneficial to have a facilitator involved in designing and

evaluating the process. However, this is not depicted in Figure 9 to make the image easier to understand.

The support provided by the scaffolding tools to the project process

The first two scaffolding types (transdisciplinary research and action research) support participatory planning processes in transitioning to sustainable mobility. They support the overall organisation of the participatory process. They organise the process for slightly different aims and use slightly different methods for information gathering and analysis. These research modes bring in both academics and practitioners to solve complex sustainability challenges, whereas participatory planning approaches might not necessarily do that.

The framework in Paper D helps understanding of the diversity in the multistakeholder groups that take part in the project processes. The diversity relates to epistemic communities, linguistic diversity and culture in the group of participants in the transdisciplinary multistakeholder processes. The framework helps facilitators to prepare for and run the process more effectively and inclusionary. In other words, it could support the *design it* and *do it* phases of the project process.

The rapid scenario planning method in Paper E helps organise the scenario planning process in a structured way that shortens the time for doing the scenario planning in a participatory process. It also shortens the time for the process leaders for prepararing such a process. This means that the scaffolding method accommodates for the urgency for change in sustainable mobility.

The MUSTS tool in Paper F offers a way of creating a structured overview of sustainability goals and links the goals to those stakeholders who have the power and legitimacy to act upon them. This means that the tool supports *define it* and *design it* phases of the project process. The tool helps avoiding cherry-picking of the goals to work with and providing a more comprehensive approach to working with target knowledge of transdisciplinary research (see Figure 4 regarding target knowledge).

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6 DISCUSSION

In this chapter, both the results and limitations in the research are discussed.

6.1 Discussion of the results

Prominent research themes in strategic planning for transitioning to sustainable mobility have been identified. Transdisciplinary research and action research as support for participatory planning processes have been investigated. In addition, three scaffolding tools that support transdisciplinary project processes have been developed, tested and evaluated.

In relation to the lack of process supporting tools (Lawrence et al. 2022), the research provides a contribution to the toolbox. This contribution gives process leaders and facilitators more possibilities to design and run processes more smoothly and effectively. The literature suggests that such processes require tools that could help participants to be open, creative and willing to discuss (Wiek 2007; Escobar 2009; Jordan 2014; Ernst et al. 2017). Based on the conducted research in Paper D, a tool that enables such discussion is provided.

The urgency of sustainability challenges (Ziegler and Ott 2011) in combination with the time-consuming transdisciplinary processes (Hemström et al. 2021; Perry and May 2021) creates a particular problem for facilitators and process leaders. Here, a rapid scenario scaffolding method (Paper E) and the MUSTS tool (Paper F) provide support in making the transdisciplinary processes more efficient.

The literature pointed to an insufficiency regarding inclusion of academics in participatory planning approaches (Moallemi et al. 2020). The findings show that both transdisciplinary research and action research provide this. The comparison of the participatory research modes in Paper C also revealed that they can be used to fulfil different aims (action-for-knowledge, knowledge-for-action). The literature tends to recommend transdisciplinary research (e.g., Méndez et al. 2013; Moallemi et al. 2020) without evaluating the benefits of action research. This points to the need for further research.

With regard to mobility planning, both transdisciplinary research and action research could provide useful support, but with different aims. The analysis points towards transdisciplinary research being more useful for strategic planning for transitioning to sustainable mobility because it creates

knowledge useful for the planning departments of the local authorities. However, no previous research in the existing literature has been found that systematically evaluates the domain of mobility planning. Further research could be to look more systematically at the benefits of utilising participatory research modes in mobility planning. When it comes to the other scaffolding tools, their design and production were all triggered by the practical needs in the mobility planning projects. This means that they were tailored for this domain.

The contribution to the toolbox was made with regards to process support in strategic planning for transitioning to sustainable mobility. However, there is room for additional tools to complement the toolbox. New tools could be designed through a systematic and theory-based approach following Thomas Jordan's (2014) suggestion to use a science-based approach to tool making, but it is also possible to learn from a review of tools in mobility planning.

Applicability of the scaffolding tools in other geographical locations and domains

Even though the proposed methodological support might be valid for supporting reflective and generative multistakeholder dialogue in various contexts, it has yet been empirically tested only in the domain of strategic planning for transitioning to sustainable mobility and only in a few geographical locations. Therefore, a discussion is given below on the potential applicability of the methodological support application in other geographical locations and outside of the mobility planning domain.

The framework for analysing complexity in relation to epistemic standpoints, linguistic diversity and culture (Paper D) can likely be of use in the contexts of Gothenburg and Kisumu. In both locations, all three aspects of the framework would be of relevance. Similarly to Karlskrona (where the empirical study took place), Gothenburg is a multinational city where diverse cultures meet every day and people speak different mother tongues and sometimes do not have a common language. Kisumu, similarly, is famous for people speaking primarily two languages in the area – *kiSwahili* (one of the two Kenyan national languages) and *Luo* (the local language in the Lake Victoria region in Kenya and Tanzania), although some people also speak English (the second national language in Kenya). Bringing stakeholders together would mean creating a meeting point for several epistemic standpoints, where each one of the stakeholders comes with their expectations, needs, and values. Therefore, all three aspects of the framework could be considered important for creating conditions for reflective and generative dialogue among stakeholders.

The rapid scenario planning method (Paper E) could likely be used in the sustainable mobility planning domain in Gothenburg, Klaipeda and Tricity, although, there was a risk of stakeholders in Klaipeda and Tricity not being ready for such visionary processes at such a high pace. In the empirical studies, it was found that participatory planning is not very common those locations. In Kisumu, on the other hand, such a process would likely not work. The value of time is perceived differently there: meetings often get delayed or cancelled, and even international conferences often get delayed (up to several hours). Since the process for rapid scenario planning has such a filled and timed schedule, a delay of several hours might lead to reduced quality of the outcomes. The importance of reflexivity, however, would remain valid for all geographical locations.

Finally, the process of the MUSTS tool (Paper F) could likely work also in Gothenburg, since planners there also have a large number of documents they need to take into consideration, and there are many people who would need to be involved in the process from different organisations. There is not enough domain knowledge to conclude anything about the usefulness of this tool in the context of mobility planning in Klaipeda and Tricity. However, identifying appropriate stakeholders for dialogue around strategic planning for sustainable mobility in a way that is proposed in the tool could be useful since participatory planning is still not very common in these locations. Additionally, for the procedure of the tool to work, the facilitator of the process should have a previously established collaboration with relevant stakeholders. Otherwise, additional tools would be necessary to initiate such a process (see, e.g., Horcea-Milcu et al. 2022). In Kisumu, on the other hand, the primary purpose of the tool (to create an overview of sustainability goals for relevant stakeholders at all levels) could be of less value due to the policy structures (there is one national policy document that integrates policies from the higher levels, which affects the regional planning documents, which, in turn, is integrated into the local plan). However, the tool could be used to assess the alignment of the goals between different levels and to identify relevant stakeholders.

In contexts outside of the domain of strategic planning for sustainable mobility, the framework in Paper D could likely be valid everywhere, where multilingual, multicultural groups with diverse epistemic standpoints meet for dialogue-based processes. Rapid scenario planning could be of use in contexts where a strategic approach is relevant, and people culturally tend to follow the plans and value efficiency in the process. Finally, the MUSTS tool could be useful for the contexts where multi-level governance is used or is being considered and/or where stakeholders need to navigate among a large number of documents.

6.2   Research limitations

In this research, a lot of attention was given to learning about the domain and the problem space. However, some more attention could have been given to the problem by obtaining theoretical knowledge on facilitation and participatory methods. Thomas Jordan (2014) suggests that many of the tools and methods for facilitation are created by practitioners and have limited theoretical foundations. Furthermore, Georges Romme and Jan Holmström (2023) suggest that the tools should be grounded in theory. This was addressed in the dissertation to a certain extent. However, there could have been more of a systematic approach.

One of the major limitations of the dissertation is the narrow definition of stakeholders used in the empirical studies, which excludes the general public from the processes. Given the short time frame and realities on the ground, the work was intentionally designed for and tested only on representatives of the local authorities, regional and urban planning officers, service providers and researchers. This meant that the designed workshops were not attended by representatives of the travellers who are also affected by transitions to sustainable mobility. Further considerations would have been necessary to include them in the process and this will be a priority in further studies.

Furthermore, the United Nations-led international agreements, such as the Paris Agreement and the SDGs, have created international pressure to change the development patterns of urban mobility worldwide. Therefore, diverse approaches and tools are rapidly developing (Gustafsson and Andréen 2018). Because of this rapidly changing landscape of approaches and tools, if someone were to repeat the studies of this dissertation, the results might turn out differently.

Finally, personal biases, based on previous knowledge and experience, might have influenced the results. Multiple methods to address the research questions and the use of reflection and reflexivity to support the interpretation and analysis of the findings were used. However, there might still be something missed or misinterpreted.

7 CONCLUSION AND FUTURE STUDIES

In this chapter, the main research contributions to the body of knowledge and practice are outlined and suggestions for possible future studies are provided.

7.1 Conclusion

Mobility planning needs to handle bureaucratic requirements of conventional planning while addressing the urgency of solving sustainability challenges. A way of doing that is utilising participatory research modes, such as action research and/or transdisciplinary research. This brings in new knowledge but also a lot of stakeholders, which is challenging to handle efficiently and effectively for mobility planning. There are many tools available to support such participatory planning but there is a lack of tools that deliver structural support to processes in order to enable reflective and generative multistakeholder dialogue.

This dissertation presents a type of methodological process support for multistakeholder participatory projects in strategic planning for transitioning to sustainable mobility. These process-supporting tools could be understood as scaffolds that help to run the project process more smoothly. Three scaffolding tools were designed, tested and evaluated, and two more were compared.

The synthesised results from this work suggest that the proposed scaffolding tools, which are rooted in transdisciplinary co-production of knowledge research, offer promising elements for a toolbox for strategic planning for transitioning to sustainable mobility.

7.2 Main contributions

The main contributions of the dissertation can be split into a contribution to the body of knowledge and a contribution to practice.

The contribution to the body of knowledge is focused on expanding the domain knowledge – related to strategic sustainable development in mobility planning, on expanding the problem space of knowledge – participatory research modes, and on contributing to solving the problem of insufficient processes for multistakeholder dialogue to plan for

contextualised transitioning to sustainable mobility. More specifically, this was done by outlining prominent research themes in strategic planning for transitioning to sustainable mobility (Papers A and B), analysing the suitability of action research and transdisciplinary research for this context (Paper C), and proposing scaffolds for multistakeholder dialogue-based processes in this context (Papers D, E and F).

The contribution to practice consists of methodological support for multistakeholder dialogue-based processes in strategic planning for transitioning to sustainable mobility. A list of recommendations for different stages of the project process is proposed. The proposed scaffolding tools are: a conceptual framework to analyse a group's diversity regarding epistemic communities, languages spoken and cultures; a rapid scenario planning method for developing scenarios in a participatory way with a major focus on time constraints among the participants, which results in a longer and more thorough preparation for the carrying out of this process; and, finally, the MUSTS tool that provides an overview of the sustainability goals for mobility planning at different levels as well as pointing out who has the power and legitimacy to act upon them. Different elements of this methodological support have been tested empirically in Karlskrona, Sweden, Tricity, Poland and Klaipeda, Lithuania.

Moving forward, it is suggested that the findings of the dissertation might be useful not only for strategic planning for transitioning to sustainable mobility but for any multistakeholder dialogue-based processes.

7.3   Future studies

There are multiple directions one could take from here. However, the interest lies within several aspects related to the facilitation of multistakeholder dialogue-based processes with the main focus on people who participate in these processes. One of these aspects is testing the scaffolding tools in different contexts and reflecting upon the outcomes.

Of particular interest is to further explore the questions of diversity in multistakeholder dialogue-based processes intended to contribute to sustainability transformations as well as its effects on facilitation and knowledge integration between the participants. This might require the development of new tools and/or adjustment of existing ones.

Inspired by the work of Karen O'Brien (e.g. 2021) on the role of people in sustainability transformations, it would be interesting to explore the care-

for-people facilitation, where more emphasis is given to the mental and physical health of participants of the process as well as those leading and organising this process. Working with questions of sustainability might create extra pressure on the participants of the process since they have to accept and address one of the most urgent challenges that humanity has ever faced (Sellberg et al. 2021; Ayers et al. 2023).

Finally, it would be interesting to explore behavioural change aspects in relation to group dynamics in dialogue-based processes framed towards strategic sustainable development. The literature suggests that the implications of behavioural change approaches could be positive if the facilitator and/or process leader is trusted by the participants and the steps of the process are clearly communicated (Escobar 2009; Ernst et al. 2017). In the context of such a study, ethical considerations would be especially important.

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Paper A

Context adapted urban planning for rapid transitioning of personal mobility towards sustainability: a systematic literature review

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Context adapted urban planning for rapid transitioning of personal mobility towards sustainability: a systematic literature review

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Abstract

Sustainability related challenges in mobility planning have been recognised at the international level, and the urgency for change has been widely discussed among scholars. However, there seems to be no general agreement on the best ways to pursue such change. To seek answers to the question of how to pursue change, this study analysed the development of the broad research fields of mobility, urban planning and transitions, and the overlap of these bodies of literature. Both academic and non-academic literatures were covered. By means of a systematic literature review, as well as bibliometric studies, several prominent research themes that address change from planning and transition perspectives were identified. Moreover, these themes describe different viewpoints and challenges in mobility planning. These include planning and policy for sustainable mobility and accessibility, backcasting and scenario planning, indicators in planning, modes of transport, decision-making, studies of global North and global South, as well as overarching themes of equity, equality and justice, roles of institutions, and co-production of knowledge. Strategies for staying up to date with these fields were also identified. In the literature covered, the temporal dimension in mobility planning was described in four different ways, but little was found about how accelerated transitions towards sustainable mobility can be achieved. Further knowledge gaps were identified in relation to behavioural change, policy development, institutionalisation of planning capacity, and social sustainability in mobility planning. This created an outline for possible future studies.

Keywords: systematic literature review; personal mobility; sustainability; planning; rapid transition; urban

1   Introduction

The transport sector significantly contributes to the sustainability challenges of today. According to Eurostat [1], 23,5% of emissions of greenhouse gas equivalents in the European Union countries come from this sector. The distribution of different modes of transport, though, is highly context-specific. For many cities, the 'peak car' period has passed [2–4]. Newman and Kenworthy [3] have suggested that we are entering a new age of more sustainable mobility that could be called 'a new golden age of rail'. This could be true, but it is debatable to what extent it will be rail and/or new integrated multimodal solutions that could overtake the private car. It is important that changes are taking place anyhow and that decisions we make today will pave the way for future development. In addition, decisions and plans for future development are largely affected by the Sustainable Development Goal (SDGs) and the New Urban Agenda. The SDGs were adopted by all United Nations Member states in 2015 and represent a call for urgent action in a global partnership (see: https://sustainabledevelopment.un.org/sdgs). The New Urban Agenda serves as a vision for a sustainable future and connects to the SDG11 [5] (see: http://habitat3.org/the-new-urban-agenda/). Many stakeholders are trying to incorporate them into existing goals and targets but they are often failing to do so since they are being tied to everyday tasks of individual organisations [6]. It therefore seems clear that incremental steps in planning are not enough and that a more radical approach is necessary.

Other issues, such as questions of social sustainability, are gaining wider attention in the planning discourse. Equity, equality, and justice are important in transitioning towards sustainable mobility [7–12]. The same applies to different categories of passengers and the adaptation of the planning process in relation to societal changes, particularly demographic transition, migration, and "floating population" (those who live in rural areas, but work in urban areas). By demographic transition we mean the situation when first mortality, then fertility is declining, leaving an increase in the aging population [12–14]. Often, these challenges are seen and addressed one by one, leading to sometimes controversial outcomes and new problems. For example, prioritisation of motorised over non-motorised transport is unfair for the poorest of the poor [8,9]. Therefore, it is necessary to understand better which issues are important to account for as well as which approaches are being used in planning to be able to identify one or more approaches to address the issues.

Finally, climate change, the IPCC reports (the most recent is the IPCC Special Report on the 1,5 degree world issued in October 2018 [15]), the Paris Agreement (signed in 2015 [16], bringing together all nations to address climate change) and other international agreements create additional time pressure to make a change towards sustainability as soon as possible. The recent IPCC Special Report [15] specifically acknowledges transport as a challenge and urges a fast radical change overall. However, there seems to be a lack of understanding regarding the extent to which planning studies and transition studies address the need for rapid changes, as well as to what extent transition studies are integrated with planning studies. This is important to investigate further, as a combination of the two would likely be necessary to bring about sufficiently rapid and extensive changes.

1.1   Research goal and research questions

Based on the general overview described above, the study aims to provide a systematic inquiry into the relevant publications, analyse to what extent studies of urban planning, mobility, and transition studies overlap in the cited literature, what main themes have been discussed to date, and what the "organisation of the field" is.

The main research question for this systematic literature review (SLR) is: "What is the current status of research on context-adapted urban planning for rapid transitioning of personal mobility towards sustainability?". This question is split up into four sub-questions as follows:

- RQ1: What are some prominent research themes within context-adapted urban planning for rapid transitioning of personal mobility towards sustainability?
- RQ2: How did the identified themes evolve during the past 10 years?
- RQ3: What are the main related bodies of literature and to what extent do they overlap?
- RQ4: What is the 'organisation of the field'?

To answer these questions, we used systematic literature review methodology and qualitative analysis, as well as a number of bibliometric methods to assist in systematising the data. The combination of research methods allowed us to classify and analyse the literature, using both algorithm-based approaches and our own understanding of the subjects.

Below we first describe some key concepts and say more about the methods and tools used in this study. Later, we interpret and analyse the results of the SLR. Finally, we discuss past, present, and likely future research.

1.2   Key concepts

Here *mobility* is defined as "the ability of an individual [...] to move about" [17] freely and easily. It contrasts the definition of transport – moving people (or goods) by different means of transport [18]. This definition of mobility opens up for a possibility to consider other ways of moving people around than by means of different modes of transport. 'Freely' in this context means that people have the freedom to move about, whereas 'easily' refers to accessibility to people, places, spaces, work, and other necessary services and facilities. In this way mobility is closely related to *accessibility* [9,19]. In a broader sense, mobility can be understood not only as movement of people or objects, but also as communication, flows of meaning, and the sharing of ideas [20–22]. However, in this paper, we still focus more narrowly on the movement of people.

In this paper, *urban planning* is defined as "an important tool for city leaders to achieve sustainable development. It helps to formulate medium- and long-term objectives that reconcile a collective vision with the rational organization of the resources to achieve it" [23]. Urban planning traditionally involves tasks, such as land use distribution, built environment design, infrastructure development, and communications. In some places transport planning forms part of urban planning, while in others transport or mobility planning have their own authorities and respective plans.

Context adapted planning implies the importance of local context considerations in the planning processes.

We did not define the terms *transition* and *transformation* in this paper, because there is no agreement on definitions among scholars and we wanted to be open to any interpretation.

There are also many definitions of sustainability and many stakeholders understand it differently, which creates a challenge for the direction in planning [24]. Using the idea of a systems approach in planning [25], sustainability was suggested by some to be a policy end-point (or sustainability as a vision [26,27]), instead of sustainability as a pathway,

where an outcome is not defined and the state would become progressively "more sustainable" [25]. Another way to understand the term is as a lens through which to look at social realities [28]. Sustainable mobility is intentionally not defined in this paper because the purpose was to explore the literature related to the research questions and not to impose or identify publications that use specific definitions of sustainable mobility and then analyse them.

2 Methods

Guidelines for systematic literature review suggest to use a time restriction to scope the study [29] (p. 48). The main focus of this study was on the publications of the past decade (2008-2018) but the literature analysed starts from 1993, when the oldest book included in this SLR was published. The year 2008 was selected due to Banister's publication "The Sustainable Mobility Paradigm" [30] that became a reference point for many future studies around sustainable mobility, suggesting that conventional planning should be reconsidered based on the sustainability perspective.

2.1 Systematic literature review

A systematic literature review was performed, mainly based on the combination of recommendations of two studies. The first of these studies, Pickering and Byrne [31], helped to identify the process (15 steps of SLR, p. 539), whereas the second study, Petticrew and Roberts [29], provided general guidelines on when to perform SLR, what types of studies to include, how to assess them, and how to address possible biases. The general flow of the SLR is illustrated in Figure 1.
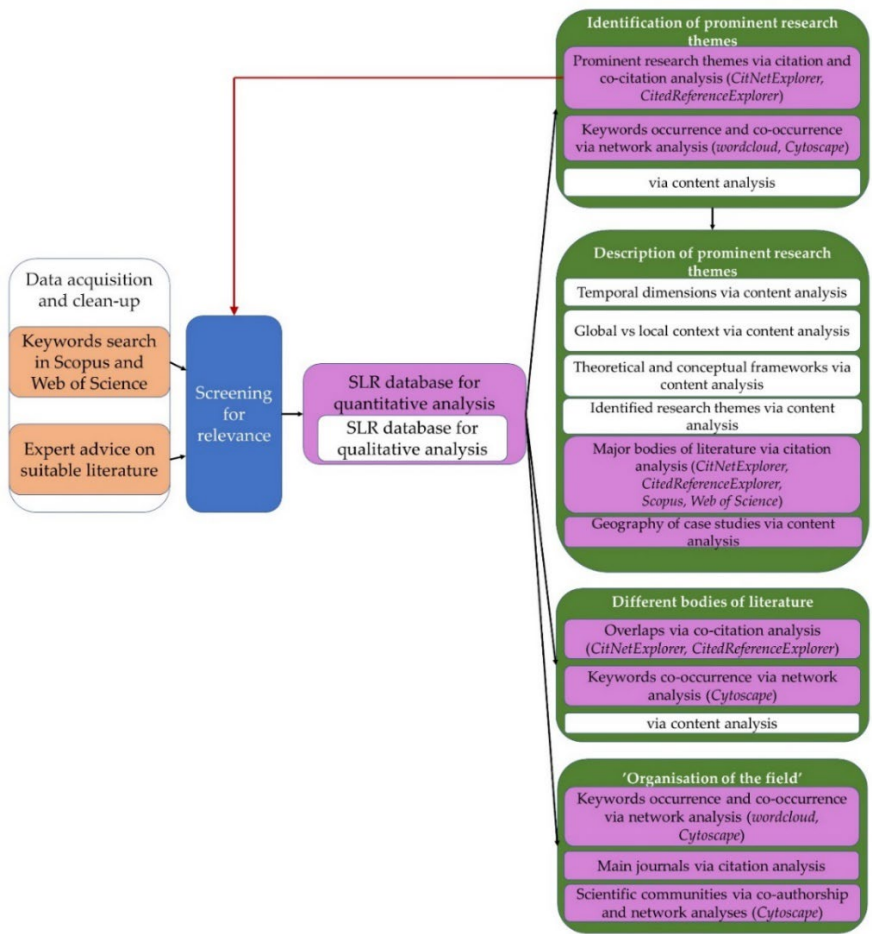
Figure 1. Process flow of the systematic literature review (white boxes on the right relate to the white box with the SLR (systematic literature review) database for qualitative analysis while purple refer to the SLR database for quantitative analysis; bibliometric research tools are written with italics).

Performing an SLR gives a comprehensive approach to assessing relevant literature using a defined methodology, identifying the criteria for selection of the published work, assessing relevance of the scholarly publications to the research questions, structuring the data extraction and analysing the results.

To address the Research Questions outlined above, several strategies for data acquisition and clean-up have been used. They consist of keywords

identification, databases identification and keywords search, and expert advice on suitable literature.

To systematise and interpret the data, both quantitative and qualitative methods have been utilised. The selected quantitative methods (some of them are bibliometric methods: citation, co-citation, co-authorship and network analyses) are described in section 2.2 and research tools in section 2.3. From the obtained data, prominent research themes have been identified and described, followed by analysis of different bodies of literature and "organisation of the field" that suits the research aim. Moreover, to better understand the fields and bodies of literature, we quantitatively analysed the geographies of case studies, as well as theoretical and conceptual frameworks utilised in the publications of the SLR.

The systematic literature review has a transdisciplinary character—meaning that both academic and non-academic literatures are included—and incorporates publications' findings from mobility, urban planning, and transition studies.

2.1.1 Data acquisition and clean-up

2.1.1.1 Keywords identification

Keywords were identified through an iterative search process starting from a few terms inspired by the research questions. After some iterations this expanded into 19 keywords: "mobility", "transport", "accessibility", "urban", "city", "$sustainable" (symbol $ refers to stemming search technique and returns all the words with the same word stem [32]), "local context", "context adapted", "plan", "fast transition", "rapid transition", "accelerated transition", "indicator", "criteria", "principle", "success factor", "decision*making" (character * refers to wildcard [33] that retrieves all the variations of the word(s)), and "decision maker*". The number of keywords was then reduced through a quick combinations test where synonyms were identified in a series of searches (Figure 2). The test searches showed that "fast", "accelerated" and "rapid transitions" were covered in "transitions"; "indicator", "criteria", "principle", "success factor", "decision*making", and "decision maker*" were covered in the literature on planning; and "context adapted" did not give any results, so a synonym term "local context" was selected for the search.
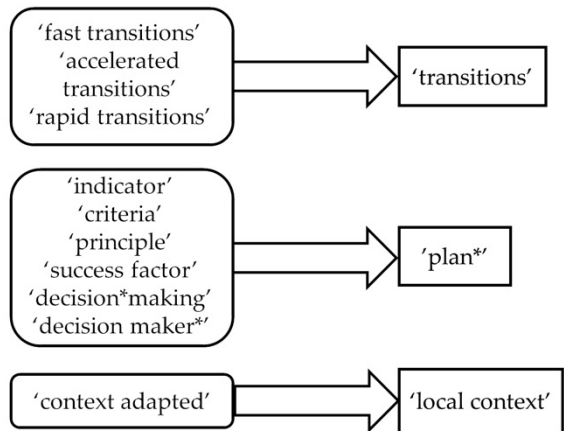
Figure 2. Reduction of keywords scheme.

Finally, the following keywords were selected for the keywords search of this SLR: "mobility" ("transport", "accessibility"), "urban" ("city"), "$sustainable" in combination with either "local context", "plan*" or 'transition'. The scheme is illustrated in Figure 3:
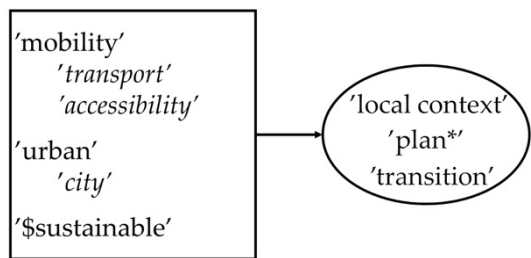
Figure 3. Key words scheme for search strings.

In the search strings, each word from the rectangle on the left in Figure 3 was used in combination with each term from the oval on the right. It created 18 search strings.

We are aware that the terms *transition* and *transformation* are sometimes used interchangeably, both referring to a radical change, and sometimes very differently, with transition referring to incremental change as opposed to more radical change by means of transformation. However, the concepts

that these terms point to come from different schools of thought, with their own underlying assumptions and distinct approaches, where transition has been said to focus more on concrete changes within societal subsystems (e.g. energy and mobility) while transformations rather deal with the link between society and ecological externalities [34]. In this study we focus on the transition term, because it is closer to our research focus.

2.1.1.2   Databases identification and keywords search

The databases Scopus and Web of Science have been used to search for publications from January 2008 to April 2018. The subject areas covered were social sciences, engineering, earth and planetary science, multidisciplinary, decision science, economics, econometrics and finance, environmental science, business, management and accounting, energy, computer science, agricultural and biological sciences, decision sciences, mathematics, arts and humanities, and psychology. Although we used both databases, our primary study showed that most of the publications from Web of Science are present in Scopus too (four publications were found in Web of Science only).

2.1.1.3   Expert advice on suitable literature

A systematic approach to keyword searching of databases in SLR has its advantages, allowing consideration of publications that might have been missed otherwise. At the same time, it has its limitations related to the selected publications, as they become the starting point of the analysis. Examples of such limitations are the publications by Robinson [35,36], one of the founders of backcasting. They were not on the resulting list of keyword searches of the SLR due to their publication dates (before 2008, namely 1982 and 1990). In addition to that, a co-citation analysis was performed, and its result did not show these publications either, because they were not cited at least four times within the selected publications. To address this limitation, expert advice [29] (pp. 104–105) on suitable literature was collected. It was done through informal consultations with experts in the field. This added 21 publications in total and ten of these were neither in Scopus, nor in Web of Science, as they were recently published books and articles.

2.1.2 Screening for relevance

The main inclusion criteria for the publications were publications being original research papers written in English and published in peer-reviewed journals (including articles in press), as well as peer-reviewed books and book chapters. Language restrictions created limitations by excluding publications written in other languages (some of them were published in Chinese, Spanish, German, and Polish). It could be seen as restricted science in transdisciplinarity [37]. However, including them in the analysis could have been difficult and risky, as content could have been lost in translation or misinterpreted. Given that the lead author had a proficient command of Russian, Ukrainian, and Czech, some additional publications that were identified through the bibliographic studies and written in these languages could also be assessed for their relevance to the Research Questions. Review papers, conference papers and reports were not included into the search.

2.1.3 SLR databases

There were two SLR databases formed for the analysis: an SLR database for quantitative analysis and an SLR database for qualitative analysis. The first one consists of the results from the primary SLR search in the Scopus and Web of Science databases and from the expert advice. In addition, citation and co-citation analyses were performed to identify further literature that could have been missed throughout the primary SLR process. These publications were added to the SLR database for quantitative analysis. To better understand the fields, the other SLR database for qualitative analysis was identified within the SLR database for quantitative analysis. The publications from the qualitative database were fully read and analysed in-depth. This enabled viewing the field from the systems perspective, identifying possible biases and knowledge gaps.

Specific methods and research tools used for the bibliometric studies are further described below.

2.2. Bibliometric methods

For bibliometric studies, we extracted the following information: authors, publication metadata, references, and citations. Several tools were used to

clean-up the data. We used Microsoft Word and Excel for primary fixes such as removing blank spaces/cells and refining the consistency of language (for example, from "decision making" into "decision-making") as well as refining the names and titles (for example, from "Gossling" to "Gössling"). In addition to that, we used OpenRefine (see: http://openrefine.org/) to go through the words and names that are slightly different, for example "city" and "cities". OpenRefine is an open source software to work with messy data, which is available in several languages. It is important to process data in this way to avoid duplicates in the analysis. Having duplicates in the networks would make it more complex and the relative importance of a particular keyword, author or publication would be decreased.

2.2.1 Citation analysis

One of the common methods of bibliometrics, citation analysis [38], has been performed for this SLR. Scientific literature is based on the arguments that are supported by relevant cited publications and in that way creates relationships between publications in the field. The usefulness of citation rankings in research evaluation is being debated [39]. Firstly, metrics do not fully reflect the overall contributions of researchers towards institutional mission and the wider public good. Secondly, studies show that women and interdisciplinary research become disadvantaged due to lower citation frequency than what is typically the case for men and disciplinary research [40]: "Evidence suggests that men are reluctant to cite women" and "interdisciplinary research ... tends to be cited less often than papers in the mainstream of disciplines". Thirdly, hyperprofilic authors might have limited involvement in the research process and "do not meet traditional authorship criteria" [41]. As suggested, the best way to address the potentially limited usefulness of citation ranking is to publish in peer-reviewed journals to supplement the ranking evaluation with a peer-review process by the experts [40].

In case of systematic literature reviews, bibliometric studies give an overview of what publications had an effect on the subsequent articles and books. Moreover, citation analysis allows the identification of main journals, research institutions and other types of data for bibliometric analysis. We used citation analysis to identify the most cited publications and the main journals within the SLR database for quantitative analysis. In addition, citation analysis helped identifying complementary literature (red arrow in Figure 1). This resulted in 69 publications, however, after removing

duplicates, only 22 publications remained, and of those, ten did not meet the eligibility criteria (see Figure 4).

2.2.2   Co-citation analysis

Co-citation analysis, in contrast to the citation analysis, shows the relationships between publications, as well as how strong those relationships are. This can be illustrated in networks of related literature (with two or more publications cited together in the same article) that would show the links between the publications and their relative proximity to one another [42]. Such an analysis can visualise groups/clusters of literature with the most relevant content [38] and lead to the identification of core themes [43] and schools of thought [42]. Moreover, co-citation analysis can show development of the field over time as interests of the researchers change [38]. In this SLR, we have analysed publications', co-citations', and keywords' occurrence and co-occurrence to describe the development of the field.

2.2.3   Co-authorship analysis

To illustrate social networks among researchers who share similar interests, co-authorship analysis has been performed. In contrast to citation and co-citation analyses, co-authorship analysis shows what groups of researchers collaborate [44]. Co-authorship analysis can therefore be used to identify schools of thought. We used this method to depict collaborations formed to publish works selected in the SLR database for quantitative analysis, as well as to focus on the most published authors' networks.

2.2.4   Network analysis

Network analysis illustrates the relations and interactions among the elements of the system. In social sciences network analysis is used to identify network properties, for example formation clusters in the system or allocation of node centrality [45]. In our SLR we used network analysis to map the keywords and authors of publications. Moreover, we calculated node size, node centrality, and how many links each node has, illustrating each node's importance within a system [42]. With that we identified the

main keywords, authors and their respective networks within the SLR database for quantitative analysis.

2.3   **Bibliometric research tools**

Open source software CitNetExplorer (see: http://www.citnetexplorer.nl/) has been used to analyse citations based on the data from the Scopus and Web of Science databases. First, we created a list of selected publications on Scopus; the publications not available in Scopus were searched and added to another list on Web of Science. Ten of the 21 publications recommended by the experts were not found in either of the databases and they were excluded from the co-citation analysis. Using an intermediate open source software called CitedReferencesExplorer (see: http://andreas-thor.github.io/cre/) we saved the data from Scopus into the suitable for CitNetExplorer format (the same as in Web of Science by default). Later, it was combined with the data from Web of Science. The compiled file was imported into the CitNetExplorer [46] that allows creating and analysing citation networks, clusters of publications and core publications. To analyse citation networks, we retrieved the reference lists from the SLR database for quantitative analysis. Only the 40 most cited publications were visualised in the network. To avoid excessive amounts of linkages between publications on the graph, the minimum number of citation links selected was two. This also excluded the intermediate publications in the paths [46] (p. 805). Then, we used the "clustering" function to identify publications that are closely connected based on their citation relations [46] (pp. 820–821). Using given parameters, the software identified three distinct clusters (blue, purple and green). Clusters are usually interpreted to represent a topic in the literature. Finally, we used the "Core Publications" function to identify those that have at least four citation relations.

To visualise data networks we used the Cytoscape open source software [47]. We created graphs that depict network layout, degree centrality, and clustering. The size of nodes represents degree centrality: the larger the node, the more times it was mentioned within the SLR database for quantitative analysis. In addition to that, the thickness of edges represents the number of times the two connected nodes were mentioned together, indicating their relevance to each other. By default, the networks were distributed from the largest to the smallest on the graph. We used this tool to analyse two sets of data—keyword co-occurrence and co-authors co-occurrence—in two stages: first, to illustrate the full network, and second,

to narrow it down for further analysis. In case of keywords, we filtered out those combinations that occur only once in the network. The bigger the size of a node, the more frequently the keyword is used. The thickness of the links between the nodes represents a number of times pairs of keywords occur (the thicker the line, the more often the pair of words is used). With respect to co-authors, we focused on the seven largest networks. The same idea applies there: the larger the node the more publications the author has (within this SLR database for quantitative analysis); the thicker the line is between two authors (thickness of the line represents the number of publications they have together), the more often they collaborated within the timespan of the SLR, the more research interests they thereby likely have in common.

Finally, we used a 'word cloud' to illustrate keywords occurrence [48] using WordClouds open source software (see: https://www.wordclouds.com/). The font size of the words represents the frequency of occurrence of the keyword in the literature selected for the SLR.

3 Results and interpreting analysis

3.1 Overview of the gradual refinement of identified publications

A flow chart adapted from the so-called Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [49] was used to illustrate the process of creation of SLR databases for quantitative and qualitative analyses (Figure 4).
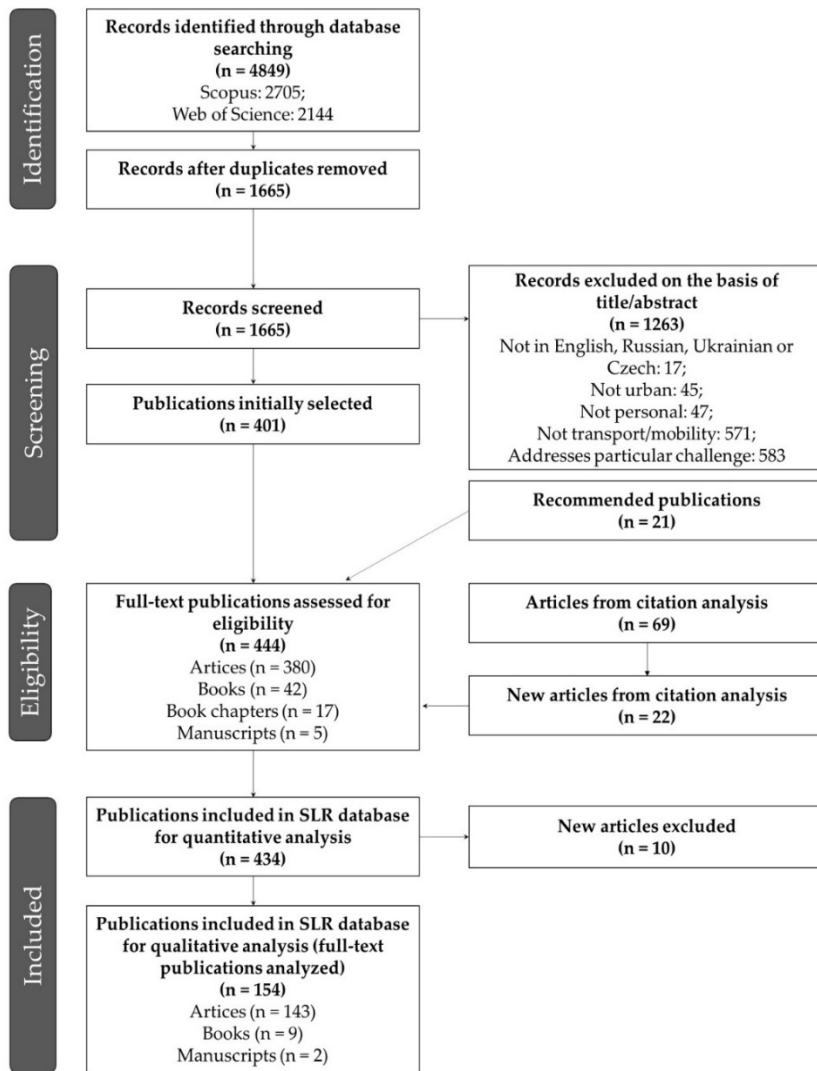
Figure 4. Adapted PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow chart based on Moher et.al. [50].

In total, 444 publications (380 articles, 42 books, 17 book chapters and 5 manuscripts) were assessed for eligibility. Ten of the articles were excluded due to their narrow focus and the remaining 434 publications were analysed using bibliometric methods. The SLR database for quantitative analysis was created based on the relevance of the literature to the Research Questions, partly identified by the authors and experts, and partly through the citation

analysis. Within that database, the SLR database for qualitative analysis was determined. It consists of 154 publications: 143 articles, 9 books and 2 manuscripts dated from 1993 to April 2018.

3.2   Identification of prominent research themes

3.2.1   Citation and co-citation analyses

For this analysis, the SLR database for quantitative analysis was used, which consists of 434 publications (see sections 2.2.1, 2.2.2 and 2.3). Of those, ten publications were recommended by the experts and not available in the Scopus and Web of Science databases. In total, 424 publications were analysed.

As described in section 2.3, the 40 most cited publications within the SLR [46] (p. 807) are illustrated in Figure 5 where each bubble represents a publication that is identified by the primary author's last name(s).
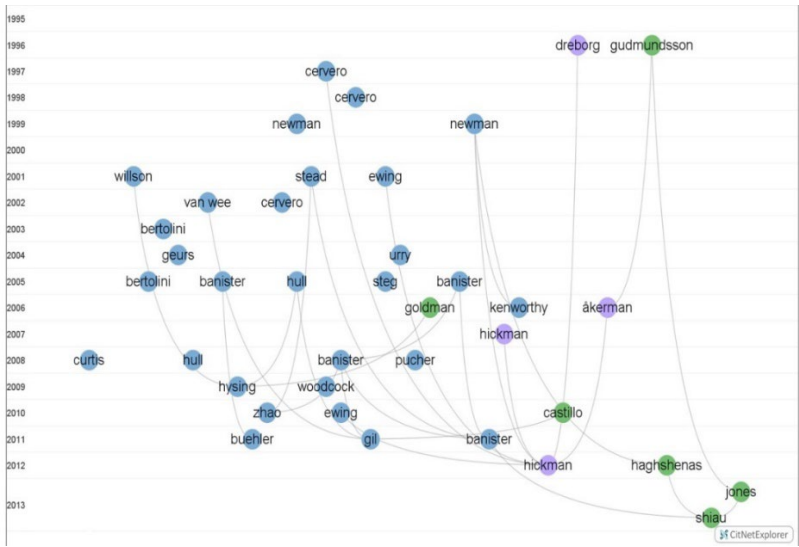
Figure 5. Citation nets. Three clusters of the literature: green represents the *indicators* cluster; purple represents the *backcasting and scenario analysis* cluster; blue represents the *planning and policy for sustainable mobility and accessibility* cluster.

This figure shows citation interrelations (connecting lines) between the selected publications: for example, Åkerman [51] and Jones [52] both cited Gudmundsson [53]. Colours represent different clusters in the selected literature. Three clusters were identified by the software (see Section 2.3). Based on our interpretation these clusters got the following names: *indicators* (green cluster), *backcasting and scenario analysis* (purple cluster), and *planning and policy for sustainable mobility and accessibility* (blue cluster). The clusters are not illustrated as separate entities as they are interlinked through some publications cited by several researchers from different clusters. Moreover, their distribution reflects the proximity of themes. For example, Kenworthy [27] and Hickman [54] from the blue and purple clusters respectively, share some citations, which places them close to each other, while Curtis [55] is depicted outside the network, which means that her work differs from the others in this graph.

A closer look showed that planning and policy for sustainable personal mobility and accessibility should be seen as two separate clusters. They correspond to two distinct fields and two groups of people that deal with their own respective questions—planners and policymakers. That is why we suggest that the blue cluster, identified by the software, should be split up into two—*cluster A* and *cluster B*. The publication by Curtis [55] in this graph is an illustration of the need to distinguish between these two themes as it is located distantly from the other publications.

Details of what publications in each cluster were analysed are described in section 3.3. More publications for each cluster we retrieved through the "Drill Down" function of the software. They were not displayed in Figure 5 due to the limitation of the 40 most cited publications.

3.2.2   Occurrence and co-occurrence of keywords

In total, 775 different keywords were analysed, most of which related to planning for mobility (transport) in urban contexts. The results of the keywords occurrence analysis are presented in a word cloud (Figure 6). A word cloud depicts the frequency of terms related to planning for transitions towards sustainable personal mobility, creating a ranking list. The top five terms identified here were "sustainability" (51 occurrences), "sustainable transport" (42), "transport" (31), "sustainable development" (26) and "sustainable mobility" (24) which is in line with the keywords search.

Figure 6. Keyword occurrence related to planning for transitions towards sustainable personal mobility.

For keywords co-occurrence analysis, we removed these five terms that were the keywords of the primary search and illustrated a network of remaining keywords that occurred at least three times (Figure 7). Those terms show up as nodes and the bigger the node is the more times it was used in the publications (see section 2.3). They represent research themes in this SLR. The biggest nodes in this network are "public transport" (22 occurrences), "travel behaviour" (13), "transport policy" (12), "accessibility" and "governance" (11 each). The term "transition" occurred three times, which means that publications on mobility transitions are represented to a minor extent in this SLR and planning for transitions is not represented. However, transition is often part of the larger discussion, for example "energy transition" or "socio-technical transition". Although, these words are also not commonly used in this SLR as the analysis shows. Moreover, sometimes the studies are about transition towards sustainability but do not use transition theory and are not associated with the field. That is why we analyse fields of mobility and urban planning alongside the field of transition studies.
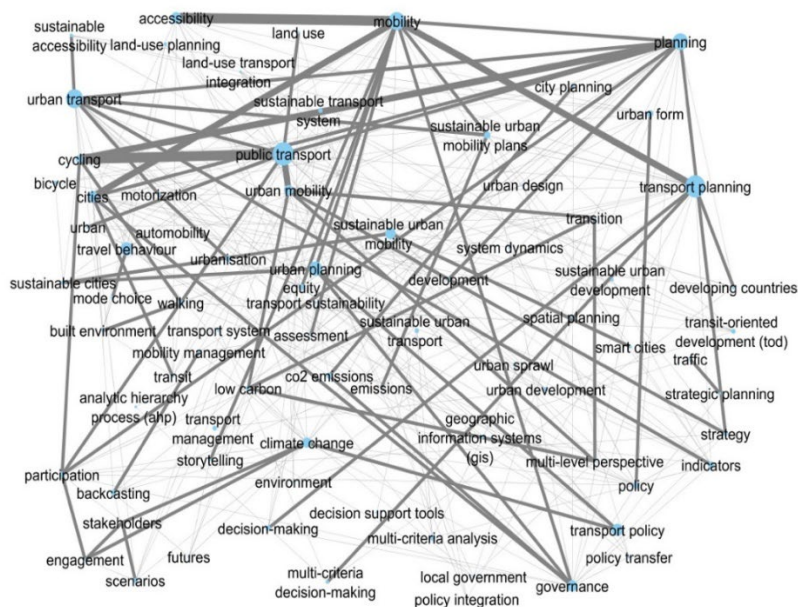
Figure 7. Keyword network. Keywords co-occurrence related to planning for transitions towards sustainable personal mobility.

The connections among the research themes identified through keywords co-occurrence are also shown in Figure 7 (for detailed method explanation see sections 2.2.4 and 2.3). As citation nets (Figure 5) suggest, some articles were assigned to the respective categories but had weak links with the other publications in the SLR selection. The same is seen in the keywords' co-occurrence analysis: there is a large interconnected network of keywords, as well as several small groups of keywords that occur together in individual articles. They were filtered out to better represent the network as they were mentioned less than three times. The thickness of the connecting lines between the keywords reveals the keywords that are commonly used together. For example, the most common combinations of keywords are: "accessibility"-"mobility", "cycling"-"public transport" and "mobility"-"cities". This seems to represent the discussion between two discourses—accessibility and mobility. In some publications of this SLR it was suggested that cycling should be included in the public transport system (see section 3.3.6). Finally, mobility in cities corresponds to the main theme of this SLR. Among those pairs of keywords that got removed in filtering were "public transport"-"sustainable transport", "developing countries"-"sustainability", "sustainability"-"transport policy", "public transport"-"sustainable mobility",

"governance"-"transport",   "mobility"-"sustainable   development",   and "sustainable development"-"transport". They mainly show the importance of sustainability in mobility planning in different contexts and that governance plays a key role in the process.

This analysis shows that, in addition to our four main clusters (indicators, backcasting and scenario analysis, planning for sustainable personal mobility and accessibility and policy for sustainable personal mobility and accessibility), one can identify a cluster of modes of transport and another one for mobility planning in the global South. In the literature the term 'developing countries' appears frequently but we prefer the term global South.

3.3   Description of prominent research themes

This section is focusing on identification and description of prominent research themes. Four of them (sections 3.3.4–3.3.7) were identified through quantitative analysis (section 3.2), the other eight themes (sections 3.3.8.1–3.3.8.8) were identified through qualitative analysis. Moreover, in section 3.3.3 we analysed theoretical and conceptual frameworks used in the literature to get a better understanding of research directions.

3.3.1   Theoretical and conceptual frameworks

Theoretical and conceptual frameworks help us understand the world and ourselves (ontology). We all use them, explicitly, such as is often done in the social sciences or implicitly as often occurs in the natural sciences [56]. Being aware of one's own frameworks is especially important in qualitative inquiries as it provides direction of research goals and outcomes, creates the scope for studies and creates a basis for evaluation of research-related criteria [56]. To evaluate what theoretical and conceptual frameworks that are used in the existing literature, we included this aspect into our analysis.

Based on the SLR database for qualitative analysis, we have identified that 43% of all sources explicitly use theoretical frameworks. All 121 theoretical frameworks determined were categorised in 17 groups. From Table 1 one can see the diversity of fields and disciplines the theoretical frameworks come

from. The largest category is planning theories (12% frequency of use), followed by economic theories (11%) and behavioural theories (9%).

There is no one planning theory that is adopted by everyone, instead there are many different versions of planning theories, which also develop over time. However, as mentioned by Tennoy et.al. [57], the works most referred to are those by Friedmann [58], Healey [59], Flyvbjerg [60], Hull [61,62], and Stead and Meijers [63] in Tennoy et. al. [57]. The difference in the theories comes with an evolving view on possibilities in planning and governance, questions related to democracy, and perceived challenges at the time. That is why it was difficult to distinguish one particular theoretical framework to present here.

The two most utilised theoretical frameworks in this SLR were (socio-technical) transition theory from the theories of change category, and utility theory from the economic theories' category.

Transition theory, sometimes referred to as socio-technical transition theory or multi-level transition theory was developed by Geels [64]. The purpose of it is to facilitate radical change using multi-level perspective in the transitions of the present time, to analyse those transitions that happened in the past, and to assist in the identification and formulation of the pathways to move forward.

The utility theory belongs to the category of economic theories. It deals with choices of individuals by ranking the available options [65]. In transport planning, it is often used in relation to modes choice.

Mobility planning in urban contexts is a complex task and requires a combination of theoretical approaches. Table 1 shows the diversity of theoretical and conceptual frameworks utilised in the publications of the SLR. Several patterns can be observed as researchers utilise theories on planning economy, behaviour, and change. These patterns correspond to the gaps often mentioned in the literature; that we need a change that would not lead our economy to collapse, that planning should be focused on people and their needs, and, finally, that people themselves need to change their habits.

Theoretical and conceptual frameworks outline the direction of the prominent research themes determined in section 3.2. It is important to

understand the fields selected for this analysis and their overlaps to answer present and future overarching questions.

Table 1. Theoretical frameworks used in the publications.

Category	No. of theories	% of occurrence	Theoretical frameworks	Publications
Social theories	7	7%	General sociological theory, assemblage theory, social innovation theory, social practice theory, theories of structuration, grounded theory, Southern theory	[9,12,66-71]
Learning theories	2	2%	Learning theory, social learning theory	[72-73]
Complexity and organisation theories	2	3%	Complexity theory, organisational theory	[12,61,75-75]
Systems theories	9	5%	Socio-technical system theory, complex systems theory, ecological systems theory, social system's theory, systems theory, systems theory, network theory, actor-network theory, social network theory	[12-14,76-78]
Theories of change	10	8%	Theory of change, evolutionary theory, theory of scientific revolutions, critical theories of transformation, theory of socio-ecological transformability, transformative social innovation theory, theories of transformation of cities, transition theory, multi-level transition theory, theories of socio-technical transition	[12,14,66,68,77,79-83]
Development theories	4	5%	Development theory, theories of sustainable development, Western development theories, resilience theory	[9,12,14,84-86]
Urban theories	10	7%	Social theory on urban development, urban development theories, urban theory, contemporary urban theory, critical urban theory, Western urban theory, theories of urban governance, urban fabric theory, sustainable cities theory, theories of cities	[3,4,12,24,73,76,87-89]
Spatial development theories	5	6%	Theories of spatial development, central place theory, location theory, space syntax theory, spatial configuration theory	[13,76,81,85,88,90,91]
Planning theories	10	12%	Transport planning theory, modernist urban planning theories, theory of backcasting, theory of ecosocialisation, C.A. Doxiadis Ekistics theory, urban planning theories, classic planning theory, collaborative planning theory, rational planning theory, planning theory	[6,9,12,57,68,74,75,92-99]

Table 1. Theoretical frameworks used in the publications (Continued).

Policy and governance theories	6	4%	The theory of environmental policy, policy mobilities theory, policy transfer theory, theories on policy change, theories on the state and its policy instruments, evolutionary governance theory	[70,78,100-102]
Political theories	1	1%	Theories from political science	[62]
Institutional theories	6	6%	Institutional theory, theories of empowerment, social justice theory, justice theory, theory of the just city, feminist theory	[7,9,13,78,101,103,104]
Community-oriented theories	3	2%	Participation theories, community-based operations theory, theory of community	[73,105]
Psychological theories	11	7%	Psychological theories, conventional choice theory, consumer choice theory, multi-attribute utility theory, rational decision theory, material possession theory, sociocognitive theory, gender theory, escape theory, flow theory, prospect theory	[13,14,30,68,74,96,106-108]
Behavioural theories	10	9%	Travel behaviour theory, theory of planned behaviour, behaviour theories, theories of communicative action, covering-law theory, discourse theories, theories of discursive constructions, meta-theory of critical realism, value–belief–norm theory, cognitive dissonance theory	[57,66,69,76,79,81,88,94,96,101,109]
Economic theories	17	11%	Neoclassical economic theory, economic location theories, theories of path dependencies, economic theory, Piketty's theory, exogenous theories, theories of political economy, decoupling theory, theories of competitive advantage, theory of externalities, utility theory, utility-based theories, bid-rent theory, financial restraint theory, path dependence theory, modern management theory, public choice theory	[4,12,57,65,68,76,81,88,94,95,110-112]
Data science theories	8	6%	Control theory, game theory, Dempster-Shafer theory, fuzzy theory, analytic hierarchy process theory, rough sets theory, theory for measuring urban material and energy flows, graph theory	[12-14,108,113-115]

3.3.2 Indicators

As was illustrated in citation networks (Figure 5), there are six publications in the green cluster; however, the "Drill Down" function of the software helped us identify 14 more publications that belong to this cluster. The main characteristic of this cluster is the focus on methodology development to utilise indicators according to their diverse purposes.

The earliest publication in this cluster focused on four innovative directions for urban transport [25], derived from sustainable development principles: limitation of human throughput, efficient technological progress, extraction of renewable resources without exhausting them, extraction of non-renewables at the rate of substitution by renewables [53]. These articles further influenced the SLR selection of publications as they were cited in the later publications.

Several methodologies were designed to assess sustainability in urban transport [114,116–119] and perform ecological footprint assessment [120]. Another example of indicators used for evaluation of sustainability was developed by Bulkaen, et.al. [121], where they combined multi-criteria analysis (MCA) and multi-actor MCA (MAMCA) to involve stakeholders into the assessment process. To have a holistic approach to transport planning and assessment of sustainability, a systems approach was proposed by Ngossaha, et.al. [102].

Evaluation was identified as another purpose for indicator use. Indicators can be used to perform comparative studies of transport in urban context through analysing transport systems [122]. Projects for transport planning can be evaluated focusing on different contexts, such as countries of global South, where a corresponding set of indicators should be utilised [52]. Strategies for sustainable mobility can also be analysed using indicators [113,123].

In case of monitoring and evaluating cities, three generations of indicators can be identified [12,124]: classical economic indicators (first generation), end use indicators based on understanding of development (second generation), and holistic and comprehensive indicators (third generation). However, most of the indicators, even of the third generation lack "geo-localized" and people-centred approaches, as well as fail to account for urban dynamics [12,85,86,124].

Articles in this cluster are mainly focused on the development and application of methods for the selection and application of indicators for planning for sustainable mobility.

3.3.3 Backcasting and scenario analysis

Another relatively small cluster of publications is devoted to studies of a backcasting approach and scenario-making as tools for sustainable mobility planning. There was no intention to go into detail with different types of backcasting, however some main points related to the approach are outlined below.

The main influence in this cluster was provided by the backcasting approach [66]. Dreborg [66], who focuses on the envisioned future and possible pathways of getting there (the "debate and decide" process [27] (p. 81)) contrasting to extrapolating trends into the future as it is done in forecasting (the "predict and provide" process). Involvement of the general public and a diverse group of stakeholders would raise awareness and build up commitment to the cause. Moreover, the focus in the temporal dimension of planning would change from short-termism to long-termism by creating vision and goals. A general trend in the approach is that it should have a place for "strategic conversation" [125,126], in other words to be participatory, inviting stakeholders to a dialogue. Backcasting can also be part of a co-production approach (having an input from researchers and practitioners) through a dynamic process [127,128].

Using a backcasting approach and scenario development allows seeing the situation from a new perspective, coming to non-conventional conclusions and posing new questions. For example, using this approach in the UK, transport planning led to the creation of two scenarios of possible future and policy packages for meeting a 2030 target [54]. Additional behavioural and technological changes would be necessary to implement these policy packages [129]. "What-who" interaction helped to create scenarios, relating actions to responsible stakeholders and in that way identifying power relations [79]. One of the interesting conclusions for urban planning in Sweden was that leisure travel can be increased by 30 % without stepping outside of the sustainable pathway by having multinuclear urban planning combined with implementation of IT solutions instead of structurally enforcing travelling (for example, commuting or shopping) [51]. Finally, new questions were asked [130]: "what is the direction of the policy development

over a long period of time? Where can new funding sources be found and how can funding power be devolved? How can land acquisition and its value uplift be monitored and regulated?"

A backcasting analysis through utopian thinking proved to have provided additional value in planning processes as it helps to define the ideal future [92,99].

A generic community planning process model developed by Robèrt and colleagues [26] is based on another type of backcasting; backcasting from boundary conditions for sustainability. This approach supports transitions in a pragmatic, systematic ,and strategic way.

The book linking the three clusters, backcasting and scenario analysis (purple) and planning and policy for sustainable mobility and accessibility (blue clusters A and B), was authored by Hickman and Banister [68]. The book covered a range of topics, from scenario development and participatory backcasting, to emerging approaches in mobility planning and transitions towards sustainable mobility with several examples in different contexts. They also brought up the concept of time and the lack thereof to make effective change. It was also the first time when these authors talked about planning for transitions.

3.3.4 Planning for sustainable mobility and accessibility

This is the largest cluster within this SLR that corresponds to the main theme—planning for sustainable mobility in an urban context. Several themes appear here in this group: urban form, modes of transport and multimodality, planning for accessibility, as well as local context.

Urban form discourse was broadly researched by Cervero and his colleagues. To achieve traditional urban planning with its transit-oriented development, Cervero and Kockelman [65] argued that the following three dimensions (3Ds) need to be taken into account: density, diversity and design. High density, land-use diversity alongside pedestrian-oriented design are favourable for non-motorized travel. In the following study in 2002, Cervero [107] developed a normative framework, where he included generalized cost and travellers' socio-economic attributes to the core 3D dimensions. Parallel to Cervero, Stead [131] analysed the relationship between land-use, socio-

economic factors and travel patterns in the UK, and came to the same conclusion that socio-economic factors play a major role in travel patterns, even larger than land-use characteristics. In 2010, 13 years after the original paper, the number of D dimensions increased to seven, by adding destination accessibility, distance to transit, demand management and demographics [132], highlighting the importance of the local context.

In 2006, Kenworthy presented a framework for decision-making that to a large extent combined the 3D dimensions, critical responses that were later presented as principles of the sustainable mobility paradigm [30] and a vision-oriented approach (similar to backcasting). Kenworthy's framework consisted of ten critical eco-city dimensions that, in addition to the above-mentioned parameters, included the protection of natural urban areas and food-production capacity. Moreover, the sustainability definition in this framework had a fourth, cultural, dimension, contrary to the common triple bottom line definition (that describes sustainability with three pillars: economic, social and ecological) [133].

Multimodality as part of sustainable solutions was presented by Bertolini and le Clercq [134], who also talked about a supply-demand relationship that could be maintained through land-use patterns. The way of integrating public transport and sustainability can be illustrated as a ladder [61], where barriers can be found on each step. This proved to be the case in the UK. Cycling is often seen as part of such an integrated transport system. Examples described here show the importance of integration of cycling into the transport system, supported by suitable policies, as well as raising awareness and education among the traffic participants [135,136]. Another side of integration relates to transport planning and land-use. Many researchers approach it through the concept of accessibility, "what and how can be reached from a given point in space" [137] (p. 207), [9,19,55].

The sustainable mobility paradigm presented by Banister in 2008 [30] brought another perspective to mobility planning: two principles of conventional planning; namely, derived demand and travel cost minimization. These were suggested to be reconsidered based on the sustainability perspective. Moreover, reasonable travel time was recommended to replace travel time minimization. Banister brought ideas of decreasing the need to travel as well as transport and land-use policy measures and technological innovation that would facilitate a change in planning towards more sustainable mobility. On the social sustainability side, the issues of public awareness and acceptability, health, as well as

stakeholder involvement were discussed. Finally, four principles of the sustainable mobility paradigm were identified: "making the best use of technology; regulation and pricing; land-use development; clearly targeted personal information" [30] (pp. 78–79). In the following study, Banister [138] developed the concept of sustainable urban mobility further, accentuating the urgency of change, and posing a question regarding leadership and commitment on the way to achieving a paradigm shift. Moreover, he brought up a rebound effect: when increased individual welfare might lead to increase in kilometres travelled. The interrelation between travel distance, speed and time was discussed the same year [106]. The author argued that the conventional paradigm of minimizing the travel time, thus increasing the speed, is unsustainable, therefore the changes in land-use planning should be applied by reducing the need to travel.

A small number of articles focused on the contextualisation of the planning. Zhao [139], using the example of Beijing, described how urban sprawl occurred and its consequences for mobility. He suggested that increased local autonomy can lead to unsustainable solutions. In a very different context, on small islands, stakeholder participation proved to be useful for the planning process [140].

The transport system is complex and cannot be seen in isolation from infrastructure, energy systems, built environment, and the people who are using it. A number of studies suggest methodologies for integration of transport with the built environment, land-use and energy [91,112,141–144]. However, there is no single methodology that is accepted by everyone. There is an expressed need for a systemic transdisciplinary approach that would include stakeholders with different backgrounds coming both from academia and practice [26,69,91,105,110,145]. In our interpretation, a transdisciplinary approach means interactive knowledge production that is happening in the context of application and provides socially robust knowledge. This stands in contrast to the North American approach, where a "boundary organisation" is seen as a mediator between politics and science [146]. Using our terminology, the North American approach would be considered as 'interdisciplinary'. The literature suggests that in the future, mobility planning should be people-oriented and place-based, and an institutionalisation of practice could be helpful in the process [147,148] that is subject to evaluation [93]. The combination of urban fabric theory and economic assessments is argued to make the acceleration in urban planning possible [4]. However, behavioural change and policy development would still remain a challenge and require additional measures.

The previously mentioned term "accessibility" was often defined as the ability to access places, spaces, labour market, knowledge and experiences. However, a broader definition complements with the allowance of social equity and the use of power and justice systems to achieve it [9,19]. It gives a space to address social challenges through the concept of accessibility.

Several studies of this SLR were devoted to the development of tools to assess accessibility, give planning an alternative view on mobility, and enable comparative analysis based on accessibility [76,95,149]. In all, they enrich the toolkit for work with accessibility.

3.3.5 Policy for sustainable mobility and accessibility

This cluster is the smallest in this SLR and its main focus is directed towards governance and policy making. Co-citation analysis suggests several publications to be the most cited within this selection.

At the same time as Banister published his sustainable mobility paradigm article, Hull [62] published her work on sustainable mobility from the governance perspective. She argued that achieving sustainable mobility requires an agreement on definitions and direction of development among all public sectors that should be involved in the process, followed by equality in decision-making, incentives for the general public to use sustainable mobility modes of transport, and legal and financial support for joint projects among the sectors and authorities.

Policy change was another widely discussed topic. One example is from Örebro, Sweden, described by Hysing [101]. There, three important factors for change were identified: new policy ideas, reorganisation of local administration and entrepreneurs that created a pressure. However, what actually made the change possible was politicians. Another positive example of policy change towards sustainable transport in Freiburg, Germany was described by Buehler and Pucher [150] using the historical view perspective. There, a principle of carrots and sticks was a success factor: car-restrictive measures were put in place while incentivising cycling, walking and public transport.

Literature within this SLR underlines the importance of challenging current prevailing policies and the way they are designed [7,151]. A case in Canada

shows that policies are often developed and implemented in a non-integrated way, which challenges their effectiveness [70]. Policy can be seen as an instrument to assist change, which would also affect politics at the local and global levels [13,14].

Based on the evidence of sustainable accessibility studies [137], Bertolini et.al. argued that policy measures in the Netherlands should be revised. They suggested getting away from the sharp limits of 30 minutes to reach the destination and to replace it with gravity-based accessibility measures: "considering, instead of the sharp limits of a contour (e.g. more or less than 30 min), a more gradual decrease in travel time or cost utility" (p. 219). Bertolini et.al. recommend assessing travel costs instead of the travel time. They also distinguished two types of competition among spatial opportunities: at origins (probability of other destinations to be chosen) and at destinations (related to the number of travellers going to competing destinations).

Urban governance is complex and comprises institutions, socio-technical elements, and networks [89]. There are at least three ways of understanding such a system: vertical (laws, regulations), horizontal (informal flows of knowledge), and infrastructural (related to the built environment and infrastructure) perspectives.

A systems approach in planning [25], as suggested by Goldman and Gorham, helps to see sustainability as a policy end-point, instead of sustainability as a pathway. A similar approach was observed in studies by Kenworthy [27], who suggested to consider sustainability as a vision, as suggested above. Moreover, the authors identified and described four areas of innovation: the "New Mobility" (dealing with "how individuals plan their daily activities"), the "City Logistics" (addressing "the business of goods movement"), the "Intelligent System Management" (infrastructure—public institutions relationship), and the "Livability" (society—transport systems interactions) [25]. Each of these areas can be described through complex systems that require development of new policies and innovation.

3.3.6 Other identified themes

In addition to qualitative analysis of bibliometric studies, this section aims to address the concepts included into the SLR database for qualitative analysis that might have been missed above. To follow up on the themes

identified in section 3.2.2 (Figure 6 and Figure 7), the *modes of transport* and *global South mobility planning* themes will be described below. Moreover, there are some other identified themes that are presented in the literature to a minor extent: *temporal dimensions in mobility planning, global vs local context, decision-making in mobility planning, equity, justice and equality in mobility planning,* and *the role of institutions in planning and co-production of knowledge.*

The need for behavioural change was expressed throughout most of the studies in this SLR. Planners and decision makers cannot achieve a transition towards sustainable mobility without involving the end users into the process [13,152]. An aging population (or demographic transition) starts becoming a concern in many places across the world too when advancement in medicine and longer life creates new challenges for mobility planning [12–14].

3.3.6.1 Modes of transport

The transport modes discourse often focuses on the land-based means of transport, specifically on the discussion of public transport replacing private cars. Electrification is argued to be the future, however, only replacing fuel-based vehicles with electric ones does not lead to fully sustainable solutions [2,4,115,153] as it will not improve some sustainability related problems like lack of urban space and traffic jam-induced stress.

Coverage of different modes of transport was another widely discussed topic. Several studies argued for some specific means of transport [4,154,155], while others argued for integrated multimodal transport systems that include private vehicles, public transport, shared services and mobility on demand [71,77,156–158].

The passenger perspective was addressed through studying mode choice between public transport and private cars [94,96,109,159]. It has been identified that location, socio-demographic parameters, psychological and cultural traits, as well as space allocation for modes of transport, are the major factors affecting the mode choice.

3.3.6.2 Global North and global South mobility planning

A majority of the literature in this SLR studied and analysed cases in the global North. Relatively few studies focused on the global South have been captured through the selections done in this SLR. This can be explained by the selection of journals in Scopus and Web of Science databases as they do not include journals edited in the global South. This paper therefore does not claim to provide a full picture of the studies, but rather to touch upon several issues identified within the scope of this SLR.

When talking about the global South, local context plays a crucial role in the planning for mobility as the solutions might be very different from those in the global North. Lahore's example (Pakistan) claims that insufficient institutional capacity led to a change from a more sustainable to a less sustainable transport system that even less meets the needs of the citizens [160]. International investments can change power relations and affect the planning process by changing the direction of development of a target country [67,160]. For example, in this way technical solutions can be enforced in a way that was not initially planned by the local government.

Several criteria/indicators were developed to support planning for sustainable mobility in the global South that were different from those for the global North [84,85]. Finally, based on the experience from Singapore, policies that enabled sustainable development in fast developing cities were outlined [161].

3.3.6.3 Temporal dimensions in mobility planning

The concept of time was often discussed within this SLR in different contexts. Four different ways of talking about time were identified: in terms of travel time, in terms of planning goals and strategies, in terms of short- or long-term thinking, and, finally, in terms of urgency for change.

Many studies were devoted to travel time and time budgets (how much time can be spent on traveling on average) [67,84,90,162]. First, mobility planning was aimed to have faster and more efficient transport systems, however, with the introduction of sustainability into the mobility discourse [30], the dialogue shifted towards slow and safe mobility [106], with additional benefits of health and other activities that can be done while traveling. In a broader picture, the discussion shifted towards slow and fast lifestyles [129].

Another perspective on time was brought up within the planning process. Trends, targets, and strategies are tied to the time plan. They affect the pace of adaptation in the planning process, technology and policy innovation. In turn, this translates into the human factor: how much time decision-making and bureaucratic processes take [13,79,87,163,164].

In the literature, short- and long-term planning are naturally combined in backcasting and other processes that start with visioning. A detailed description of the body of literature devoted to backcasting and scenario analysis is provided below (see section 3.3.5).

The indirect reference to time can be identified in discussions around urgency for change. The Brundtland Report [165] gave the first push for discussions around the need for different planning practices [30,54,68,100,106,135]. Increasing emissions, alongside other factors, added concrete reasons for change [123,138,166], and the more recent Paris Agreement's 1,5-2 degree target created additional pressure for change. Rapid urbanisation concepts, in turn, included new stakeholders in the discussion [101,125,139,140,167–169]. Finally, the need for transition towards sustainable mobility was underlined [26,80].

3.3.6.4 Global vs local context

We are part of the global societal system and our local context identifies our challenges and possibilities, giving advantages and disadvantages for implementation of a rapid change. Globalisation comes with shared technologies and knowledge; however, it brings along goals (e.g., the SDGs), agendas (e.g., the New Urban Agenda) and recommended plans (e.g., Sustainable Urban Mobility Plans [170]). While this can be seen as a push towards sustainable development at the global level, one of the important challenges lies in the translation of it down to the local level.

It is widely known that there is likely no solution for everything and that just transferring knowledge and solutions between countries and contexts is not likely going to be enough. Many studies concluded that there is no universally suitable mechanism for the integration of goals at different levels and translation of them into everyday tasks [6,12]. At the local level, the process is often constrained by barriers of rebound effects, conflicting visions at different levels, lack of consensus among stakeholders, path dependencies (when decisions made in the past could affect solutions in the future),

diverse needs of passengers, and institutionalisation of policies [74,87,171,172]. For example, in China rapid urbanisation brought increased private transport, relocation of residents and inadequate service provision [88,173]. Even within the same geographic and political context, there could be difference in mobility patterns (mobility cultures) [171]. Thus, local context creates a core for planning processes [6,9,12,74,87,88,141,156,171–175].

3.3.6.5 Decision-making in mobility planning

Emberger and colleagues [176] identified three approaches to decision-making in Europe (vision-led, plan-led and consensus-led) and five levels of public participation (provision of information, consultation, making decisions together, acting together, and supporting independent stakeholder groups). Later, taking a plan-led approach as a base, the researchers developed a process for decision-making. Finally, they tested the transferability of this approach in the context of South East Asia, where four elements were identified as transferable (objectives, policy instruments, barriers and strategies) while others had to be changed.

The other literature in this SLR has described several methods for decision-making processes for mobility planning [72,177,178].

3.3.8.4 Equity, justice, and equality in mobility planning

Questions of urban equity (rights, opportunities, accessibility and affordability [8,9]), justice (electoral, procedural, distributional justice as well as enforcement [8,9]), and gender are often framed as part of social sustainability [14]. In the context of the global South, justice and gender equality are often neglected in planning processes [10,67,74,83,179].

As mentioned before, social justice and equity are emerging concepts in social sustainability of cities [7,11,12]. They can be analysed through the concepts of accessibility [9,19], utilisation of justice theory [104], or frameworks such as the one described by Boisjoly and Yengoh [73].

3.3.6.7 The role of institutions in planning

In many publications within this SLR, institutions were mentioned as important factors for achieving the change. Planning always depends on space and time, and decisions made in the past could affect solutions in the future, creating path dependencies. Institutional change is necessary for stepping out of the path dependency [12,78,94,160]. Five groups of institutional barriers can be identified: financial, cultural, legislative, political, and technical [13] and a systemic approach is required to overcome them.

3.3.6.8 Co-production of knowledge in planning

The final theme of research in this SLR is about co-production of knowledge in planning processes. Lack of knowledge on co-production among transdisciplinary researchers and practitioners has been emphasised throughout this SLR [9,12,75,145,180]. The studies from the global South underline the importance of co-production between different thought collectives, attention to the existing social organisation in the local context, and the diversity of stakeholders to be involved in the planning process to enable learning, experimentation and creation of adaptive transport systems [181].

3.3.7 Major bodies of literature

We know that the number of citations in itself may not show the relative influence of a certain publication. Still, as a complement to other analyses, we think it is important to identify the most cited publications. We expected this to further help to analyse the prominent research themes identified above (see section 3.2).

In the process of SLR as described in section 2.1, 434 publications were selected (this refers to the SLR database for quantitative analysis, see section 2.1.3). Firstly, to determine the publications that had been cited the most, a search for the most cited of the selected publications was conducted using the Scopus and Web of Science databases. This search was limited to publications that had been cited at least 100 times. This resulted in 16 of the publications being highlighted. Within those 16, it was found that Cervero and Kochelman [65] was the most cited with 1190 citations globally.

Secondly, a search for citations within the initial 434 publications was conducted to compare results. It was found that 13 publications of the previous 16 were still among the most cited, with the article by Banister [30] being the most cited with 51 citations. The results of this process are shown in Table 2.

The articles in Table 2 were already described above (see sections 3.3.6 and 3.3.7) suggesting coherence in the results from two types of analyses. These articles do not represent the key concepts in the field, but they are rather major bodies of literature and it is useful to be aware of them when outlining the field and making one's own judgements.

Table 2. List of the most cited publications.

Author(s)	Year	Publication title	Publisher	No. of citations (Scopus & Web of Science)	No. of citations (within the SLR)
Cervero, Robert, and Kara Kockelman	1997	Travel Demand and the 3Ds: Density, Diversity, and Design	*Transportation Research Part D: Transport and Environment*	1190	30
Ewing, Reid, and Robert Cervero	2010	Travel and the Built Environment: A Meta-Analysis	*Journal of the American Planning Association*	1040	22
Banister, David	2008	The Sustainable Mobility Paradigm	*Transport Policy*	562	51
Pucher, John, and Ralph Buehler	2008	Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany	*Transport Reviews*	534	13
Woodcock, James, Phil Edwards, Cathryn Tonne, Ben G Armstrong, Olu Ashiru, David Banister, Sean Beevers, et al.	2009	Public Health Benefits of Strategies to Reduce Greenhouse-Gas Emissions: Urban Land Transport	*The Lancet*	452	12

Table 2. List of the most cited publications (Continued).

Dreborg, Karl H.	1996	Essence of Backcasting	*Futures*	305	10
Cervero, Robert	2002	Built Environments and Mode Choice: Toward a Normative Framework	*Transportation Research Part D: Transport and Environment*	302	10
Kenworthy, Jeffrey R.	2006	The Eco-City: Ten Key Transport and Planning Dimensions for Sustainable City Development	*Environment and Urbanization*	165	below 5
Stead, Dominic	2001	Relationships between Land Use, Socioeconomic Factors, and Travel Patterns in Britain	*Environment and Planning B: Planning and Design*	143	14
Bertolini, Luca, Frank le Clercq, and Loek Kapoen	2005	Sustainable Accessibility: A Conceptual Framework to Integrate Transport and Land Use Plan-Making. Two Test-Applications in the Netherlands and a Reflection on the Way Forward	*Transport Policy*	132	11
Goldman, Todd, and Roger Gorham	2006	Sustainable Urban Transport: Four Innovative Directions	*Technology in Society*	125	below 5

Table 2. List of the most cited publications (Continued).

Zhao, Pengjun	2010	Sustainable Urban Expansion and Transportation in a Growing Megacity: Consequences of Urban Sprawl for Mobility on the Urban Fringe of Beijing	*Habitat International*	121	below 5
Hickman, Robin, and David Banister	2007	Looking over the Horizon: Transport and Reduced CO_2 Emissions in the UK by 2030	*Transport Policy*	114	10
Banister, David	2011	Cities, Mobility and Climate Change	*Journal of Transport Geography*	107	5
Åkerman, Jonas, and Mattias Höjer	2006	How Much Transport Can the Climate Stand? - Sweden on a Sustainable Path in 2050	*Energy Policy*	105	8
Hull Angela	2008	Policy Integration: What Will It Take to Achieve More Sustainable Transport Solutions in Cities?	*Transport Policy*	104	15

3.3.8 Geography of case studies

The final type of analysis helpful to describe prominent research themes is the geographical distribution of case study locations across the world (where the case studies were conducted). The selected 434 publications have a wide geography of case study locations. This is illustrated in Figure 8, spanning 72 different countries, with the largest number of publications from China and the UK (31 publications each), followed by Sweden (23) and Spain (20). Several publications had a broad focus on Europe, global South and Asia. They were not included in Figure 8, as only studies related to individual countries are counted there. The largest number of studies has been conducted in Europe 56% (230 case studies) and Asia 23% (96 case studies). Some other publications that do not show up in Figure 8 are those that do not have a geographical focus since they are conceptual, methodological or describing various models.
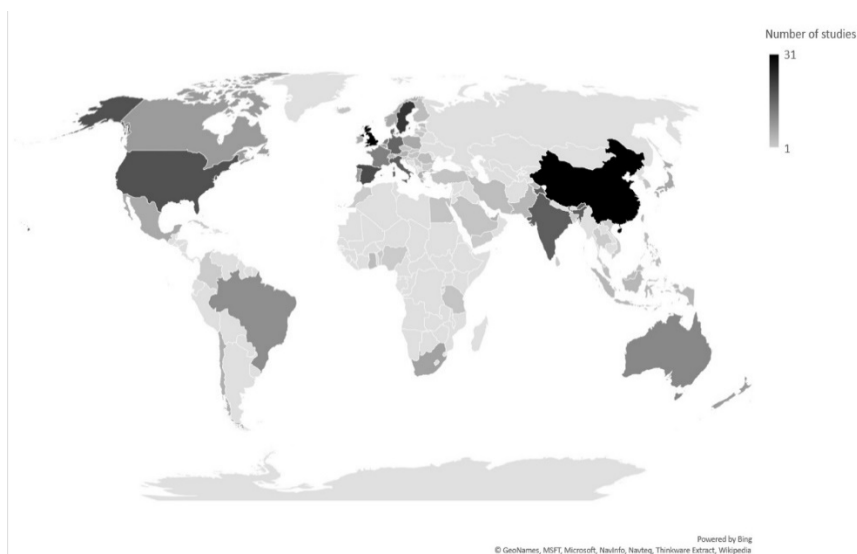
Figure 8. Number of case studies per country.

Figure 8 illustrates some limitations of the geographical scope of case studies in this SLR. This includes a low representation of studies in the global South. Several reasons for this limitation can be suggested. First of all, as suggested above, in section 3.3.8.2, journals edited in the global South are not part of Scopus and Web of Science databases. Language could be seen as another explanation to a limited geographical scope. As was mentioned in section

2.1.1, publications written in languages other than those that the authors' have a sufficient level of understanding of were excluded. Some of them could have had case studies of the local contexts. Finally, research finance plays a big role in where the research is done: often money is allocated for local projects to address the issues there. Establishing new partnerships, especially with places of different culture, are time and resource consuming processes with many bureaucratic barriers and often seen as too demanding for pursuing.

3.4 Different bodies of literature

In this SLR we had an inquiry into the three bodies of literature that were related to mobility, urban planning and transitions. Keywords occurrence and co-occurrence analyses (Figure 6 and Figure 7) showed that mobility and urban planning are closely related. Prominent research themes of these two fields were outlined above in section 3.3. Transition studies, though, have not yet been characterised. A brief summary of transition studies related to mobility are presented below.

Based on the qualitative analysis, we have identified that the need for transition is no longer a question [100,182]. Current research in transition studies is addressing levels at which transition should or could be happening and who should be involved [102,183,184]. The multiple level perspective (MLP) [185] describes three levels where the change can be happening: niche, socio-technical regime, and socio-technical landscape. It was identified that technical transition would not be enough to achieve a sustainable state. It should be happening at the socio-technical level, meaning that society has to change too. Politicians, institutions, and communities need to cooperate in such a radical change. New knowledge created through participatory approaches and comparative studies would benefit the planning process. As co-benefits, it would allow a shared understanding of the sustainability discourse, as well as a combination and reconfiguration of existing solutions and governance processes. From retrospective transition studies we know that the system expected to change should be ready (for example, infrastructure should be in place) and there should be acceptance from people. Urban transitions of today should be based on causal dynamics, comparability, and acknowledgement of differences, as well as they should be planned [12,80,82,87,94,100,102,183,184,186,187].

This brief summary shows that the bodies of literature in planning and transition studies discuss similar topics and face similar challenges, however it seems that collaboration between them is lacking. If a transition were to be successful, the literature suggests that it should be planned for, preferably in a co-production manner.

3.5 'Organisation of the field'

3.5.1 Keywords

In order to stay up to date with the research, it is useful to create alerts in the databases, such as Google Scholar. As outlined in section 2.1.1, there are some keywords that are useful for the future search strategies (see: Figure 2. Reduction of keywords scheme.). Moreover, further analysis of keywords occurrence and co-occurrence (Figure 6 and Figure 7) showed other useful keywords. Depending on what the next research questions would be, different combinations of keywords could be used.

3.5.2 Main journals

Another way of monitoring the fields is through subscriptions to the journals. To identify what the main journals in the field are, we conducted the following analysis. Figure 9 shows the number of articles selected through systematic literature review per year published in the top journals (that have more than 10 publications within this SLR) from 2008 to 2018. It shows that on average there are articles relevant to this SLR in three to four out of five journals each year and the highest number of relevant articles was published in 2013. The total number of journals within the 434 selected publications is 147. The main journals identified in this study are *Transport Policy* (total, 22 articles), *Journal of Transport Geography* (total, 19 articles), *WIT Transactions on Ecology and the Environment* (total, 16 articles), *International Journal of Sustainable Transportation* (total, 14 articles), and *Transportation Research Part A: Policy and Practice* (total, 11 articles). One can see that the total yearly number of relevant articles (see the top of Figure 9) has approximately doubled from 17 in 2008 to about 45 in 2015–2017. This means that the academic community likely has evolved.
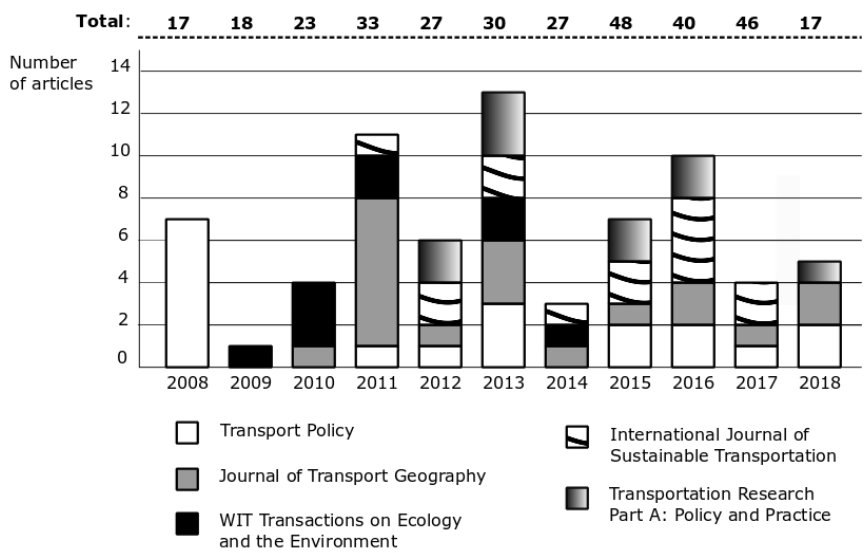
Figure 9. Number of articles about planning for transitioning towards sustainable personal mobility in total and in the top 5 relevant journals from 2008 to 2018. Source of data Scopus and Web of Science.

Interestingly, five of the most cited publications identified in Table 2 were published in the main journals identified in Figure 9. The other 11 articles were published elsewhere, which means the topic of planning for transitions towards sustainable personal mobility could be found in a diverse range of journals and, significantly, that there is no undisputed leading journal in the field.

3.5.3   Scientific communities

The third way of staying up to date with research is to follow certain researchers. For this purpose, we have analysed scientific communities within this SLR. A key authors network analysis (for method description see section 2.3) showed 215 networks in total: 90 publications were written in pairs; 51 publications were written in groups of three; 31 publications in groups of four; 12 publications in groups of five; 16 publications in groups of six; 6 publications in groups of seven; 2 publications in groups of eight and, finally, 7 publications in groups of nine or more authors. Only the largest networks are illustrated in Figure 10.

Figure 10. The largest networks of co-authorship with countries of authors' affiliations.
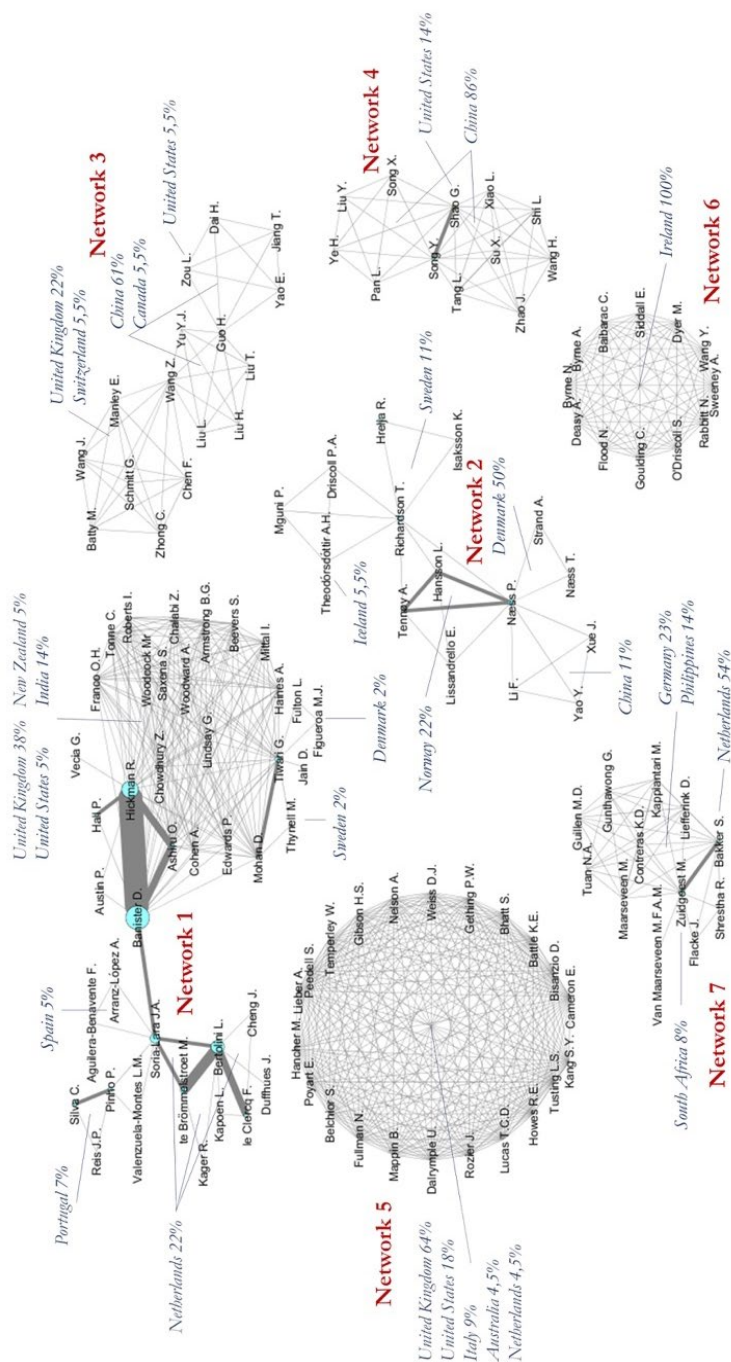
The three largest author nodes are David Banister (with 14 publications in this SLR selection), Robin Hickman (ten publications in this selection) and Luca Bertolini (eight publications in this selection). They belong to the same network—Network 1, the largest one (represented by 19 publications). Moreover, between 2008 and 2018, Banister and Hickman worked together tightly, and within this time published six common works. This network of authors is coming from five different countries (with the majority from the United Kingdom) and have diverse expertise: planning, geography, environmental science, social science, and transport science. All together, they create a multidiscipline thought collective that focused on topics discussed above: accessibility [188] and "mobility environments"—another way of combining land-use and mobility planning [97], planning for sustainable mobility [111], challenges of interpretation of goals into indicators [189], dialogue processes among stakeholders [190] and, related to that, integration and creation of knowledge [191]. In several articles, the researchers mention the need for behavioural change and policy implementation in order to create a modal shift away from the current dominance of private cars [192]. As for modes of transport, a combination of train and bicycle was analysed in the Dutch case [193]. Finally, researchers in this group studied the time required for decision-making in the given context [163] and developed sustainability pathways for non-OECD countries [166].

Network 2, the second largest network is based on six publications written by planning researchers from five countries and represents another thought collective. Four of the publications are about the importance of co-production of knowledge from experts and researchers to meet the goals and targets [57,81,194,195]. Two more publications in this network have a bit narrower focus. One is on radical policy change and its conflicting implications [103]. The other one is questioning the electrification of cars as a single technical fix towards sustainable mobility [153] and comes to the conclusion that it, if it would be the only focus, would not break the path-dependency of the car-based transport system, but rather take away financial and institutional resources from efforts to promote non-motorized and public transport.

Figure 10 contains two international networks (Network 3 and Network 4) that focus on quantitative analysis of urban travel in China [167,168,196–198].

Network 5 illustrates a multidisciplinary group of researchers coming from five countries working on the assessment of accessibility worldwide with the

help of creation of a travel time to cities map [199]. Within this SLR these researchers have only one publication together, making it the largest network of collaborators for an individual paper. Another single article network (Network 6) was focusing on design for sustainable built environment [200].

Finally, Network 7 is international and multidisciplinary, focusing on policy for sustainable mobility in the global South [169,201].

The analysis shows the diversity of research topics and countries of affiliation. The largest network covers a broad range of topics and, as has been discussed above, has some of the most cited publications within and outside of this SLR (according to Scopus and Web of Science database analysis, see section 3.3.9). However, most of the publications in this SLR are written by small groups of authors, often working on the local scale.

4 Concluding discussion and further work

This systematic literature review has aimed to outline and map the main themes related to planning for rapid transitioning of personal mobility towards sustainability as well as their development in the past decade, analyse overlaps of different bodies of literature, and create an organised view of the field for continued information retrieval.

To sum up reflections throughout the paper, SLR as a method has its inherent limitations by not being able to identify literature outside the parameters given by the researcher. To address that, expert advice was collected (resulting in 21 additional publications) and citation analysis was performed (giving another 12 relevant publications). Although the selected articles do not cover an exhaustive list of publications in the fields of mobility, urban planning and transitions, the literature analysed here should be seen as an initial map of these areas (up to April 2018) with observations of general trends and outlines of the main gaps in research in the respective fields and their combination.

The following paragraphs briefly answer the posed Research Questions (RQs):

- RQ1: What are some prominent research themes within context-adapted urban planning for rapid transitioning of personal mobility towards sustainability?

Four different ways of talking about the temporal dimension in mobility planning have been identified. This includes travel time, planning goals and strategies, short- or long-term thinking, and, finally, the urgency for change. However, not much literature was found that discussed how we can make change towards a sustainable state happen quickly enough to meet the goals and strategies identified on local, national and international levels, keeping in mind a long-term perspective and meeting passengers' needs to move about freely and easily.

In order to understand a large picture where rapid transitions could fit, prominent research themes were also identified. The literature that was selected in the SLR process brought up a number of themes: *planning and policy for sustainable mobility and accessibility, indicators, backcasting and scenario making, modes of transport, decision-making in planning, studies of global North and global South,* as well as overarching themes of *equity, justice, gender, the role of institutions and co-production of knowledge in planning processes*. Most of the publications were devoted to *planning*: who we are planning for, what the best solution is and what we focus on. However, not so many of them focus on the *how*: how we prioritise actions, how we make sure all the important stakeholders are included in the process, how we plan using a people-oriented, place-based approach, and how we make all of this happen fast enough to sustain present and future generations.

- RQ2: How did the identified themes evolve during the past 10 years?

The analysis also shows a shift in the planning approach as the field seems to move away from the predict-and-provide [100] to the long-term-focused visioning approach [26,92,100,127–129]. Social sustainability is underrepresented in this selection of literature, which might be indicating a minor integration of social issues in planning processes. Recent literature, though, emphasises the importance of addressing equity, justice, and equality when planning for sustainable cities. The analysis shows that there are many indicators available for different purposes. However, it was found that the main question is how to integrate them to meet all the local, regional and national requirements, as well as international agreements, such as the

SDGs. Participatory approaches in planning, particularly backcasting and co-production of knowledge, are in trend, assuring a combination of academic and practical knowledge, as well as access to other types of knowledge, such as indigenous knowledge. It shows that planning is acquiring a systems approach, where needs of diverse stakeholders are addressed in relation to sustainability. So far, these approaches have not proven to bring necessary changes, but they have raised awareness among stakeholders and the general public, which is the first step to major changes.

- RQ3: What are the main related bodies of literature and to what extent do they overlap?

Planning for transitions was mentioned only once [68], and as identified above, transition and planning scholars are seemingly not collaborating with each other. In this study, it was found that this could be due to the differences in epistemic communities and perspectives taken by the scholars. We found that planners typically look forward, while transition scholars analyse the past, create pathways for transitions, and recently also started analysing the present. In all, their discussions tend to be parallel since it is not common to plan for transitions.

- RQ4: What is the "organisation of the field"?

As for "organisation of the field", in this SLR we identified that there is no undisputed leading journal. The authors' network analysis showed a clear dominance of one research group with the leading researchers David Banister, Robin Hickman and Luca Bertolini. Their research network is international and multidisciplinary and covers several topics within transport research.

To our knowledge, no SLR on the crossroad of the fields of mobility, urban planning, and transitions has been done before. The closest study that we have found that can be compared to our study was done by Wittstock and Teutenberg [202] and focused on transformations towards sustainable public transport. Their analysis can be seen as a complementing part to our analysis, as it covers one of the aspects of sustainable mobility: public transport. Our study, in contrast, has a systemic approach and analyses planning for sustainable mobility as a whole, also including, for example, walking and bicycling. Therefore, our study can likely be of value for scholars and practitioners working with questions of urban planning, sustainable mobility and to some extent, transition studies.

To conclude, the main knowledge gaps identified in the studied literature relate to the question of accelerating the transition towards sustainability. This might be an accurate reflection of a knowledge gap. It might also be related to a possible variation in terminology and approaches used to address change. Still, the many synonyms investigated and related topics investigated suggest that the gap is accurate in relation to the fields of mobility, urban planning, and transition studies.

Given the identified knowledge gaps, we have several recommendations for future studies within the overarching theme of accelerating transitions towards sustainable mobility. We see two main types of studies that could be done. One could use either a systemic perspective or do research on specific elements of mobility systems and approaches. Among the latter, more analysis is required on behavioural change, such as motivating sustainable travel habits, and what policies need to be implemented to move towards sustainability in an integrated way. Furthermore, institutionalisation of planning capacity and social sustainability in mobility planning are other questions that need to be answered. It would also be interesting to analyse the temporal dimension in mobility planning in terms of technological change and policy development and implementation, and what role institutions play in this process.

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Paper B

Sustainable Transport Futures: Analysis of the Selected Methodologies Supporting the Planning Process towards Achieving Goal 11 Sustainable Cities and Communities

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Sustainable Transport Futures: Analysis of the Selected Methodologies Supporting the Planning Process towards Achieving Goal 11 Sustainable Cities and Communities

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Abstract

A quarter of energy-related greenhouse gas emissions (GHG) originate from the transportation sector. Continuously increasing demand for transportation services worldwide is one of the main urban challenges addressed by Sustainable Development Goal 11, target 2. One way to address this issue is to develop an integrated transportation system that can ensure confidence and comfort for the passengers. This will contribute not only to the customers' experience, but also to operators and authorities through sustainable, cost effective and profitable services. Conversely, the lack of such a system or a poorly managed system prevents the economy and society from realizing its potential.

In the transition towards sustainability the planning process of complex systems such as transportation, often requires supportive tools and methods, such as futures methodologies that assist decision making by providing information about possible futures. In today's rapidly changing environment, forecasting tools do not always provide the expected outcomes since it is difficult to predict all the unexpected events. Therefore, there is a demand for alternative methods that not only grasp the constant changes, but also create additional value (for example, meeting the needs of multisectoral collaboration and creation of common vision).

The present article investigates the usefulness of three such methodologies, namely backcasting, foresighting and SymbioCity, for the planning process of the bus park and railway station in Kisumu, Kenya and Centralen in Gothenburg, Sweden. The paper's contribution is a description of the Kenyan transportation system (which has not been studied in detail before),

planning process and pertinent issues related to the stations both in Kisumu and Gothenburg, located in the sharply contrasting contexts of global South and global North respectively. On the basis of field research, interviews and feasibility study of futures methodologies, the paper concludes that backcasting is the most suitable of the methodologies for both places, since it can be applied at a small scale, provides creative solutions and has a high level of integration of stakeholders. Furthermore, the paper examines the application of the futures methodologies in multisectoral urban transitions apart from transportation and draws conclusion on what can be learnt from it.

Key words: *sustainability, development, transition, transportation, planning process, multisectoral collaboration, current state, backcasting, forecasting, bus park, railway station, Kisumu, Kenya, Centralen, Gothenburg, Sweden*

1   Introduction

Transportation has not always featured on development priority lists. It was not part of the UN Millennium Goals, but it is included in Agenda 2030's Sustainable Development Goal (SDG) 11: "make cities inclusive, safe, resilient and sustainable". It's Target 11.2 requires all states "by 2030, [to] provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notable by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (UN n.d.). The transportation sector has several leverage points that can be influenced. They are closely connected to demographic changes. Factors, such as ageing population, growth of the middle classes, and increasing integration of women within the labor market increase demand in mobility. It is both a challenge and an opportunity for development.

One of the main challenges facing cities worldwide is to meet constantly increasing demand for transportation services. A well-planned public transportation system provides passengers confidence in their daily mobility. Conversely, when the system does not function adequately, neither a city nor its inhabitants can realize their true economic potential. This is often the case in rapidly growing urban cities such as Nairobi (Daganzo, et al. 2007, Becker 2011, Graeff 2013) and Kisumu. At the same time, Gothenburg – which was awarded a Climate City 2015 prize in the Earth Hour City Challenge from Worldwide Fund for Nature (WWF 2015) – faces several transport challenges related to carrying capacity, air pollution and transition towards a sustainable system (Cullberg, Montin and Tahvlizadeh 2014). These require an understanding of how the system works, its strengths, weaknesses and possibilities for improvement.

Aim and scope

This paper investigates the usefulness of backcasting methodology in the planning process of the bus park and railway station in Kisumu, Kenya and Centralen in Gothenburg, Sweden, compared to standard forecasting methodologies. Moreover, it examines applications of the futures methodologies in multisectoral urban transitions other than transportation and draws conclusion on what can be learnt from it. Both cities face challenges for transitioning towards sustainability, within which the respective study sites have strategic importance. The paper does not provide full descriptions of the futures methodologies (backcasting, foresighting, SymbioCity approach), which are readily available elsewhere, but concentrates on the main aspects related to their applicability in diverse

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contexts. Since Gothenburg's planning process and current situation have been studied to a greater extent than Kisumu, special attention is devoted to Kisumu, for which only limited documented data exist.

2   Methodology

Two main themes are investigated: the respective planning processes and current state of the stations in Kisumu and Gothenburg. In order to understand the planning process in Kisumu, learning about Kenya and its transportation, document studies and 13 interviews were conducted. For the Swedish context, a literature study and two interviews were conducted.

To better understand the suitability of the particular futures methodologies (backcasting, foresighting, SymbioCity approach) in the planning process, these were analyzed based on the framework proposed by Baumann and Cowell (1999). Backcasting can be used as a supportive tool in the decision-making process, which with time developed strong a focus on sustainability. Contrary to the other selected methodologies, a backcasting exercise produces a strategy towards achieving the locally defined goal (Holmberg 1998). Moreover, it is recommended as a planning tool by the UN (UN n.d.).

The research process includes the field studies, which require appropriate preparation, implementation, and analysis methods and techniques. Prior to the field studies the following issues were taken into account: the research ethics (ESRC 2015), field study (Mikkelsen 2005) and positionality (Simmel 1908, Godbole 2014). While in Kenya and Sweden, methods of sociological primary research (Driscoll 2011) were applied: observation (Agar 1980, Scheyvens and Storey 2003, Kawulich 2005), semi-structured interviews (Arksey and Knight 1999, Burton 2000, Flowerdew and Martin 2005), the "snowball" technique (Arksey and Knight 1999, Scheyvens and Storey 2003) and survey (Burton 2000, De Vaus 2013). This was followed by analysis using SWOT (Maylor 2010), stakeholder management (Thompson 2015) and futures methodologies in the planning process (Amara 1991, Dreborg 1996, Baumann and Cowell 1999, Holmberg and Robèrt 2000, Vergragt and Quist 2011, Ranhagen and Groth 2012, Kuosa 2014).

3   Results and analysis

3.1 Planning processes in Kisumu and Gothenburg

The planning processes of Kisumu and Gothenburg differ substantially. Due to the small capacity in Kisumu's City Planning Department, most planning

services are outsourced to private actors. The standardized procedure defined by the national government is followed (E. Otieno 2015, M. Otieno 2015). Currently there is one large plan - the *Integrated Strategic Urban Development* (ISUD) plan – that is in the process of being enacted into law in order to ensure the legality of the document and its legal enforceability (KAM 2016). Its main purpose is to guide new investment, rather than being a mandatory master plan. Bureaucratic procedures and the reactive approach of the local planers constantly delay the planning process. Lack of long-term vision is another challenge that has to be addressed urgently (Eising 2015, E. Otieno 2015).

At the time of the empirical study, work at the railway station was frozen. Nevertheless, on the international level, Kenya Railways has a big developmental project, which also involves Uganda, Burundi and Rwanda (Mumo 2014). The main aim of the project is to build a standard gauge regional system (since the current one is old, partly destroyed and does not correspond to international standards). The project has 2 consecutive phases. The first phase involves the Mombasa-Nairobi line (by July 2016, 75% of work was complete), while in the second phase, the railway will continue from Nairobi to Malaba (the border town) through Kisumu. The second phase has been confirmed by the government in 2016, with up to 85% financed by the China Exim Bank and 15% by the Kenyan Government (Mutambo 2016, Mwende 2016).

For the next 15 years the Kenyan government has picked five priority SDGs for primary development. Goal 11 is not one of them, which means that the transportation sector will remain as a secondary area of interest (Muchangi 2015). In Sweden, every municipality/city decides for itself whether to include the SDGs in their planning or not and which ones are the most appropriate. Gothenburg's Climate City 2015 award, for example, shows local authorities' willingness to work and report on the progress towards achievement of the SDGs (WWF 2015).

As for Sweden, the planning process there is structured and well defined. Considerable attention is devoted to the preparatory stage. Consultations with the regional state authorities and municipalities are implemented on the early stages; consultations with the citizens on initial proposals are a norm (Larsson 2006). One example of such inclusion is the "Älvstaden" project, which includes big installation displaying the future Gothenburg city centre, with the screens on the walls show the past, present and future development projects (Göteborgs Stad, 2015). Gothenburg also has a defined procedure for the planning process (Kain 2015).

One of the largest current projects in Gothenburg is the Västlänken project by Trafikverket (the national traffic and transport authority) (Trafikverket

u.d.). It is meant to create a new commuter and regional train connection with three new stops and reduce the number of modal changes required to reach several parts of the city. Further exploration of the projects in Gothenburg is beyond the scope of the current paper.

Development of the transportation sector in Gothenburg forms part of the Transport Strategy for 2035. The plan incorporates a sustainability perspective in its vision. The strategy was developed "in an integrated process with the Development Planning Strategy and the green strategy" (Hellberg and Jonsson 2014). Based on the policies that influence the transport strategy, several small-scale plans are being developed or in progress, i.e. road safety programme (City of Gothenburg 2010 b) and bicycle programme, which is in the development stage (July 2016) (Hellberg and Jonsson 2014). In Gothenburg, the planning process faces challenges in terms of collaboration among the large number of stakeholders involved.

Both Gothenburg and Kisumu have a strategic advantage in long term planning based on their waterside locations. At the same time, the main difference is the perception of time: while Sweden has visions and development plans for 2030, 2050 etc (City of Gothenburg 2010 a, Hellberg and Jonsson 2014, Göteborgs Stad 2015), "in Kenya tomorrow is already (the) future" (Eising 2015).

3.2 Current situation: organization of the system, key stakeholders and pertinent issues

3.2.1   Kisumu

Kisumu is a national and regional centre for trade, commerce, industry, administration and communication. It was developed as a port and railway terminus due to its strategic location. Kisumu was the connection point for passengers and freight via Lake Victoria and overland to Tanzania, Uganda, Rwanda and Burundi as well as to the other big Kenyan cities, such as Nairobi and Mombasa. The transportation system in Kisumu is represented by water transport (the lake port and the dry port managed by Kenya Ports Authority), air transport (Kisumu international airport), road transport with a variety of means (*boda-boda*[1], *piki-piki*[2], *tuk-tuk*[3], taxi, *matatu*[4], long-distance bus),

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[1] *Boda-boda* - usually motorbike taxi, but can be bicycle taxi
[2] *Piki-piki* - motorbike taxi
[3] *Tuk-tuk* - motorized scooter taxi with a canopy
[4] *Matatu* - minibus with 14 seats on average

and railway transport (as mentioned before under the large developmental project).

The bus park is a self-evolved unit in Kisumu. It provides mainly short-distance services within and between neighbouring counties, but is also served by several long-distance operators. The bus park has no statistical data documented. To grasp the size of the park, based on the assumptions of the city planner and bus park superintendent, and assuming that every *matatu* leaving the park is full in the mid-season (summer), an educated guess would be that about 11000 people per day travel through the bus park (E. Otieno 2015, Rawinji 2015).

At the initiation stage, there was limited planning by the state – mainly provision of designated space. The structure of the bus park involves many actors that have different levels of power to influence the current situation and future development. Figure 1 (below) depicts the system of the bus park that was identified during the field studies. The most decision-making power and ability to influence the current state in the bus park belongs to the government, although transportation is not a governmental service. There is top-down control over the government-owned land. Regulations connected to the services provided by the park are dictated by the National Transport and Safety Authority (NTSA). The service providers are Savings and Credit Co-operatives (SACCOs)[5]. In Kisumu, 3 groups of SACCOs operate within the bus park: the ones that are registered in Kisumu (24 co-operatives), SACCOs of the western region (19 cooperatives) and SACCOs registered in the neighbouring county – Kisii. One can see that the number of Kisumu SACCOs represents 1/3 of total SACCOs that are involved in the provision of services at the bus park. It means it is more difficult to influence the situation at the bus park due to involvement of external stakeholders.

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[5] SACCOs can exist in any industry, not only for transportation. In order to become a legal SACCO a group of individuals has to register at the Ministry of Co-operative Development and Marketing. Usually one SACCO in the transportation sector operates in one route (Graeff 2013)
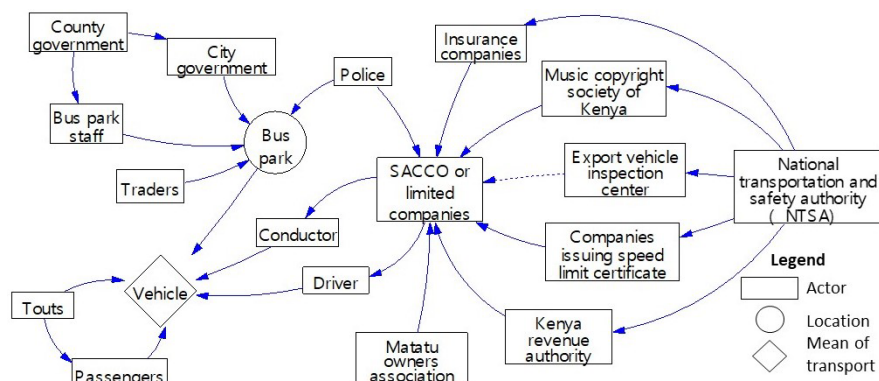
Figure 1. Bus park system.

Current demand for services is met, although at first sight it might not seem so. The SACCOs act reactively and ensure their performance, sometimes with a certain delay. Since there is no future development plan, there are no projections towards future demand and further study is needed.

The main challenges observed at the bus park are sanitation, solid waste, and maintenance of the park (especially drainage system), which often leads to damages of the vehicles. Based on our survey of the SACCOs' representatives, 11 main challenges were identified within the bus park, with the top three being harassment of passengers and vehicles by *touts[6]/manambas[7]*, inadequate space (too many vehicles for very limited area), competition with other vehicles (*probox[8]*, *tuk-tuk*, private cars). Overcoming these challenges would be a stepping stone towards achieving SDG 11 Target 2. However, further research on the state of the art of private services and more detailed investigation on how to meet future needs would be necessary to develop the transition pathway.

The controversial role of *touts* was flagged as a sensitive or important issue by all survey respondents. The *touts* are vital to the operation of SACCOs, providing route and stop information to passengers. The controversy exists partly because many of the *touts* are or were homeless street children and possibly are involved with criminal groups/activities. The methods of coercion used by the *touts* can go beyond what would be considered respectful or appropriate in Europe. This is in part due to the intense competition between SACCOs and the importance of convincing customers to travel with their vehicles. There is thus a negative perception of these

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[6] *Tout* - a person who provides route and stop information to passengers

[7] *Manamba* – tout that is possibly involved with criminal groups/activities

[8] *Probox* - model of the car with 5 seats capacity

touts, as customers may feel unsafe due to the threat of physical or other types of harassment. It is controversial to suggest removal of these *touts*, not least due to the difficulty of enforcement, but also due to the important and useful role that they play (information messengers) and the fact that it is a valuable means of employment for people with fewer opportunities.

Several challenges outside the bus park (from the transportation system perspective) were also identified based on the SACCOs' survey. The main three were high taxes, bad roads and bribery to traffic police ("Corruption from traffic officers is a big problem. Please act immediately!!").

Pertinent issues identified above are not directly related to SDG 11 except for the issue of touts maintenance and challenges outside of the bus park. That supports the decision of Kenyan's government to give priority to the other SDGs, namely Goal 3 (good health and well-being), Goal 4 (quality education), Goal 5 (gender equality), Goal 8 (decent work and economic growth), Goal 12 (responsible consumption and production), and Goal 13 (climate action) (Muchangi 2015, UN n.d.).

3.2.2   Gothenburg

Centralen Gothenburg is an interchange that combines bus station (the Nils Ericssonterminalen), central railway station and the surrounding territory: city buses, trams, taxis, stores and a major indoor shopping centre. It is a hub that provides urban, national, regional and international services. The three main challenges identified at Centralen that make the planning process difficult are large number of actors, lack of co-operation among actors and the physical state of individual elements of the station.

The number of actors involved within Centralen Gothenburg is very high, which makes the system difficult for the researcher to understand. The "*Market model*" has been applied to the central station in Gothenburg: different parts of the technical system were outsourced and built separately to mimic a market. Each element of the station belongs to different actors: "The tracks are managed separately, as well as traffic management and traffic information; to run the trains themselves constitute another business, broken down by a growing number of different actors; command and information in the wagons handled by yet other companies; ongoing equipment maintenance of yet other actors; Station buildings, commercial space located in a separate company, while waiting rooms operated by another, with the exception of the platforms that are subject to the return of another player. There are some examples of how the system has been fragmented. There are also several different operators running the same traffic route" (Meijling 2014).

Jernhusen is a key player in the system and planning process in Gothenburg with considerable perceived power. This state-owned company "owns, develops and manages properties along the Swedish railway" (Jernhusen AB 2011). Its activities embrace both passenger transportation and freight.

Centralen meets today's travel demand and the future forecasts are taken into account in its development plans. The challenge remains the same – communication and collaboration among the stakeholders. From the brief exploration of Gothenburg's situation, improvement of the physical appearance of the station as well as the management system would help to contribute to SDG 11.2 to make it more safe, accessible and sustainable.

3.3 Futures methodologies in the given context

3.3.1   Futures methodologies in the planning process

Futures methodologies are not obligatory elements of planning processes; however they could be of great help. They allow stakeholders to see how the future could/should/would look, thus making the future more concrete. When conducting such studies, it is very important to figure out who your target stakeholders are (planners, companies involved etc), because it will affect how the results will be presented. The analyzed approaches of backcasting, foresighting and SymbioCity are used for the same purpose of assisting the planning process, but they require different information and sometimes different procedures. They may also outline new perspectives.

The outcome of backcasting is a step-by-step strategy for sustainable development towards the vision shared by the stakeholders. At the same time it is difficult to know the future possibilities and the process requires thorough selection of the experts for qualitative data collection. The forecasting methodologies (foresighting and SymbioCity approaches) provide scenarios of how the future will look based on the current trends and historical data. In this case, it is difficult to avoid "locked-in" solutions and there might be a need for more expert contributions. Therefore, all three methodologies can be equally recommended to apply in the developmental process in general.

In the given context, the following points arose. Several authorities (Eising 2015, Nzomo 2015, E. Otieno 2015) working with city development in Kenya mentioned during the interviews that it would be helpful to use foresighting or similar methodologies in their planning work. No universal approach would work for any environment. **It always depends on the local context.**

That is why the three selected approaches are discussed below taking into account current state of the stations in Kenya and Sweden.

3.3.2 Kisumu

Based on the assessment of futures methodologies described above, only *foresighting* would be difficult to apply in Kisumu since it requires historical data, which are rarely documented. Thorough research on the previous performance would be necessary as the basis of the approach. The other two compared approaches (backcasting and SymbioCity) would be possible to apply in such environment. Their respective challenges and advantages are discussed below.

In case of *backcasting*, different level of education and different spoken languages (*Luo*[9], *KiSwahili*[10] and English) could be a challenge in creating common ground among the stakeholders involved in the early stages of the process. The high number of key stakeholders that are important for the participatory workshop would make it even more complex. During the assessment of the current state, environmental, economic, social and spatial elements should be investigated, described, documented and illustrated. The land issue would top the challenge list. Kisumu is a rapidly growing city and its transportation system is developing and evolving without official control. Various different means of transport creates bigger demand for their services. The bus park is growing informally too, which makes the users (passengers as well as drivers) think that the only solution is bigger space for the bus park (based on the interviews and the survey). This topic would be one of the most sensitive among the stakeholders. To make the process inclusive, one would need to run several participatory workshops (on vision creation and discussion of the results). Nevertheless, using backcasting would ensure participation in the development process, creation of the shared vision among the stakeholders and a concrete strategy towards the formulated goal. At the time of the study, backcasting had not been applied in Kenya, so using it would be a trial and might require adjustments due to the different culture.

Using the *SymbioCity* approach is also possible given the conditions in Kisumu. It is mainly used for city development; however elements of the approach can be used on a smaller scale, such as the bus park. In fact, SymbioCity suggests using backcasting in the final stages: developing

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[9] *Luo* - local language in the Lake Victoria region in Kenya and Tanzania
[10] *KiSwahili* - first Kenyan national language, followed by English

alternative solutions, evaluating their impacts and integrating them further into the strategies.

Related to that, further challenges could be specification of the objectives, indicators and targets. As mentioned before, for Kenya tomorrow is the future and actions of the government are reactive. If one is looking for solutions for the short term, SymbioCity could be a better option, although definition of "short term" has to be justified.

Depending on the main reason for using futures methodologies, the result could be a single solution or several solutions. If one desires a single answer – one way to go – SymbioCity would be a good option. However, if several alternative solutions are required in order to better understand what are the possibilities and opportunities, backcasting would be a better option.

When talking about development of the bus park, the scale is small in comparison to the city level (and deals mostly with one social problem despite the complexity); therefore it would be easier and more "user-friendly" to apply the backcasting approach.

3.3.3   Gothenburg

For Centralen in Gothenburg, the SymbioCity approach would not be useful to apply. It has several dimensions which would not contribute to development, for example building design and architecture. The station already has all the necessary constructions and building something additional would be use of materials, while sustainability often implies (depending on the local conditions) trying to avoid building new and using what already exists.

Backcasting and foresighting would be applicable in the given conditions of Centralen. Advantages and disadvantages are described below.

The challenge for using backcasting would be involvement of stakeholders. Their number is very high and even organizing a joint meeting could prove challenging. Nevertheless, backcasting provides creative solutions to existing problems and helps to avoid lock-ins. With the rapid development in the Nordic countries, backcasting would allow new ideas to develop based on possible trends, instead of relying on existing technologies. At the time of the study, backcasting had been applied in different sectors of Gothenburg city and municipality, which led to dialogue creation among the stakeholders and some innovative solutions.

Foresighting could also work in Gothenburg. However, since the results are based on historical data and the current situation, it might lead to unimaginative solutions.

Depending on what expectations from the futures methodologies are, foresighting could be helpful in order to see what the possible future of Centralen could look like, while backcasting would show what steps that should be undertaken to reach the envisioned future.

3.3.4 Futures methodologies in multisectoral transitions other than transportation

Three examples were investigated related to household nutrition, cities and systemic change for sustainability and climate adaptation in coastal regions, where the main methodology used was participatory backcasting.

The Sustainable Household Nutrition (SHN) project as part of "Strategies towards the Sustainable Household (SusHouse)" took place between 1998 and 2000 in the Netherlands. It was followed up throughout the process, as well as its impact after 10 years. The project had a limited budget, which has been identified as one of the main reasons for low levels of active stakeholder participation and the project did not have follow up activities when the application for future funding was rejected (Quist, 2007).

Wolfram and Frantzeskaki (2016) examine the necessity of radical systemic changes in urban development in order to have sustainable development without crossing planetary boundaries. No matter what direction one would take and which indicators they choose to assess the results, the current planning processes require additional support of futures methodologies.

Another project combining of backcasting and adaptive management was implemented in South Africa (van der Voorn, Pahl-Wostl and Quist 2012). The authors underline the constraints of the current methodologies that are being applied for adaptation strategy creation. Therefore, the two above-mentioned methodologies has been combined. The proposed framework is suitable for application in the strategy and policy creation and has been tested in the Breede-Overberg coastal region.

The investigated cases show the need for alternative methodologies to support the planning process. The complexity of current challenges requires an interdisciplinary and multisectoral approach that would contribute to sustainable development transitions. Such an approach should also contribute to the policy-making process. Futures methodologies can be complementary to existing ones and the combinations with the other

emerging disciplines can have a great positive impact on the sustainable transitions.

Funding is one key challenge in the follow up after the implementation of futures methodologies. In case of Kenya, it is crucial. As was investigated during one of the interviews, depending on what the funding would become available for, the government would react correspondingly adjusting all the plans and current activities (E. Otieno 2015). Similar attitude can be seen in the Netherlands with the SNH project, where stakeholders' activity was low due to the limited budget (Quist 2007).

4   Conclusion

The sharply different planning processes in Kenya and Sweden both have defined procedures; however reality does not always correspond to the norms or rules.

As described before, Kisumu railway station has a revival plan, which is at the end of the first phase of implementation. The bus park, on the other hand, is not managed by any level of government – hence it is unique in terms of self-development. There is no plan for its development yet, hence there is a chance of incorporation of the appropriate SDG target. Several interviewees working with development planning mentioned the need for futures methodologies in their work (Eising 2015, Nzomo 2015, E. Otieno 2015).

The transportation sector in Gothenburg has several approaches to sustainability integration at different levels. Nevertheless, our literature review and interviews show that planners are facing several challenges (Hellberg and Jonsson 2014, Isitt 2015, Kain 2015). That is why supportive methodologies could be useful for further development.

Futures methodologies can be applied to support the planning process. Depending on the local context, both backcasting and forecasting methodologies can be used. Backcasting would actually work in both the Kisumu and Gothenburg cases, since it can be applied at a small scale, provides creative solutions and has a high level of integration of stakeholders. The modest study reported here has demonstrated its value, receiving a positive response from key interviewees in both cities.

Learning from the other fields, one can say that futures methodologies make a great contribution to the complex challenges that the world is facing and contribute to addressing several SDGs at the same time. Future development

and adaptation to the local conditions would be the next steps in the research.

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Paper C

Distinguishing transdisciplinary (and) action research in sustainability science: a comparative systematic-narrative hybrid literature review

Paper C is a manuscript:

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Distinguishing transdisciplinary (and) action research in sustainability science: a comparative systematic-narrative hybrid literature review

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Abstract

There are many socially engaged research modes in sustainability science. The main ones are action research and transdisciplinary research. There is also transdisciplinary action research, a field that seems to combine the two. This paper aims to provide a better understanding of the differences between these research modes in the context of sustainability science to help potential users to determine appropriate research mode(s) to fulfil their purposes. To do so, we asked three research questions: (i) What are the aims of these research modes? (ii) What are some methods used to fulfil the aims of these research modes? (iii) In what empirical domain are the different approaches being used today? Using a comparative systematic-narrative hybrid literature review and bibliometric studies the paper attempts to fulfil the set aim. In total, we analysed 1487 articles in-depth, of which 633 utilised the action research mode, 787 used transdisciplinary research, and 67 used transdisciplinary action research. There are a lot of similarities between the research modes, e.g. they all use traditional qualitative social science research methods, engage the same types of stakeholders, and address the same sustainability issues. But the differences relate to the aims of the research modes. Researchers employing action research seem to be more intent on achieving action in the practice domain and knowledge from that action for both practitioners and researchers (*action-for-knowledge*). In contrast, researchers employing transdisciplinary research rather seem to be more intent on producing new, relevant and shared knowledge for an action that is later undertaken in the practice domain (*knowledge-for-action*). Although this might be a premature conclusion, researchers employing transdisciplinary action research seem to be more intent on achieving action based on integrative knowledge (*integrative knowledge-for-action*). Finally,

some advice regarding the choice of research mode for a particular purpose is presented.

1. Introduction

We need research leading to timely, meaningful, contextually appropriate solutions for society's complex sustainability challenges. Though transdisciplinarity is often positioned as sustainability sciences' *modus operandi* (Brandt et al., 2013; Komiyama & Takeuchi, 2006; Lang et al., 2012), there are many other similar approaches used in sustainability science, including some with long-standing traditions of socially engaged research, e.g., applied research (Hedrick et al., 1993), citizen science (Silvertown, 2009), scholar activism (Blomley, 1994), post-normal science (Funtowicz & Ravetz, 1993), mode 2 science (Gibbons, 1994), triple helix – science-society-industry collaboration (Shinn, 2002), and knowledge co-production (Polk & Kain, 2015) and co-creation (Simon et al., 2018). Action research (AR) is another widely used approach that seems to utilise the same methods as transdisciplinary research (TDR) and has been used for decades, both within and beyond sustainability science. There is also an emerging body of work attempting to combine the two, called transdisciplinary action research (TAR). The differences between these research modes are not well-understood. In cases where their differences are described, interpretation often depends on contrasting the approaches on a conceptual or methodological basis, rather than considering publications as empirical data and analysing them (e.g. Schodl et al., 2015).

The impetus for this paper is a practical one. We want to know more about the research modes we are using and guide other researchers and practitioners to make informed decisions about theirs. Our study will treat the literature as empirical material to better understand how AR, TDR and TAR are spoken about and employed in practice in the field of sustainability science.

Therefore, in this paper, we aim to provide a better understanding of the differences between AR, TDR and TAR in the context of sustainability science to help potential users to determine appropriate research mode(s) to fulfil their purposes. To do this, we will answer the following research questions:

    (i)   What are the aims of these research modes?
    (ii)   What are some methods used to fulfil the aims of these research modes?
    (iii)   In what empirical domain are the different approaches being used today?

Answering the first question (i) will help users understand what kinds of research questions each approach is best suited to address while answering the second question (ii) will show what kinds of methods could be used to do so. Illuminating empirical domain of the current use (iii) will also show the areas in which each of the approaches could be used, as well as where existing communities of practice lie.

Before answering these questions, we will begin by outlining how our work extends previous research about these three research modes and describe the methods we used to address our research questions.

2. Background

Below we briefly present how the TDR, AR and TAR research approaches are used in sustainability science, what some existing communities of practice are and what the knowledge gap in comparing the three is.

Today, AR is advocated as a methodology for sustainability science because of its focus on solving urgent problems in collaboration with stakeholders outside of academia (Wittmayer and Schäpke 2014; Egmose 2015). However, participatory action research (a variation of AR) in sustainability needs "some degree of intellectual cohesion [...] to strengthen outcomes and collectively advance the field" and researchers need to engage in more critical reflection about how to "shift control to grassroots investigators," integrate different knowledge types, and on "efforts to transition to more sustainable ways of living" (Keahey (2021, p. 292, 303). AR praxis is supported by a variety of communities of practice such as the Action Learning, Action Research Association (ALARA) which operates globally, as well as national and regional communities, like the United Kingdom's Collaborative Action Research Network (CARN), and Action Research Network of the Americas (ARNA).

Shortly after the inception of the field of sustainability science in the 1980s (Clark & Dickson, 2003; Kates et al., 2001), TDR was advocated as the underpinning research mode due to its way of solving sustainability challenges together at the intersection of different disciplines and with societal actors (Barth & Michelsen, 2013; Brandt et al., 2013; Komiyama & Takeuchi, 2006; Scholz, 2020; Scholz et al., 2006; Stauffacher et al., 2006). While the term is often accepted in German-speaking countries, the Netherlands and some Nordic countries, in the United Kingdom the term interdisciplinarity is used instead (Vienni Baptista et al., 2019). There are

three discourses of TDR: those focused on disciplinary transcendence, those focused on problem-solving (this discourse is thought to dominate today (Klein, 2020), and those seeking to transgress by critiquing knowledge and education systems and promoting the democratisation of knowledge (Vienni Baptista et al., 2020). Finally, there are various combinations of these discourses (Klein, 2014). TDR has several communities of practice, such as the Global Alliance for Inter- and Transdisciplinarity (ITD Alliance) and national and regional groups like the Network for Transdisciplinary Research (td-net) based in Switzerland, the Academy of Transdisciplinary Learning and Advanced Study (ATLAS) in the United States, and the Integration and Implementation Sciences Network (I2S) in Australia[1].

TAR, on the other hand, is an emerging research mode. It is seemingly combining TDR and AR. It is not clear how TAR is used and there does not seem to be any community of practice.

There have been several studies of AR, TDR and TAR in the context of sustainability science, including some attempts to compare them. From these studies, there are preliminary indications of some of the differences between TDR and AR. There is, however, limited research about how TAR differs, apart from Daniel Stokols' conceptual framework (see more in section 4.1.1). It is not clear how TAR is used and there does not seem to be any community of practice.

The only comparative study of TDR and AR we found is Ifan Shepherd's book chapter (2017) assessing the comparative suitability of AR and TDR in the context of professional doctorate programmes. He outlined several subtle differences, which were that TDR engages in "a more formal and detached form of systems analysis" (Shepherd, 2017, p. 5) while AR has a long tradition of insider and professional AR engaging in complex organisational dynamics, TDR emphasises the unity of knowledge across disciplines, while this is "a less evident goal" for AR, action researchers are often agents of change within their own projects (presenting more complex and abundant ethical issues), while TD researchers "help devise plans for change" but take part in enacting change much less often (thereby presenting fewer, less complex ethical issues), and large teams are common in TDR, while single primary researchers are found more commonly in AR. This analysis, however, was reflective in style and focused on a specific case (a professional doctoral

[1] I2S works with TDR, but also with other participatory research modes that integrate knowledge from various disciplines and societal groups.

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programme at a single university), so the conclusions drawn are not necessarily relevant or generalisable broadly.

There have been previous reviews of TDR and AR in sustainability research (some of which have been systematic), although these have been comparatively small. For example, Jennifer Keahey (2021) reviewed 72 articles employing participatory action research in the field of sustainability, while Partic Brandt and colleagues (2013) reviewed 236 articles about transdisciplinarity in the field of sustainability science. There have been no reviews of TAR given the limited research conducted using the approach and reviews investigated differences between AR, TDR, and TAR. Given that the application of these three research modes in sustainability science is growing rapidly, a systematic analysis of a broader literature set is necessary to take stock of both empirical and conceptual-theoretical literature to better understand the suitability of each research mode for different contexts.

3.   Methods

To address the research questions, we conducted a comparative systematic-narrative hybrid literature review and bibliometric analyses, which we describe below.

3.1.   Comparative   systematic-narrative   hybrid literature review

Systematic-narrative hybrid literature reviews are suited for systematic extraction and analysis of large volumes of existing information while using a narrative approach to synthesise the findings (Turnbull et al., 2023). The search protocols and inclusion/exclusion criteria are adapted from systematic literature review practices (Jesson et al., 2011; Xiao & Watson, 2019). A systematic approach to data extraction is valuable because it is structured, transparent, and reproducible. Furthermore, the systematic nature of the article extraction and analysis can prevent bias from reviewers over-emphasizing pet interests.

3.1.1. Identification and inclusion of articles

To begin our review, we sought out relevant peer-reviewed literature from Scopus on October 7, 2021. We chose Scopus since it is the largest database

of peer-reviewed literature (Elsevier, 2023) and it contains publications from a broad array of disciplines. We did not search other complementary databases because to conduct the bibliometric analyses[2] a single data source was necessary. Moreover, previous studies of TDR showed that the contribution of the Web of Science provided few additional articles (Nikulina et al., 2019).

The Scopus search returned spreadsheets with bibliometric information (journal title, authors' affiliations etc). We screened the articles to assess whether they stated that they employed AR or TDR and/or engaged substantively with AR and/or TDR and whether the article was positioned within the context of sustainability. Those that did not meet these criteria were excluded. Further information about these criteria can be found in Appendix A. The results of the identification of articles are presented in Figure 1.

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[2] Bibliometric studies facilitate the analysis of large sets of data and identify patterns in publications, using publication metadata, references and citations (Donthu et al., 2021).
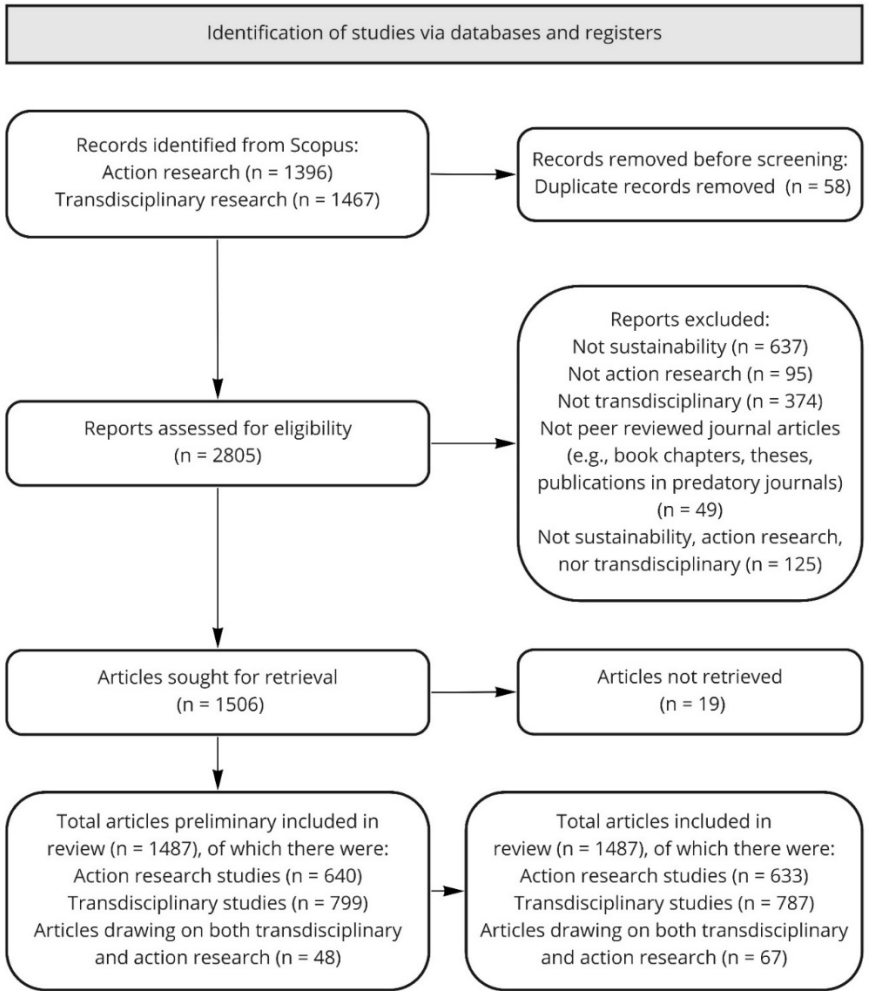
Figure 1. PRISMA flow diagram (based on Page et al., 2021).

Our analysis showed that more articles used both AR and TDR than the Scopus search indicated. The two searches (of AR in sustainability and TDR in sustainability), when combined, had some duplicates. Duplicates were removed and the remaining articles were labelled as a third category TAR. Therefore, the number of included articles using AR was 633 instead of 640, TDR was 787 instead of 799, and TAR was 67 instead of 48.

3.1.2. Article analysis

We then reviewed the articles themselves. In most cases, the sections reviewed were title, abstract, and methods, however, articles with hybrid or non-traditional structures often were read more fully to extract all necessary information. Initially, one researcher reviewed each article. Consistency between reviewers in the article analysis was ensured by creating a detailed analysis guidance for each category to be analysed (Appendix A), a collaborative analysis of nine articles to calibrate between co-authors, and an amending analysis guidance based on the questions raised by the collaborative analysis. Quality was also ensured by defining general principles to guide analysis, running virtual co-working sessions for troubleshooting, and requiring second reviewers for articles that were difficult to analyse. See Appendix A for greater detail.

3.1.2.1. Identifying the aims of the research modes

To identify the aims of AR, TDR, and TAR (what the research modes are intended for), we conducted several analyses for each research mode: narrative studies of brief histories and methodologies, identification of clusters of core literature, identification of schools of thought, and analysis of definitions.

First, we selected some articles to produce brief narrative histories of each research mode. We then complemented these with other relevant sources found during previous research and further literature searches in academic databases.

For the citation and co-citation analyses, we conducted an identical search in Scopus to the search for a comparative systematic-narrative hybrid literature review in 2021 (see section 3.1.1), on July 8, 2022, and filtered out any new publications to ensure the datasets were identical. Before explaining these methods and how we used them, it is important to understand the difference between, a direct citation, a co-citation, and an indirect citation (Figure 2). A *direct citation* means that an article (e.g. A3 in Figure 2) cites another article (e.g. A1). An *indirect citation* relation means that there are intermediary citations in the chain. An example of an indirect citation is the relation between A4 and A1. Finally, *co-citation* means that two articles (A2 and A3) were cited by the same article (A4).
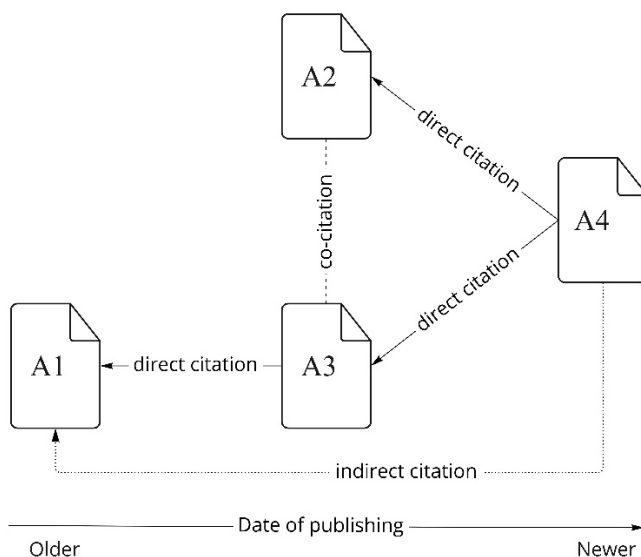
Figure 2. The difference between direct citation, indirect citation, and co-citation.

To identify clusters of core literature, we conducted a citation analysis (van Eck & Waltman, 2017; Yu et al., 2014). Additionally, we identified the most cited articles. The outcome of this study is the most influential publications in each research mode (Pilkington & Meredith, 2009). We used the CitNetExplorer software (van Eck & Waltman, 2014) to illustrate the citation networks of the 40 most cited publications of articles for each research mode[3]. The software's 'clustering' function was used to illustrate publications which were closely related in the citation network. Clustering was based on the number of direct citations[4] (see Figure 2). Analysis of the most cited articles was done based on the article's citation count in Scopus.

To identify schools of thought ("the cognitive realm of a field by showing the consensus of citers to important contributors and works" (Yu et al., 2014, p. 281)), we conducted co-citation analysis (Pilkington & Meredith, 2009; Yu et

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[3] Note that only citations by other articles within the reviewed dataset are counted. It could be different from the article's citation count in Scopus (presented in Appendix B). Only the 40 most cited publications are visualised due to the limitations of the software.

[4] Articles in one cluster might have direct citations to articles in the other clusters (which would be depicted by close horizontal distribution on the figure), which would result in articles from the same cluster not being illustrated in the same area on the figure. More details about the computational algorithm used to generate the figures in Section 4.1.2 can be found in van Eck & Waltman, 2014.

al., 2014). This analysis identifies the clusters in the literature that affect the development of the field. For that, we illustrated how articles are related considering the number of times they are cited together (see Figure 2). We used open-source VOSviewer software (van Eck & Waltman, 2017). The software analysed 1000 selected authors based on the strongest co-citation links of a given researcher with other researchers[5].

Finally, for definition analysis, we screened articles to assess whether they defined the research mode they employed. When articles included definitions, these definitions and any associated citations were recorded. Citations were further analysed to identify frequently cited definitions. The definitions of TDR were also categorised according to Julie Thompson Klein's (2014) discourses of TDR, see section 2.

3.1.2.2. Identifying methods

First, we recorded the article's main purpose as one of the following: 'understanding and/or solving a real-world problem', 'academic methodological/conceptual/theoretical advancement', 'both' or 'other', meaning they had a unique purpose not fitting to the categories described. We also recorded whether articles were reviews; collected and/or analysed data (i.e., dealt with the material empirically); whether the empirical material was primary or secondary; and used a qualitative, quantitative, or mixed methods approach. The methods used in the study were open categories where text from the articles was recorded verbatim. Only methods mentioned in the article were recorded. This category was subject to a second round of analysis to draw out themes. This was done inductively. If articles about AR mentioned using a specific number of AR cycles, this was also recorded. We then also recorded whether the article described the involvement of societal stakeholders in the study and who these stakeholders were according to a categorisation based on key literature defining stakeholder typologies (Durham et al., 2014; Jolibert & Wesselink, 2012; United Nations, n.d.). We defined societal stakeholders to be those not affiliated with an academic institution.

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[5] See details about the algorithm in van Eck & Waltman, 2017, 2020.

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3.1.2.3. Identifying empirical domains in which AR, TDR, and TAR are used

We sought to find empirical domains in which the research modes were used. We explored the geographic areas by considering which countries the research was being conducted in and the number of countries in which the research took place. The disciplinary areas in which authors were located were identified through a journal analysis (Donthu et al., 2021) in which we counted how many articles were published in each journal. Furthermore, we clustered the titles of journals through an inductive process based on the topic of the journal and the disciplinary focus. Finally, to analyse the sustainability issues studied, we analysed articles based on the pre-defined categories that were developed based on relevant and seminal texts (Basbas & Politis, 2008; Birner & Wittmer, 2009; Raworth, 2017; Steffen et al., 2015; United Nations, 2015). We understood the term 'sustainability issue' to encompass social and environmental problems (e.g., climate change, natural disasters), subjects of protection (e.g., landscapes, biodiversity), and sectors that cause or alleviate social and environmental problems (e.g., forestry, mining, research). Reviewers chose up to three sustainability issues for each article. Finally, we conducted author network analysis, which shows social networks among researchers (Arif et al., 2012). We used this analysis to understand collaboration within the communities and to identify the main groups of collaborators if any. VOSviewer software (van Eck & Waltman, 2017) was used to depict research networks in the fields.

4.   Results

The results are presented in relation to the research questions. A summary of the results is provided in table 16 in Appendix G.

4.1.   Aims of Transdisciplinary (and) Action Research

4.1.1. Brief history and methodology of Transdisciplinary (and) Action research

Action research

AR has a long history before the development of the discipline of sustainability science. It has many interpretations, with some using it as a method, and others suggesting that it is rather "an orientation to inquiry,

with many schools, theories and practices" (Bradbury 2013, p. 3). Many trace its roots back to Kurt Lewin (1946), who coined the term 'action research' (Adelman, 1993). He developed the concept of AR in workplaces where he focused on democratic participation in the design of workplace training (Adelman, 1993). John Dewey was another early influence in the field of AR (although he never used the term itself) through his theory of instrumental intelligence and democratic instrumental education, and his legacy can be seen through, for example, today's use of cooperative inquiry (Harkavy & Puckett, 2014). Paolo Freire has also been highly influential in the AR community through participatory AR (PAR), which is rooted in "postcolonial, postmarxist, and postmodern critiques of power" (Keahey 2021, p. 292).

Although there are thought to be three main traditions of AR (Masters, 1995), the two that dominate today are pragmatic and critical AR (Johansson & Lindhult, 2008). Pragmatic AR focuses on creating useful and actionable knowledge through dialogue, while critical AR is focused more on dialogue and action that promotes emancipation and disrupts power structures (Johansson & Lindhult, 2008).

More traditionally, AR has been employed mainly within the fields of social psychology (Brydon-Miller, 1997), teacher research (Pine, 2009), and development studies (McTaggart, 1997). Today it's most commonly associated with research within the 'helping' professions (Bradbury-Huang, 2010). It is within the field of development studies that AR first met sustainability, through, for example, Robert Chambers' (1994) work on participatory rural appraisal. Sustainability-focused AR also has roots in organisational AR (e.g. Bradbury 1998), and another early engagement with AR in the field of sustainability was in environmental education (e.g. Fien & Corcoran, 1996; Wals, 1996).

AR is often represented as a series of spirals that involve a combination of action and reflection (Figure 3a). There are different variations of how this is articulated, but some commonly used ones are Constructing–Planning action–Taking action–Evaluating (Coghlan, 2019), Look–Think–Act (Stringer, 2013), and Observe–Reflect–Plan–Act (O'Leary et al., 2004). These spirals are repeated, and in doing so, generate a deeper understanding of the phenomenon in question, and improved actions to address the phenomenon. Sometimes these spirals are depicted with a wider base becoming narrower over time, as the understanding of the phenomenon becomes more detailed and the actions become more targeted and specific

(Figure 3b). Conversely, the spiral is sometimes depicted as becoming broader and more nuanced over time as the complexity of the phenomenon is better understood and as offshoot spirals are created as new questions emerge from the process (Figure 3c).

a)
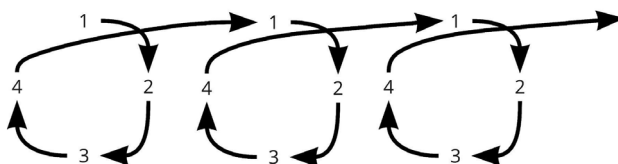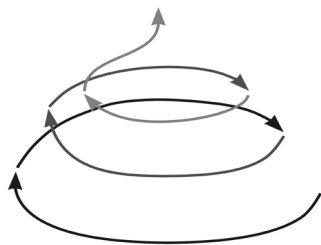
b)   c)
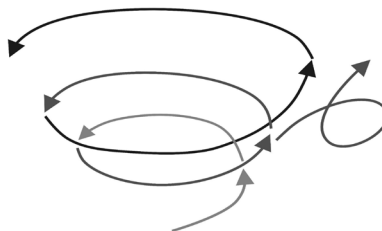
Figure 3. The AR spirals: a) depicting three cycles of action and reflection (e.g. Baptista-Nunes & McPherson, 2002); b) representing more detailed understanding and targeted and specific actions over time (e.g. Haynes et al., 2007); c) representing more complex and nuanced understandings over time which create offshoot spirals addressing questions that arose from the process (adapted from McNiff 2013).

Transdisciplinary research

The term 'transdisciplinarity' has roots in interdisciplinary research, with its first use in 1970 (Klein, 2020). It emerged due to the need for going beyond limited disciplinary scopes and creating an overarching combination of perspectives (Klein, 2020). Independently to this, Jack Lee Mahan, Jr. produced a dissertation where he proposed similar ideas and also contributed to the need to embed ethics in the approach (Bernstein, 2015). Then the field was dormant for about two decades except for work by Joseph Kockelman (1979) focusing on the development of a theoretical framework

for science and education (Bernstein, 2015). TDR later gained momentum in German-speaking countries in Europe on the verge of the 1980s - 1990s in the context of environmental research (Klein, 2020). Similar approaches, such as Kurt Lewin's experimental AR "may be seen as a precursor to transdisciplinarity" (Scholz and Steiner 2015, p. 528).

Several researchers and theories have influenced the development of TDR. Jürgen Habermas' work on the concept of communicative rationality (Habermas, 1968) created a foundation for "models of dialogue and knowledge claims" (Hirsch Hadorn et al., 2008). Furthermore, systems theory has influenced TDR (Hirsch Hadorn et al., 2008). Moreover, Ulrich Beck (1992) pointed out that sciences are becoming reflective, addressing the negative consequences of technological innovation (Hirsch Hadorn et al., 2008).

The concept of transdisciplinarity is used differently across geographical scales and diverse contexts, e.g. in environmental sciences (Scholz et al., 2006), landscape management (Naveh, 2005), health (Wernli et al., 2021), critical development research (Geiser et al., 2011) and community science (Stokols et al., 2003).

Researchers working within the problem-solving discourse of TDR developed an ideal-type model of a research process (Lang et al., 2012), which originates from work by Thomas Jahn (2008). According to this model, research emerges from real-world challenges and includes close collaborations between researchers and societal actors. The model suggests that TDR is an "interface practice" (Lang et al. 2012, p. 27) that initiates from a societal problem and through the development of methods, approaches and learnings contributes to scientific practice. The ideal-type model has three phases: the framing of the problem and team building, transferable knowledge co-creation solving a problem at hand, and (re-)integration and utility of this knowledge. Although the model might appear linear, the phases should be done iteratively or in recursive cycles. There are other similar models for TDR processes that go to different levels of detail and have various foci (Hoffmann et al., 2019; Jahn et al., 2012; Pohl & Hadorn, 2017; Scholz et al., 2006).

In addition to the ideal type of TDR process, there have been several attempts to define principles of TDR that guide the process (e.g. Dennison, 2017; Pohl & Hirsch Hadorn, 2007; TD-Net, n.d.), as well as quality criteria (Bergmann et al., 2005). Furthermore, significant attention in TDR has been

given to reflection and reflexivity (e.g. Polk, 2015; Popa et al., 2015; Steger et al., 2021). Christian Pohl, Pius Krütli, and Michael Stauffacher (2017) identified ten reflective steps necessary to make TDR socially relevant and fulfil the requirements to make it transdisciplinary.

Transdisciplinary action research

Some studies drew on both AR and TDR traditions (however, sometimes framing their research as only one of them), and others go as far as to combine the approaches into TAR (Klein, 2020; Stokols, 2006). In 2006, Daniel Stokols called for the establishment of the science of TAR (Stokols, 2006). TAR "investigates how surroundings influence behaviour and well-being in human transactions with natural, built, social, and virtual surroundings" (Klein 2020, p. 5). TAR draws on AR by making normative judgements about impacts and TDR through the integration of different disciplines. Daniel Stokols (2006) identified three modes of collaboration in TAR: interdisciplinary, defined as multidisciplinary scholar collaboration; interprofessional, defined as multidisciplinary scholar collaboration with practitioners from diverse fields; and cross-sector, defined as community collaboration at different levels. This shows a great overlap with the traditions of TDR and AR. The relatedness of TAR to TDR and AR requires further attention to the language. It changed over time, which reflects the shift in the theories and concepts used in grounding research (Klein, 2020). Finally, there does not seem to be any community of practice specifically addressing the needs of TAR. TAR does not have a unified methodology or ideal type for conducting research.

To summarise, using narrative analysis of AR, TDR and TAR, we can see that AR originates from practice, it is influenced by the application of participatory methods, and the AR spiral (Figure 3) emphasises that research focuses on the same context over a longer time. TDR, on the other hand, originates from the need for co-producing knowledge beyond scientific disciplines. Finally, it is premature to reflect upon TAR's development since it has too few publications.

4.1.2. Core literature of each research mode

We produced three figures from the citation analyses (see Figure 4): one for each research mode. In each figure, the articles are represented by circles and labelled with the last name of the first author of the article. The curved lines between publications represent a direct citation (as depicted in

Figure 2). The horizontal axis represents the citation relations, which is used to indicate the strength of the relations between publications (the closer the publications are, the more related they are). The articles are also clustered thematically, represented by different colours.

a)
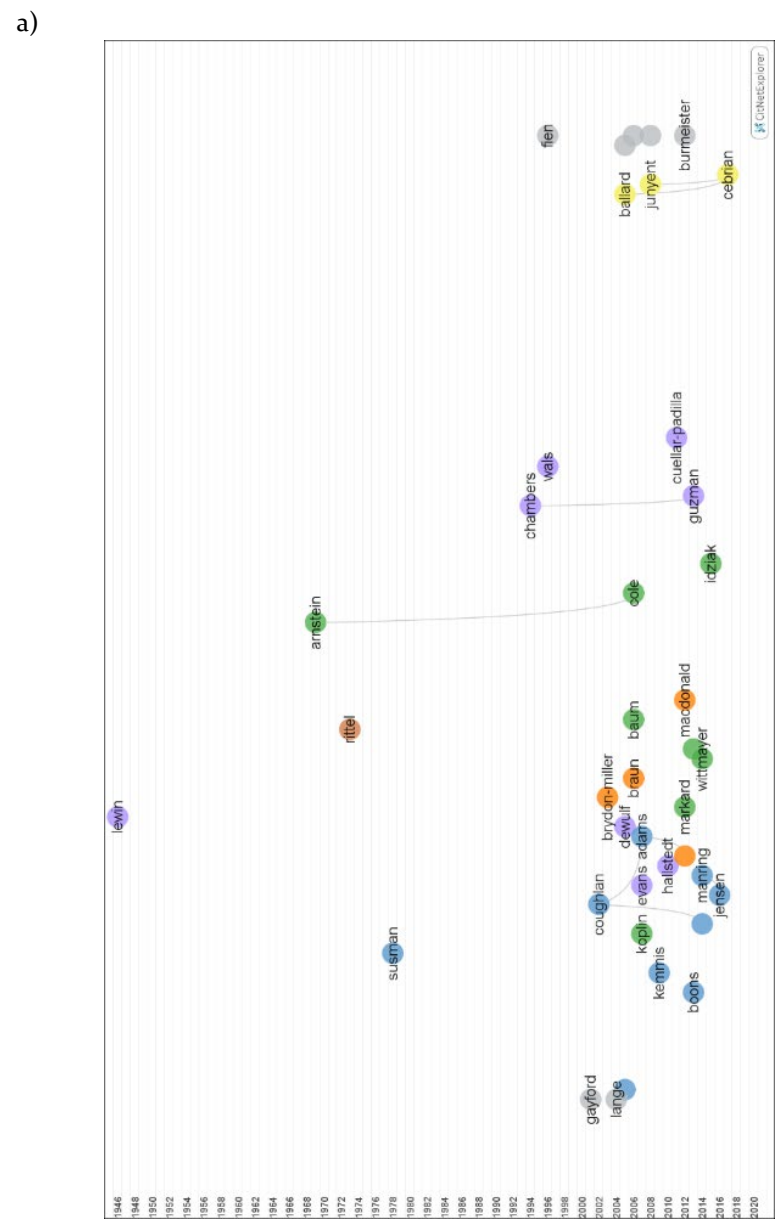
b)
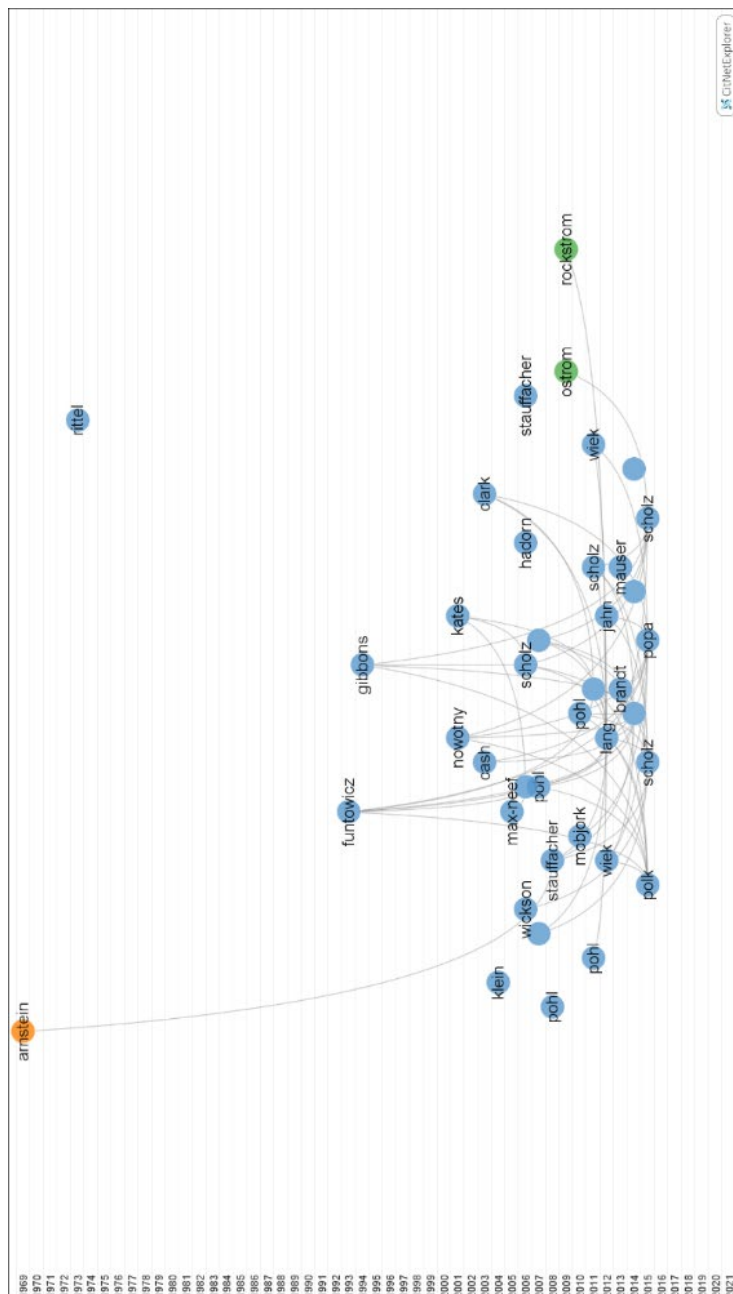
c)
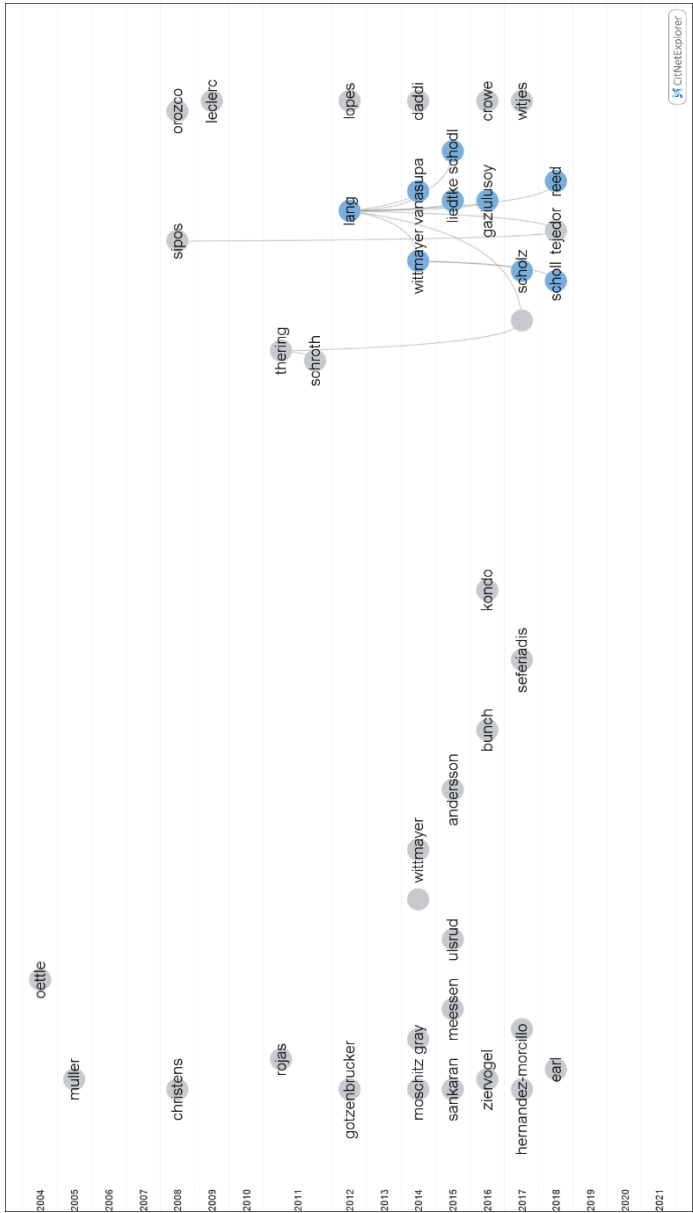
Figure 4. Citation clusters of research modes: a) AR articles: blue represents AR application, green represents aspects of participation, purple represents participatory AR, orange represents methodological advancement, yellow represents education for sustainable development, brown represents social policy problems, and grey represents other literature; b) TDR articles: blue represents TDR

> *theory and methodology, green represents sustainability assessment, and orange represents citizen participation; c) TAR articles: blue represents solving sustainability challenges, and grey represents other literature.*

Few of the 40 most cited AR articles cite one another, indicating that the main articles being cited are not in dialogue. There are also six different clusters of core literature depicted, and there is no single cluster which dominates. The clusters of core literature can be typified as follows: AR application, aspects of participation, participatory AR, methodological advancement, education for sustainable development, and social policy problems. Other articles do not create a cluster.

The citation analysis of TDR articles shows a much different picture. Most of the 40 most cited articles cite at least one other top-40 article, and many cite multiple. Furthermore, there is a single thematic area (TDR theory and methodology, in blue) to which nearly all cited publications belong to. This is all reflective of a literature base which has an established canon of seminal texts.

The earliest citation depicted from the AR citation analysis was, unsurprisingly, Kurt Lewin's (1946) seminal work. The earliest cited work from TDR (also depicted in the AR citation analysis) is Sherry Arnstein's seminal work (1969). Both figures also include work by Horst Rittel and Melvin Webber (1973) in which they introduce the term 'wicked challenge'.

Most of the 40 most cited publications by TAR articles were published recently, with the oldest published in 2004 (Oettlé et al., 2004). Daniel Lang and colleagues' article (2012) introducing the TDR ideal type was also represented in both TAR and TDR. Julia Wittmayer and Nicko Schäpke's (2014) article on the roles researchers play in sustainability transitions, in which they draw on both AR and TDR scholarship, was represented in all three citation analyses. Only one cluster could be identified within the TAR citations (Figure 4c), which is, based on our interpretation, focused on solving sustainability challenges. This said, TAR is an emerging approach, and it might be premature to draw conclusions based on the limited literature base.

Analysing the most cited publications based on the articles' citation scores in Scopus, we found that the top-cited TDR article (n=1298) had far more citations than the corresponding AR (n=312) and TAR articles (n=389). More details can be found in Appendix B.

To conclude, there is no one cluster of core literature in AR in sustainability science, instead, there are several closely connected clusters. This is unlike TDR, which is focusing on its conceptual development. Finally, TAR has too few publications, and it might be premature to make judgements about the clusters of core literature.

4.1.3. Schools of thought

The result of the co-citation analysis can be interpreted as schools of thought as it shows which authors are cited together. Every circle represents an author and is labelled with the last name and initials of the author. The larger the circle is, the more publications they have produced. The thickness of the lines represents the number of times they have been co-cited by the same article. If there is no line between the two authors, it means that none of the authors' publications has cited a publication made by the other author within the dataset. The horizontal and vertical distribution of the circles in the figures does not have a meaning. However, the distance matters: the more times a pair of authors were cited by the same publication, the closer they are to each other. Finally, the colour of the circle represents a cluster defined by the software's algorithm[6] and shows the broad subfields or schools of thought.

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[6] see more in van Eck and Waltman 2017.

a)
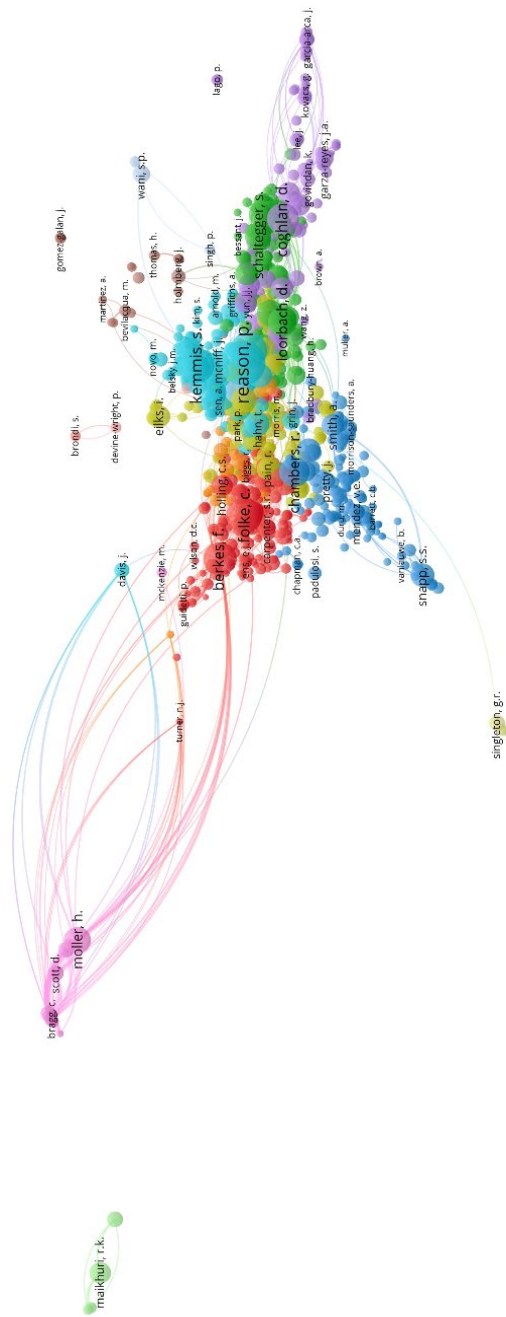
b)
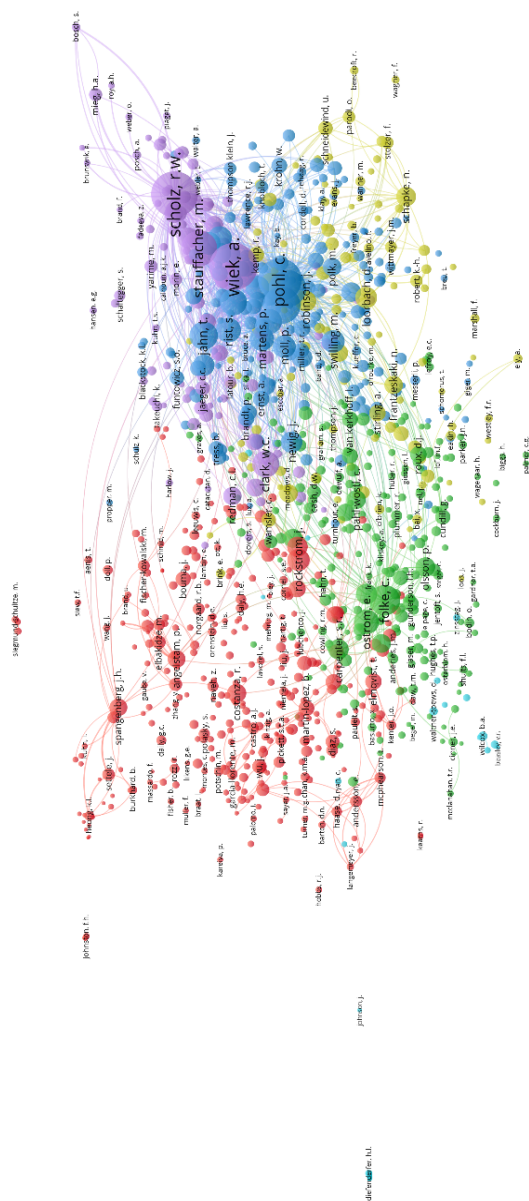
c)
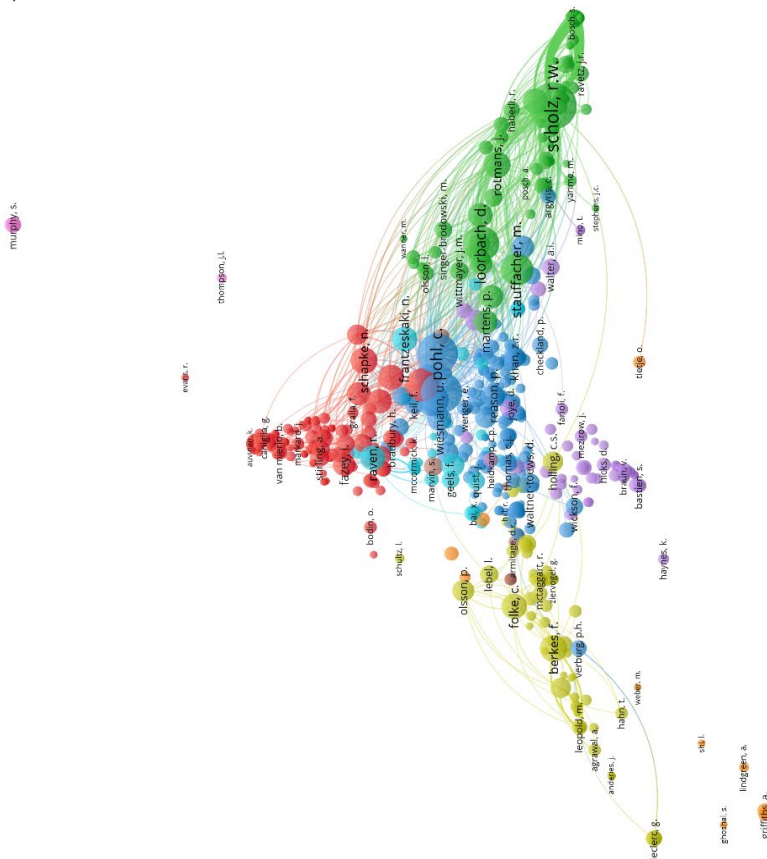
Figure 5. Co-citation analysis: a) AR articles – 14 clusters: the largest ones are AR theory and methodology (light blue), resilience (red), agriculture (dark blue), transitions (green), organisational studies (purple), education (mustard). Pink represents participatory AR, and the light green represents resource conservation; b) TDR articles – 6 clusters: TDR theory and methodology (dark blue), learning to solve sustainability challenges (purple), ecosystems (red), resilience (green),

transitions (mustard), health (light blue); c) TAR articles – 9 clusters, the largest ones are: TDR theory and methodology (dark blue), learning and transitions (green), TAR (red), sustainability studies (purple), urban development (light blue), resilience (mustard).

The software identified 14 clusters or schools of thought for AR (see Figure 5a). It is interesting to see how most of these clusters are connected, e.g. conceptualisation of AR (light blue) and transitions (green), whereas some are disconnected, e.g. education (mustard) and organisational studies (purple). The pink cluster (focusing on participatory AR) has a lot of connections to the other clusters, although still stands on its own. Moreover, there are a lot of medium-sized circles that represent individual researchers, which tells us about the number of publications produced by these researchers and co-cited within our dataset.

For TDR, the software identified 6 clusters (Figure 5b). We can see that the clusters are mainly interconnected and have a lot of smaller circles and some large circles representing researchers, which means that many researchers were co-cited once or twice and a few of them were co-cited many times. This can be interpreted as the work of researchers depicted by large circles is central to the school of thought. Overall, comparing Figure 5a and b, schools of thought of TDR are more closely related compared to AR (which is depicted by the compactness of the figures).

For TAR, the software identified 9 clusters (Figure 5c). We can see that there is a core (TDR theory and methodology) and some branches growing to the sides (e.g. learning and transitions, TAR, sustainability studies, and resilience). Similarly to TDR, there are a lot of smaller circles and some large circles representing researchers, who, as we interpret, dominate in the schools of thought.

Comparing the research modes of AR, TDR, and TAR, we can see that AR and TAR have more schools of thought, than TDR. Based on our interpretation, studies of resilience and transitions are present in all three research modes. Moreover, TAR is closer to TDR in terms of authors being co-cited and a large focus on TDR theory and methodology in both modes.

4.1.4. Definitions

Similar proportions of articles that employ or are about TDR defined the term (50%) when compared to articles that employ or are about AR (40%).

Of those that defined AR, most definitions (86%) contained references to other works. However, the collection of works referenced was highly diverse. There were, however, some definitions which were referenced more frequently than others, and these can be seen in Appendix C. Although it is clear that Peter Reason and Hilary Bradbury's (2001; 2008; Bradbury 2015) is the most frequently used contemporary definition, few AR definitions (9%) cited it overall. The most frequent citations for AR definitions were to books (e.g. Bradbury, 2015; Greenwood & Levin, 1998, 2007; Kemmis & McTaggart, 1985; Reason & Bradbury, 2001, 2008; Stringer, 1996, 1999, 2007, 2014), rather than articles. None of the sources most frequently cited was framed for a sustainability context, however, several definitions cited specific disciplinary perspectives on AR.

Of the definitions of TDR given, 85% contained references to other works. Like with the AR definitions, the sources cited were highly diverse. For example, Daniel Lang and colleagues (2012) was the most frequently cited source for TDR definitions, although few (13%) TDR definitions cited it overall. The most frequently cited TDR definitions were framed for a sustainability context and were published in prominent sustainability journals. It is widely thought that problem-solving is the dominating discourse within transdisciplinary sustainability research today (Klein, 2020), so it is notable to see that definitions in alignment with the transcendence and problem-solving discourses dominate (45%).

Ninety per cent of definitions in TAR articles contained references to other works. Of these, the most referenced definitions were AR and TDR (24% each). We found only one definition of TAR (in 9% of articles), which was that from Daniel Stokols (2006).

At their core, AR definitions emphasised societal betterment (e.g., "flourishing of individual persons and their communities" (Bradbury, 2015; Brydon-Miller et al., 2003; Reason & Bradbury, 2001, 2008)). For TDR, on the other hand, knowledge production was its bottom line, particularly knowledge production that both draws on and transcends disciplinary boundaries (Brandt et al., 2013; Hirsch Hadorn et al., 2006; Jahn et al., 2012; Lang et al., 2012; Scholz et al., 2006; Scholz & Steiner, 2015), is socially robust (Scholz & Steiner, 2015), and addresses societal problems (Brandt et al., 2013; Hirsch Hadorn et al., 2006, 2008; Jahn et al., 2012; Lang et al., 2012; Scholz et al., 2006; Scholz & Steiner, 2015). Similarly to AR and TDR, TAR definitions emphasise working across disciplines and science/practice, while expanding geographical scope by going from local to global (Stokols, 2006).

4.2. **Methods used in Transdisciplinary (and) Action Research**

Before outlining the methods used and describing patterns in stakeholder involvement, we will first describe the proportions of different types of articles that were published from each tradition. This has bearing on the subsequent sections given that the choice of article type has bearing on whether methods are described, and if so, which ones.

AR articles primarily focused on understanding and/or solving problems (56%), followed by a dual purpose of methodological, conceptual and/or theoretical advancement and addressing problems (31%), while giving less attention to the advancement of the field as a sole purpose (11%), see Figure 6. TDR articles, conversely, were more oriented towards methodological, conceptual and/or theoretical advancement (41%), although there was still a considerable focus on understanding and/or solving problems (34%) and combining these two purposes (23%). TAR articles were split almost equally between understanding and/or solving problems (39%), advancing the field (27%), and having a dual purpose (31%). Few articles from each approach (AR: 2%; TDR: 2%; TAR: 3%) included articles that did not fall under the other three categories (describing instead experiences from research institutes, for example).
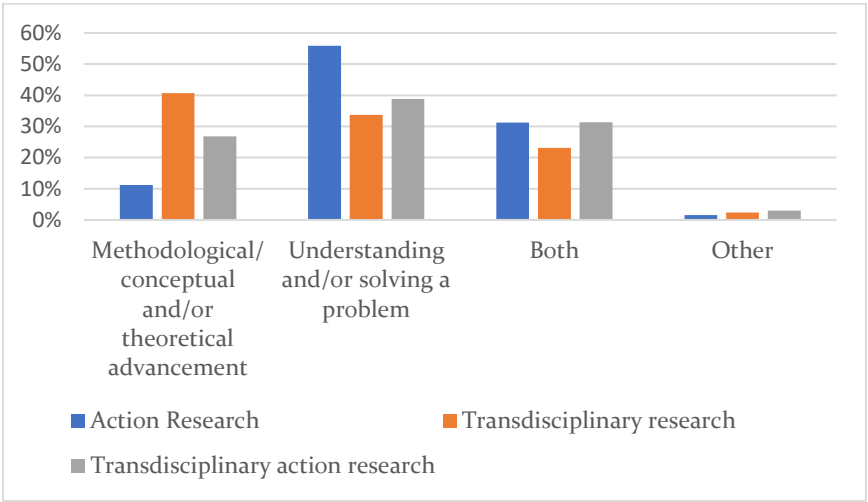
Figure 6. The differences in paper purpose for each research mode in percentage.

Over time, the proportion of both AR and TDR articles aiming to understand and/or solve problems as well as advance the field methodologically, conceptually, and/or theoretically has increased. This may indicate there is an increasing trend of bringing together societal problem-solving and intellectual advancement. TAR's focus on methodological, conceptual and/or theoretical advancement increased over time, which might indicate the ongoing establishment of the field.

Most articles analysed collected and/or analysed data. Nearly all AR articles (92%) collected and/or analysed data, while this figure was smaller for TAR (82%) and TDR articles (68%). We also identified 1% of articles that presented data but did not specify methods and 3% of articles that described methods but did not provide data. For all three approaches, the use of primary (over secondary or a mix of primary and secondary) data dominated, with 75% of AR articles, 71% of TAR articles, and 62% of TDR articles using exclusively primary data. Very few AR (3%) and TDR articles (14%) used exclusively secondary data, while no TAR articles did.

4.2.1. Methods used

Expectedly, qualitative methods exclusively were favoured by all three research modes (AR: 64%; TDR: 55%; TAR: 50%). Very few articles (AR: 5%; TDR: 8%; TAR: 2%) used exclusively quantitative methods, while mixed methods were regularly employed by each research mode (AR: 32%; TDR: 48%; TAR: 37%). Many traditional qualitative social science research methods were used to a great extent in all three research modes, including interviews, questionnaires, participant observation, and focus groups (Figure 7). However, scenarios, forecasting, and modelling were used more frequently in TDR than in AR and TAR. Notably, TAR and AR reported the use of participatory (13% and 12% respectively) and reflexive/reflective methodologies (15% and 11% respectively) in roughly double the percentage of articles compared to TDR (7% and 5% respectively). Many articles reported 'discussion' (AR:19%; TDR: 8%; TAR 27%) and 'meetings' (AR: 16%; TDR: 8%; TAR: 12%) as methods, although these are not traditionally considered methods. However, given the sheer proportion of articles describing them, we chose to mention them. The median number of methods varied considerably between methods, with most AR articles reporting using three (18%) or four (17%) methods, while most TDR (30%) and TAR (15%) articles only employed one. Few articles (20%) mentioned the AR spirals, but of those that did, most mentioned going through one and three (5% each), with fewer mentioning two (4%) or four (3%) cycles.
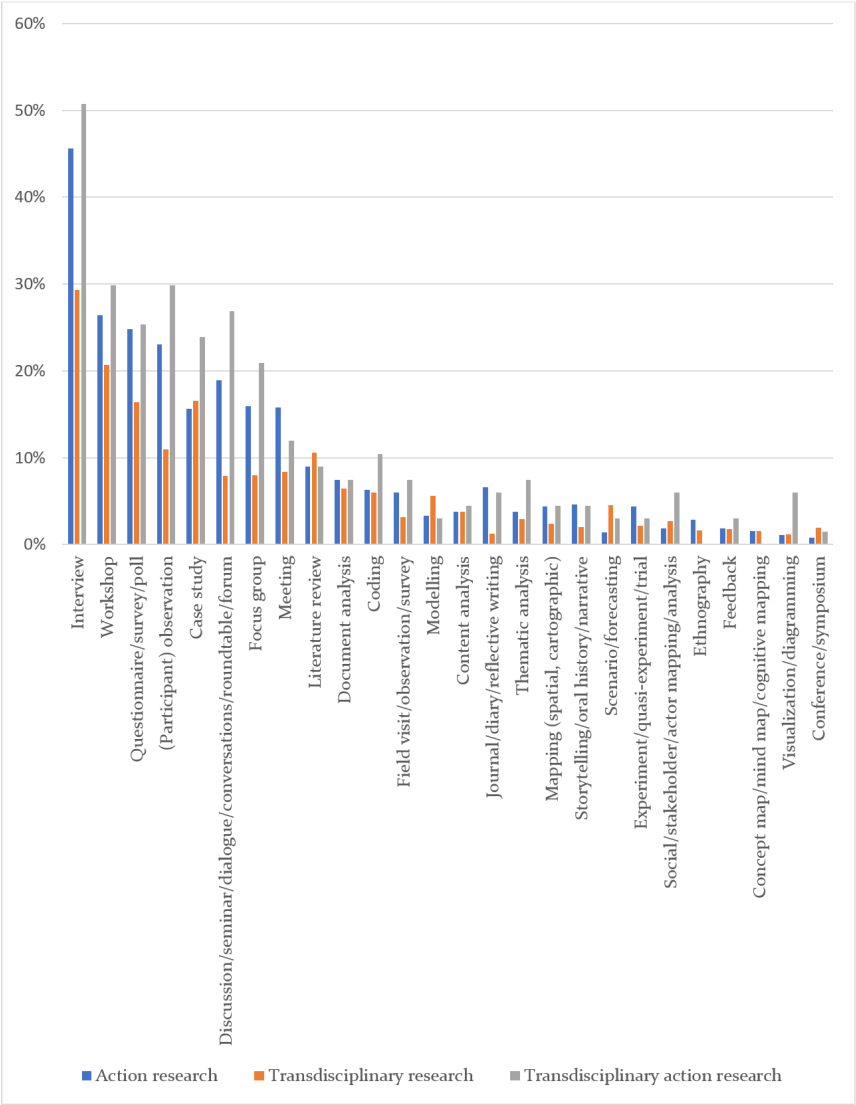
Figure 7. The most common methods used in AR, TDR, and TAR articles. The percentages are calculated out of the total number of articles meeting the criteria for each methodology.

There is more similarity than difference in methods used between the different approaches, as can be seen in Figure 7. That said, action researchers appear to use traditional qualitative research methods to a greater extent than TD researchers. However, this difference may be because AR researchers used more methods overall. TDR researchers use

scenario/forecasting and modelling more than AR, which is indicative of the interest in better understanding the (un)sustainability of development trajectories in TDR. This difference seems modest but given that fewer methods were employed in each TDR study overall, the difference is more pronounced than it appears. Although TAR articles had higher proportions of articles employing most methods, these findings are unlikely to be significant given the small dataset of TAR compared to AR and TDR.

4.2.2. Stakeholder involvement

Stakeholders were engaged in studies about or employing the different research modes to varying degrees. In empirical articles, the highest stakeholder involvement was observed in AR and TAR articles (94% and 98% respectively), whereas in TDR it was 77%. The three stakeholder groups most engaged with were the same for all research modes (Figure 8): professionals, workers, and trade unions (AR: 42%; TDR: 32%; TAR: 43%), local communities (AR: 35%; TDR: 18%; TAR: 42%), and government departments, politicians, policymakers and advisers (AR: 27%; TDR: 26%; TAR: 51%). Finally, the TAR findings are unlikely to be significant given the small dataset.
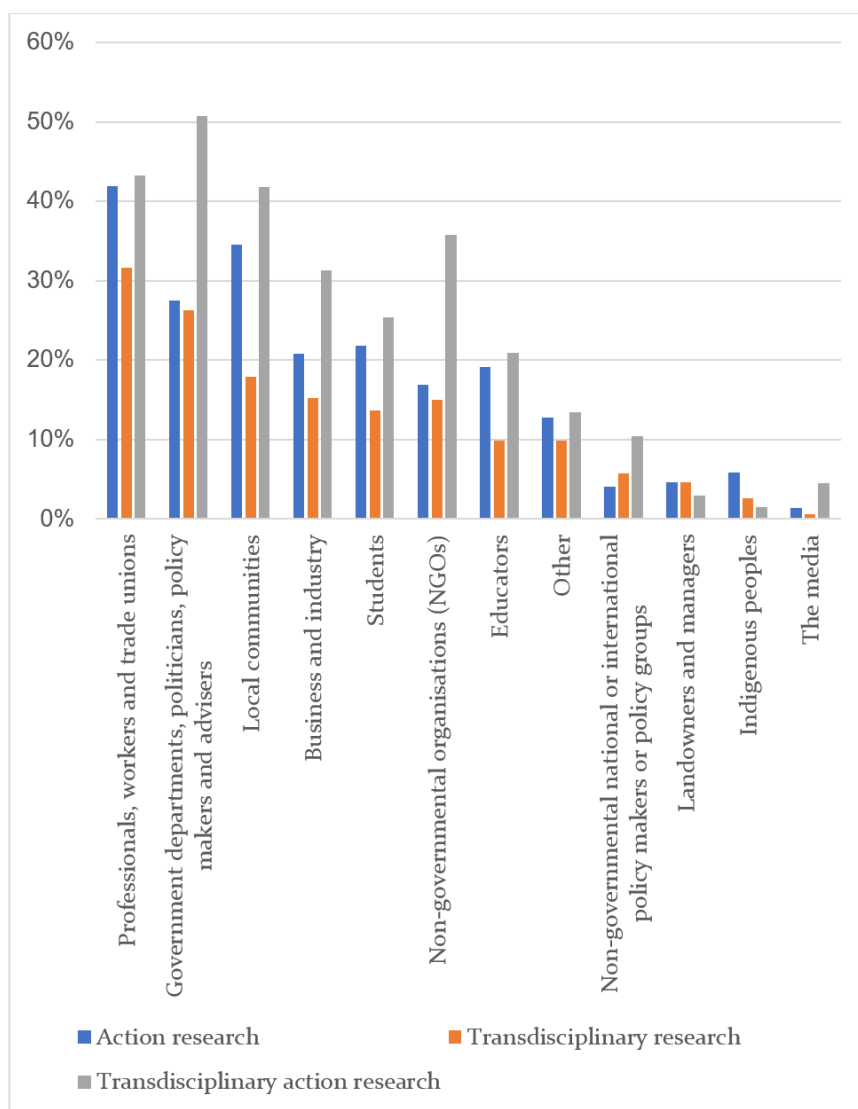
Figure 8. Percentage of stakeholder types out of the number of articles in total engaged by each research mode (AR, TDR, and TAR).

The greater proportion of reported engagement with stakeholders in AR compared to TDR articles reflects AR's emphasis on applied research and stakeholder participation, and the comparatively greater proportion of TDR articles that aim to advance the field (as in section 4.2). Given their engagement with governmental actors and civil servants, it seems as though TDR has a greater emphasis on shaping policy. AR has a greater focus on

working with local communities, as well as students and educators. The former reflects the emphasis on societal betterment seen in AR definitions, while the latter likely reflects a continuation of the historical engagement of AR practitioners in teacher-practitioner research.

4.3. Empirical domain Transdisciplinary (and) Action Research are applied in

In this section, we will present the geographic and disciplinary areas, sustainability issues studied and author networks of the research modes.

4.3.1. Location of studies

The empirical studies of AR articles took place in 102 different countries, TDR in 112 countries, and TAR in 52 countries (see Appendix D). For AR, particularly well-researched countries were Australia (8%) and the UK (7%); for TDR, they were Germany (9%), the US (8%), Switzerland (6%) and Sweden (5%); finally, for TAR, they were the Netherlands (8%), Canada (7%), Germany, the UK and the US (6% each), and Austria (5%). Some articles did not focus on a particular geographic location: in TDR it was about 30% of all articles, which correlates with articles' focus on conceptual, theoretical, and methodological advancement (41%), whereas in AR and TAR, it was 10%. Finally, we found that AR and TAR studies tended to focus their work within a single country (92% and 81% respectively), whereas a greater number of TDR articles (7%) studied three and more countries, partially comparatively.

4.3.2. Disciplinary distribution

In all three research modes, the journal where the most articles have been published was Sustainability (Switzerland)[7], which is an open-source journal with a broad variety of topics and relatively short review times. For AR the journal with the second most publications (5%) was the Journal of Cleaner Production[8], which is focusing on cleaner production, and research on sustainability and the environment. This could indicate the focus on practical questions, such as waste reduction in production, which is one of the key themes in the journal. Finally, TDR and TAR articles were frequently

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[7] https://www.mdpi.com/journal/sustainability

[8] https://www.sciencedirect.com/journal/journal-of-cleaner-production

published in the Sustainability Science journal[9] (9% each), which is focusing on building sustainability science as an academic discipline. This could indicate interconnections between the fields of sustainability and TDR/TAR.

In our analysis, we found that all three research modes publish in journals with inter- and transdisciplinary focus (AR: 18%; TDR: 36%; TAR: 37%) (see Appendix E). The rest of the journals are highly diverse. The second largest focus of the journals is on education among AR articles (16%), environmental studies and forestry among TDR articles (20%), and engineering and technology among TAR articles (12%). This might indicate the main disciplines involved in each research mode. Notably, AR and TAR researchers also publish in methodological journals (4% and 3% respectively), whereas TDR researchers do not. We also found that there were no journals specifically focusing on rural development where TDR and TAR were published, whereas there were several journals specifically focusing on rural development where AR articles were published, however, we do not have an explanation of why this might be the case.

4.3.3.   Sustainability issues studied

Of the sustainability issues studied, the ones that dominated among the AR articles were education (in 25% of articles), industry (22%), and agriculture (13%). Research/knowledge production was by far the dominating issue in TDR articles (at 35%), although education (17%) was also well-represented. TAR studies also focused mainly on research/knowledge production (30%) and agriculture (16%) to a lesser extent.

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[9] https://www.springer.com/journal/11625
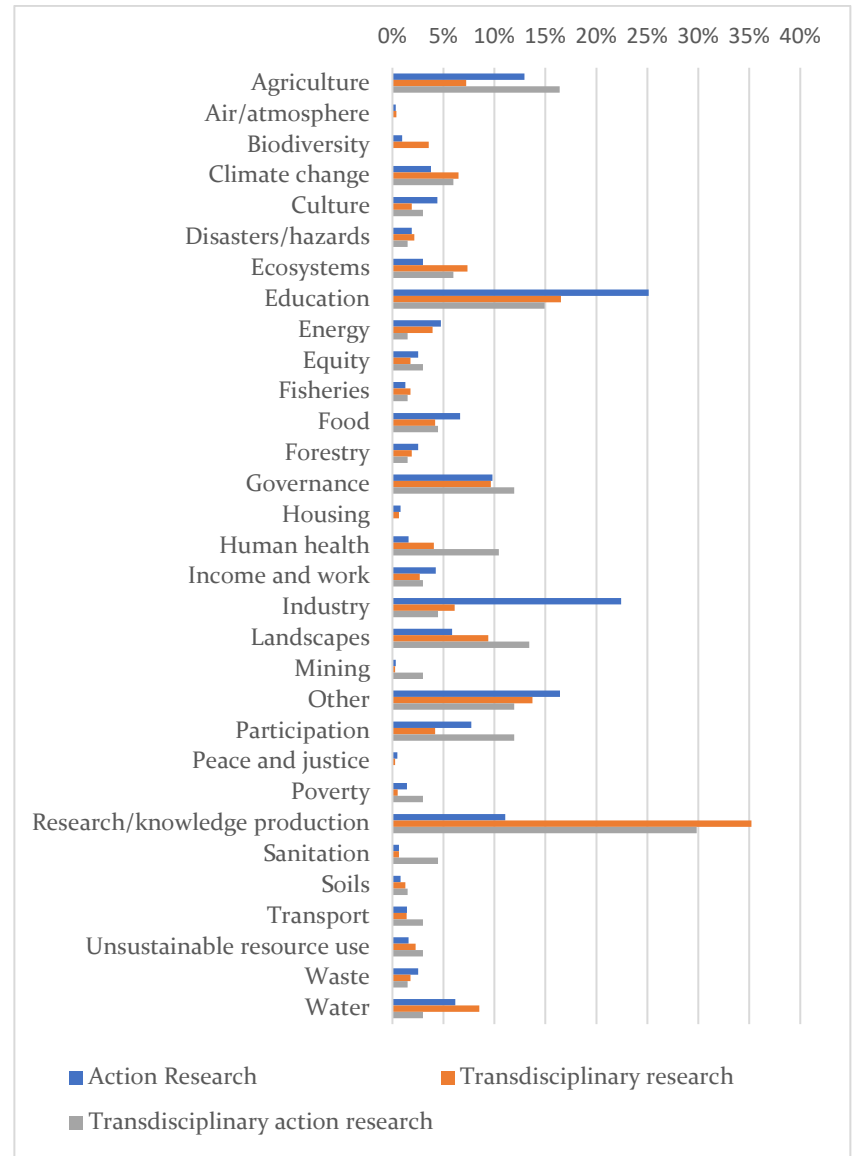
Figure 9. Sustainability issues studied: percentage of sustainability issues addressed by research mode. The category 'Other' covers sustainability issues that were considered unique and uncommon. They include 'technology', 'collaboration', 'design', and 'sustainability'.

The issues that AR articles focused on are ones in which there are established traditions of AR (outside of a sustainability context), e.g. education and industry. The reason AR is making headway in these particular areas of

sustainability research may be that there is already a precedent for this modality. TDR articles focused to the greatest extent on research/knowledge production, which is likely because much of the development of TDR is taking place within the field of sustainability science or because TDR articles engage with knowledge works. Conversely, there is considerably less focus on research/knowledge production as a sustainability issue in AR articles. This may be because there has been considerable development of theory and methodology in literature outside of the field of sustainability science. TAR seems to combine the focus on research/knowledge production (as TDR) and the contexts of application, such as agriculture (as AR).

4.3.4. Author networks

Our author network analysis revealed that only TDR has a large community, where researchers collaborate across institutions and epistemic and geographical borders, whereas researchers of AR and TAR tend to work in small groups or individually (see Appendix F).

5. Analysis

In this article, we expected that our studies would provide us with the ground to give some advice to researchers and practitioners who seek to determine an appropriate research mode to fulfil their purposes within sustainability science.

5.1. What are the aims of Transdisciplinary (and) Action Research?

The three research modes were established with about 30 years between them: AR being coined in the 1940s, TDR in the 1970s and TAR in the 2000s (see section 4.1.1). There appear to be some similar scholarly roots in the work by Kurt Lewin (Scholz and Steiner 2015), however, AR emerged from practice-based problems in education and the workplace that were initially considered through the lens of education, learning, and psychological theories, while TDR emerged out of the discourse around interdisciplinarity and TAR emerged from both AR and TDR. Notably, broad systems theory had a great influence on TDR, and, in turn, on TAR.

It is important to note that research communities of all three research modes are heterogenous and therefore broad-based comparisons may not hold true when considering sub-communities within these modes. Moreover, there seems to be no collaboration between networks in AR and TAR, while TDR researchers closely collaborate between networks and across countries and conduct comparative studies. Nevertheless, the transgressive discourse may have more in common with the critical tradition of AR than the transcendent discourse, even though they are both under the umbrella of TDR (more on TDR discourses in section 2).

From the identification of clusters of core literature and schools of thought (sections 4.1.2 and 4.1.3), we can see that AR articles are focused on conceptual and empirical development of the field, whereas the schools of thought have a sectoral/application focus, whereas TDR clusters of core literature and schools of thought overlap to a greater extent and focus on the theoretical and methodological development of TDR. This corresponds with other findings suggesting the focus of AR on the action and TDR on the co-production of knowledge, described below. Only one cluster of core literature was identified for TAR, therefore it cannot be compared to AR and TDR in the same way.

When it comes to definitions of AR and TDR, it seems that the main focus of AR is on societal betterment, whereas TDR definitions do not specify that (see section 4.1.4). Additionally, TDR definitions include concepts of reflexivity and co-production, while our methods analysis showed that AR researchers are using reflective/reflexive and participatory methods twice as many times. This could signalise that TDR researchers do not use such methods for data collection in the articles, but rather have them as a principled approach in the work. It is worth noting that some definitions of TDR did not include references to the involvement of societal actors, and instead emphasised bringing together multiple disciplines. Although this was a minority of articles, it does reflect interpretations of TDR in other disciplines, like gender studies (e.g. Zabaniotou et al. 2020), etc. Given that sustainability science is a field which brings together many disciplines (Kates et al., 2001), the language used in the field should be flexible and cognizant of these.

Based on our findings, we can conclude that AR seems to focus on taking/analysing/evaluating action to create knowledge, i.e. *action-for-knowledge*; TDR seems to be creating knowledge before taking action, i.e. *knowledge-for-action;* and a preliminary conclusion about TAR could be

made that it seems to focus on creating integrated knowledge before taking global action, i.e. *integrated knowledge-for-action.*

5.2. What are some methods used to fulfil the aims of Transdisciplinary (and) Action Research?

Methodologically, AR, TDR and TAR have a considerable amount in common. All three research modes emphasise engagement with societal stakeholders and/or knowledge users, the value of diverse sources of knowledge and an orientation towards solving practical societal problems and/or the betterment of society. All three research modes use the same traditional qualitative social science research methods, such as interviews and questionnaires (see section 4.2.1) to do so, however to a different extent and some of the methods are used more often in one mode than in the others. Moreover, they might be using them for different purposes. Further investigations would be necessary to answer this question. Many articles reported 'meetings' and 'discussion' as methods, although these are not traditionally considered methods as such. One explanation for that could be a 'messiness' of the AR and TDR processes (e.g. Perry et al. 2021), where researchers choose descriptive language to clarify the sources for data collection. All three search modes prefer to use primary data sources, which is in line with participatory research guidelines (e.g. Barreteau et al., 2010; Baum et al., 2006). However, we have noted some differences that we will outline below.

AR researchers prefer qualitative methods (64%) over quantitative and mixed methods, whereas TDR researchers choose qualitative and mixed methods more equally, and TAR researchers use them equally. Almost half of the AR articles and over half of TAR articles used the interview as a method, which might indicate high involvement with societal actors. As for TDR, an interesting observation could be that the third most popular method is a case study. This method could be useful for comparative studies (e.g. Flyvbjerg 2011), which are adopted among the TDR researchers (see section 4.3.1). Furthermore, each research mode has a preferred method compared to the other two research modes. For AR, these methods are discussion, focus group and journalling, which could be explained by a focus on learning in the practical context and the high involvement of professionals (as described in section 4.2). TDR researchers use scenario, forecasting and modelling more than AR and TAR researchers, which could be correlated with the overall focus of TDR on knowledge production before taking action and the high involvement of government departments (incl.

politicians, policymakers and advisers) who often require such results. Finally, TAR researchers spend a considerable amount of time doing literature reviews, meetings, and coding. This could be explained by the early stages of field development.

5.3. In what empirical domain are Transdisciplinary (and) Action Research being used today?

Each research mode is being used in various geographical locations. AR researchers prefer to study English-speaking countries, such as Australia and the UK, whereas TDR researchers focus on Europe and the US, and TAR researchers do not have a preference. Moreover, AR and TAR are focusing on single location studies, whereas TDR analyses three and more countries, partially comparatively.

Doing research across the borders of scientific disciplines can create challenges with publishing as many journals still have focus or roots in individual disciplines. All three research modes are published in inter- and transdisciplinary journals (see section 4.3.2). What we found interesting is that TDR researchers seem to prefer publishing in journals closer to the context of the application (e.g. environmental studies and forestry, 20%), whereas AR researchers publish in journals focusing on education (16%). This could be explained by AR and TDR following their historical roots thus remaining within main disciplines. It is premature to make similar conclusions about TAR.

6. Discussion

Here we outline the limitations of this study and propose some future research.

6.1. Limitations of the study

There are several limitations of this study that should be pointed out.

Systematic literature reviews, such as this one, risk being atomistic and superficial compared to narrative reviews because reviewers 'scan' and 'extract' information without necessarily taking in the context that the information is presented within (MacLure, 2005). However, such a large-scale preliminary review comparing AR, TDR and TAR has not been

conducted to date, and there is considerable value in gaining a broad, if superficial, understanding of these pieces of literature before comparing them on a more granular level. Furthermore, the quantitative nature of such reviews can prevent bias from co-authors over-emphasizing their interests. In such a review, there could be errors and inconsistencies among co-authors but we addressed this by having a second opinion on the analyses that were doubtful, and by investigating inconsistencies in the results by going back to the source articles and re-doing analyses by another person.

A further limitation relates to the scope of this study. Although books were only partially referred to in our narrative analysis, it is worth noting that there are many books and other guides about how to conduct AR. Some of these focus on specific areas such as educational AR (e.g. Noffke & Somekh, 2013), or AR in the context of development studies (e.g. Burns 2007) but there are also many which take a broader approach and apply to sustainability research (e.g. Reason & Bradbury, 2001). There are also books and guides about conducting TDR but there are fewer of these, and they are often focusing on the conceptualisation of TDR (e.g. Hemström et al., 2021; Hirsch Hadorn et al., 2008; Leavy, 2011).

Another limitation relates to the limit of words for many of the articles. AR, TDR and TAR processes are often complex and describing them in 8000-10000 words article is a challenge. Therefore, we could only analyse what the articles describe and not necessarily assessing all the related information.

Finally, there are limitations around the definitions of a method. As a field that brings together a variety of disciplines, there are no agreed-upon standards for what 'counts' as a method, how the methods section ought to be described, and methodological rigour. This is an asset to the field, as it means that sustainability issues can be investigated through different epistemological viewpoints while employing different techniques and methods. However, it also means that it is difficult in reviews like this to compare and appraise methods because of the differences in how methods are described in articles, and what different articles even consider methods to be. Well-established qualitative social science methods (e.g., interviews, focus groups, questionnaires) were most frequently reported in articles. However, established methods were privileged in the analysis because they were more easily identified when reviewing articles. Less conventional methods were often captured in the 'other' category; however, some were not captured at all because they were not named. There are also differences in how methods are understood and employed in different disciplines. For

example, some articles used 'case studies' to briefly illustrate an argument in their article, while others used the term 'case study' to describe a rich analysis of a case from which theory is developed. In the analysis, it was too cumbersome to make distinctions like these given the number of articles being analysed. However, this is an important consideration.

6.2. Future research

We see this article as an introductory review with a focus on the link between the aims of the research modes and methods that could be useful to employ in each of them. Further research could be focusing on the history of science analysis or philosophy of science analysis to better understand the roots of each of the approaches and why they developed the way they did. One could go deeper into looking into correlations between the aims of the papers within each research mode and what methods researchers chose to address these aims. We recommend that a further, more fine-grained investigation of the types of methods being used in sustainability-focused AR, TDR and TAR is undertaken to better understand trends related to the less-established and novel methods used in these fields (as well as how to ensure rigour in their use). That way we could make more precise recommendations for researchers and practitioners who seek to choose a research approach for their work. Another potential type of future follow-up studies could be narrative analysis or linguistic analysis to better understand how communications are organised within AR, TDR and TAR, i.e. how scientific publications are structured and written.

7. Conclusion

This study provides an introductory comparative analysis of AR, TDR, and TAR in sustainability science to identify the links between the aims of each research mode and methods used to address these aims, as well as what empirical domain they are being used in today. We used a comparative systematic-narrative hybrid literature review and bibliometric studies to do so. In total, we analysed 1487 articles in-depth, of which 633 utilised AR mode, 787 used TDR, and 67 used TAR. The volume of TAR articles increased as a result of our in-depth analysis compared to the initial extracted data.

7.1. Key findings

We found that all three research modes are very similar: they address similar sustainability issues, they use the same methods but to a different extent, and they engage with the same stakeholder types but to different degrees among other aspects. However, we found some indications that these research modes have different aims, namely that researchers employing AR seem to be more closely engaged in action to produce knowledge (*action-for-knowledge*), researchers employing TDR rather seem to be focusing on producing knowledge before implementing it (*knowledge-for-action*), and, although this might be a premature conclusion, researchers employing TAR seem to be focusing on creating integrative knowledge before implementing it (*integrative knowledge-for-action*). Below, we give some advice for researchers and practitioners who want to make an informed choice about the research mode to fulfil their needs.

7.2. Some advice for researchers and practitioners when choosing a research mode

Any of these research modes could be useful for addressing complex sustainability problems, however, based on the small differences between them we can give the following advice.

Choose AR if you see the need to:

- have action in the focus of your research;
- find a practical solution to your sustainability problem;
- focus on a single geographical context and gain in-depth knowledge about it.

In this research mode, there is a strong precedent for traditional qualitative social science research methods, such as interviews, questionnaires, and other field-work related methods. Suitable journals could be those that focus on inter- and transdisciplinarity, social sciences and methodological advancements.

Choose TDR if you see the need to:

- address complex sustainability problems by going beyond scientific disciplines;
- co-produce knowledge with societal actors;

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transitioning to sustainable mobility

–   create new methods, tools and approaches for sustainability problem-solving;
–   conduct (comparative) studies in multiple locations.

Not only traditional qualitative social science research methods could be useful for this work, but also mixed methods, including modelling and scenario development. Suitable journals could be those that focus on inter- and transdisciplinarity, social sciences and environmental sciences and forestry.

Choose TAR if you see the need to:

–   clarify the role of AR and TDR in TAR;
–   address large-scale sustainability problems by going beyond scientific disciplines;
–   co-produce knowledge with societal actors.

Not only traditional qualitative social science research methods could be useful for this work, but also literature reviews and coding. Suitable journals could be those that focus on inter- and transdisciplinarity, social sciences and engineering and technology.

Data availability statement: The authors confirm that the data supporting the findings of this study are available on request and in its supplementary materials.

Declaration of interest statement: No potential conflict of interest was reported by the authors.

Appendix A. Guidance for co-authors

Inclusion criteria

To be included in the literature review, the article must (1) be framed within the field of sustainability, and (2) have a substantive focus on transdisciplinarity or action research.

Criteria for Sustainability

The article must be framed within the field of sustainability.

Table 1. Description of criteria for sustainability.

Criteria	Clarifying info	Examples
Needs to be framed within the field of **sustainability**	Sustainability is understood to be sustaining social-ecological systems that are just and inclusive	
	Mentioning "sustainable value creation" without explicit reference to social or ecological dimensions is **not** sufficient for inclusion.	
	Mention of the sustainability of interventions is **not** sufficient for inclusion.	Sustainability of health (Maluka et al., 2020); Sustainability of peacebuilding (Akande, 2021); Sustainability of learning (Malebese, 2019)
	Mention of the sustainability of society in the context of an ageing population or social movement without explicit reference to	society (Akiyama, 2020); social movement (Bretherton, 2018)

	ecological dimensions is not sufficient for inclusion.	
	Mention of sustainability in the context of moving to other planets is **not** sufficient for inclusion.	(Rapp, 1992)
Needs to be **framed** within the field of sustainability	Framing the research mainly within a field that is not sustainability (e.g., public health), even if there are sustainability-related themes (e.g., climate change), is **not** sufficient for inclusion.	(Neuhauser et al., 2007)
	Framing within the lens of the sustainable development goals (even if they focus on less-traditional goals – e.g., Industry, Innovation and Infrastructure) is sufficient for inclusion.	Music education in the context of the SDGs (Isusi-Fagoaga, 2020)
	Framing around another issue (e.g., youth development) where sustainability is presented as complementary rather than a core part of the framing is **not** sufficient for inclusion.	(Koen, 2008)
	Framing through the lens of transdisciplinarity and using sustainability among several other disciplines or fields as an example or case studies is **not** sufficient for inclusion.	(Schmidt, 2008)

Criteria for Action Research

The article must have a substantive focus on action research, meaning that (1) the article needs to employ an action research methodology, and/or (2) the main focus of the article must be on action research.

Table 2. Description of criteria for AR.

Criteria	Clarifying info	Examples
Employing an action research methodology means...	Stating that an action research approach is employed. Participatory action research and action research are not distinguished - both are included.	E.g., it is not sufficient to observe that the methodology could be labelled action research
AND/OR		
The main focus of the paper is on action research means...	The material about action research is a substantive part of the paper and the main contribution contributes to the body of research about action research	
	The article may propose a methodology/framework/concept which will help operationalise/clarify concepts in action research	
The main focus of the paper is **not** on action research when...	The article suggests the field needs to be more action-oriented without meeting the above criteria	
	The article suggests that we need to learn from action research within X field without explaining implications or meeting the above criteria	
	The article brings action research to a new arena without explaining the implications or meeting the above criteria	
	The term 'action research' is used only in the keywords but not in the article itself	

	An action research project is discussed as one project among other (non-action research) projects	

Criteria for Transdisciplinarity

The article must have a substantive focus on transdisciplinarity, meaning that (1) the article needs to employ a transdisciplinary methodology, and/or (2) the main focus of the article must be on transdisciplinarity.

Table 3. Description of criteria for TDR.

Criteria	Clarifying info	Examples
Employing a transdisciplinary methodology means…	Stating that a transdisciplinary approach is employed. We do not discern between different interpretations of transdisciplinarity - this is part of what we want to study.	E.g., it is not sufficient to observe that the methodology could be labelled transdisciplinary
AND/OR		
The main focus of the paper is on transdisciplinarity means…	The material about transdisciplinarity is a substantive part of the paper and the main contribution contributes to the body of research about transdisciplinarity	
	The paper may propose a methodology/framework/concept which will help operationalise/clarify concepts in transdisciplinary research	(Müller et al., 2005)
The main focus of the paper is **not** on transdisciplinary research when…	The article suggests a field needs to be more transdisciplinary without meeting the above criteria	Ecological economics (Meppem & Gill, 1998)

		Landscape ecology (Naveh, 2000)
	The article suggests that we need to learn from transdisciplinarity within X field without explaining implications or meeting the above criteria	(Hillman, 2005); (Ueda et al., 2009)
	The article says that X is a transdisciplinarity sustainability science without meeting the above criteria	(Zalewski et al., 2021)

Analysis guidance

The purpose of this section is to support the analysis process by clarifying what information to harvest from the articles and how. Use this in conjunction with the Excel template provided.

Background information:

- 2862 articles have been screened for inclusion
- We used two search strings:

    o (TITLE-ABS-KEY ("action research") AND TITLE-ABS-KEY ("sustainab*")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English", "Swedish", "Russian", "Ukrainian", "Czech"))

    o (TITLE-ABS-KEY ("transdiscip*") AND TITLE-ABS-KEY ("sustainab*")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English", "Swedish", "Russian", "Ukrainian", "Czech"))

Instructions for article analysis

1. Each analysis package contains approximately 75 articles. All authors must sign up for at least one.

2. Once you have signed up for a package, check which articles you will be analysing (each article is numbered).
3. Fill in the first three columns of the spreadsheet directly from the master spreadsheet.
4. For each article in turn,

    4.1. Search and access the article. Download it as a PDF and add it to the Google Drive folder. Please title it by the paper number (i.e., 32, 765). If you cannot access the article, please make note of it and once you have accessed all the other articles contact the rest of the team to see if anyone else can access your missing articles.

    4.2. Scan the title and abstract to confirm whether the article should be included according to the inclusion criteria (column D).

    4.3. Scan the abstract and fill in columns E-H. Highlight all sections of text that contain information used to fill in these columns.

    4.4. Scan the methods section and fill in columns I-AG. Highlight all sections of text that contain information used to fill in these columns.

    4.5. If there are columns that are left blank and should not be, review the article further. (Note that, in some cases, columns should be left blank – for example, if the article does not analyse data the remaining methodological questions would not be relevant.)

    4.6. For all columns that are intentionally left blank, please fill them with 'nd'.

General principles for analysis

Inclusivity principle: when it is unclear if information should be included or not, lean on the side of being inclusive, it helps answer the RQs/further the purpose of the paper. Not that this is not inclusivity for the sake of inclusivity, but inclusivity in cases where it will be helpful for future analysis.

Don't over-analyse: When a paper is unclear, focus on just reporting what the papers say (even if it seems inconsistent with other components of the paper). That is, try not to interpret what the authors say.

Guidance for columns of the spreadsheet

Column A: TD or AR

Review whether the article meets the transdisciplinary criteria, the action research criteria, or both. This is already indicated in the master spreadsheet because have already reviewed the titles, abstract, and keywords for inclusion. Please note that we are taking a generous rather than strict approach to these criteria, so the purpose of this criteria is:

1. to make sure nothing strange got through the cracks,
2. to check if the articles labelled TD/AR genuinely both meet the criteria for both approaches, or if only one criteria is met, and
3. to identify if any articles meet the criteria for both TD and AR that are not labelled as such.

transdisciplinary = meet transdisciplinary criteria
action research = meet action research criteria
both = meets both transdisciplinary and action research criteria
neither = meets neither criteria

Column B: Article number

This is the predetermined number we have assigned the article. This should just be copied over from the master spreadsheet. (Click the link above to access the full list of articles.)

Column C: Title

The title should be copy-pasted here. This is in case there are any mix-ups with article numbers, we will still have identifying information that we can use to link the article to the analysis.

Column D: Inclusion

Report whether the article meets the inclusion criteria or not. The inclusion criteria can be found on page 11. If you believe the inclusion criteria are not met, do not analyse the article any further.

> yes = the article meets the inclusion criteria
> no = the article does not meet the inclusion criteria

Column E-H: Sustainability issue

Report the main sustainability issue(s) the article addresses from the list below. In most cases the issue should be discernible from the abstract. Choose the category that is most relevant to the framing of the article. Try to limit this to one category, however in some cases up to three can be used. When choosing only one category, please mark the empty cells with N/A.

We understand the term 'sustainability issue' to encompass: social and environmental problems (e.g., climate change, natural disasters), subjects of protection (e.g., landscapes, biodiversity), and sectors that cause social and environmental problems (e.g., forestry, mining). Because these are different framings, there are some topics which have inevitable overlap. For example, 'habitat loss in the Amazon' could fit under biodiversity, landscape or forestry depending on the emphasis in the article.

If there is overlap between different categories, choose up to three of the most relevant. If no listed categories capture the issue, choose 'other' and specify what it is in Column H.

> Agriculture (e.g., breeding crops, permaculture, livestock production)
> Air/atmosphere (e.g., air pollution, ozone)
> Biodiversity (e.g., genetic diversity, extinction)
> Climate change (e.g., mitigation/adaptation)
> Corruption
> Culture (e.g., preservation of traditional practices/knowledge, creative practices, the arts)
> Disasters/hazards (e.g., natural disasters, environmental risk)
> Ecosystems (e.g., invasive species, fire suppression, nutrient cycling)
> Education (e.g., schooling, higher education, adult education, popular education, awareness-raising)

Energy (e.g., energy-saving, production)

Equity and justice (e.g., gender, racial equity, distribution of wealth, opportunity for social mobility)

Fisheries (e.g., overharvest, disease)

Food (e.g., food security, sustainable diets, local food)

Forestry (e.g., overharvest, sustainable practices, disease)

Governance and participation (e.g., municipal, regional, national, project governance, civic participation in governance)

Housing (e.g., sustainable housing, homelessness)

Human health (e.g., physical & mental health, healthcare, environmental medicine)

Income & work (e.g., decent employment, unpaid work)

Industry (e.g., product development, business models)

Definition of industry: group of productive enterprises or organisations that produce or supply goods, services, or sources of income

Landscapes (e.g., land-use change, landscape management, watershed management)

Mining (e.g., metals, minerals, oil)

Participation

Peace (e.g., violence, conflict)

Research/knowledge production (e.g., development/refinement of methods, frameworks)

Sanitation (e.g., sewage, clean drinking water)

Soils (e.g., degradation, pollution, remediation)

Transport (e.g., roads, mobility, traffic congestion, public transport)

Waste (e.g., landfills, disposal)

Water (e.g., overharvest, pollution)

Other (please specify)

Livelihood

Column I: Paper purpose

Report whether the paper's main purpose is understanding and/or solving a real-world problem, academic methodological/conceptual/theoretical advancement, or both of these. In most cases this should be discernible from the abstract. If the 'real-world' problem is a real-world methodological/conceptual/theoretical problem (e.g., testing new curricula design), record this only as 'understanding and/or solving a problem', not 'both'.

understanding and/or solving a problem (in the 'real-world')
methodological/conceptual/theoretical advancement (in academia)
both solving a problem and methodological/conceptual/theoretical advancement
other

Column J: Is the article a review article?

Report whether or not the article is a review article. A review article is an article that summarises/synthesises/reviews/reports on already published articles. This may be done systematically or otherwise.

yes = the article is a review article
no = the article is not a review article

Column K: Is there data?

Record whether or not the article collects and/or analyses data. The definition of data we are using includes quantitative data, qualitative data, or both. This may include data like interview transcripts, audio or video recordings, fieldnotes, drawings, images, field notes, numerical data, etc.

yes = The article collects and/or analyses data.
no = The article does not collect and/or analyse data. This may include opinion-style articles, articles proposing a new theory, concept, or idea, etc.

Column L: Qual/Quant/Mixed

If the answer in Column K is 'yes', then record whether the article uses a qualitative, quantitative, or mixed methods approach. In most cases this should be discernible from the methods section. If the answer in Column K is 'no', then choose 'no data'.

qualitative = works exclusively with qualitative data (non-numerical data, typically drawing on words and/or images).
quantitative = works exclusively with quantitative (numerical) data

mixed methods = works with both quantitative and qualitative data. This might include drawing on both quantitative and qualitative datasets (e.g., using data about soil nitrogen levels and interview transcripts), or manipulating qualitative data to turn it into quantitative data (e.g., count of different categories of responses to an open question on a survey).
no data

Column M: Primary or secondary data?

If the answer in Column K is 'y', then record whether the author(s) collected the data themselves (i.e., primary data) or whether the data they used was previously collected by someone else (i.e., secondary data). If the answer in Column K is 'no', then choose 'no data'.

primary data
secondary data
both primary and secondary data
no data

Column N-W: Methods used

If the answer in Column K is 'y', then record the methods used. In most cases this should be discernible from the methods section. If the answer in column K is 'no', then write 'no data'.

Note that only methods used or applied described in the project should be recorded. If the authors create or propose a new method, do not record this here unless they employ the method.

Each method should be recorded in its own column. If there are more methods than columns, list all remaining methods in the final column, separated by a semicolon. If there are blank cells, please record 'no data' in these cells. The methods should be recorded as text using the terminology from the source (e.g., if they use the word 'survey,' write 'survey' and don't replace it with 'questionnaire'. Make sure to record all methods including both data collection and analysis methods. Also make sure to record the methods in singular rather than plural (e.g., interview rather than interviews).

Note that the action research cycle (e.g., 'feedback cycle') nor the phases within the action research cycle (e.g., 'intervention', 'action planning', 'taking action', 'evaluation') are not considered to be methods for the purposes of this review.

Some examples of methods you might see are: interviews, ethnography, autoethnography, surveys, coding, narrative inquiry, thematic analysis, content analysis, lifecycle analysis, q-methodology, scenario development, systematic literature review, causal loop diagramming, etc.

Column X: Does the article describe involvement of societal stakeholders in the study?

State whether the article describes involvement of societal stakeholders in the study or not. Only choose 'yes' if involvement of societal stakeholders is explicitly mentioned (i.e., do not infer that they were involved). If the answer in column K is 'no', then write 'no data'.

We define societal stakeholders to be stakeholders that are not affiliated with a research institution (e.g., a university). If there are university students or non-research employees who are not involved in the research and are stakeholders of the study, they are considered societal stakeholders.

> yes
> no
> no data

Column Y-AD: Who are the societal stakeholders involved?

If the answer in Column K is 'y', then record each stakeholder group in its own column. If no listed stakeholders capture stakeholders described, choose 'other' and specify what they are in column AD. If the answer in column X or K is 'no', then write 'no data'.

> Government departments, politicians, policy makers and advisers (local, national)

Non-governmental national or international policy makers or policy groups (e.g. European institutions, environment agencies)
Non-governmental organisations (NGOs)
Business and industry
Local communities
Landowners and managers
Educators
Students
The media
Indigenous peoples
Professionals, workers and trade unions
Other (please specify)
no data

Column AE-AJ: Location of study

If the answer in Column K is 'yes', and if the study focuses on a particular location, record the country of the study here. If there are locations in more than five countries, record them (separated by a semi colon (;)) in the 'other details' column. If there are less than five countries, write no data in the empty cells. If the answer in column K is 'no', then write 'no data' in all cells.

Column AK: Definition of AR

If the article meets the inclusion criteria for action research, record the definition used in the article. Copy the definition directly into the box. If there is no definition used, write 'nd'.

Column AL: Citations

If there are any references used for the definition of action research or, if any references are provided for the term, please record them here. Copy-paste the references directly from the reference list. This should include the author name, date, and title of the article, at the very least. If there is no definition used, write 'nd'.

Varvara Nikulina
Scaffolding for multistakeholder dialogue-based processes in strategic planning for
transitioning to sustainable mobility

Column AM: How many cycles of AR?

If the article meets the inclusion criteria for action research, record the number of action research cycles undertaken as a numerical value. Only include those that clearly show they go through these cycles - do not make inferences. If this is not described, write 'nd'.

Some key words to help you find sections talking about these cycles: 'cycle', 'phase', 'intervention'.

See below for some typical depictions of an action research cycle (Figure 10-13).
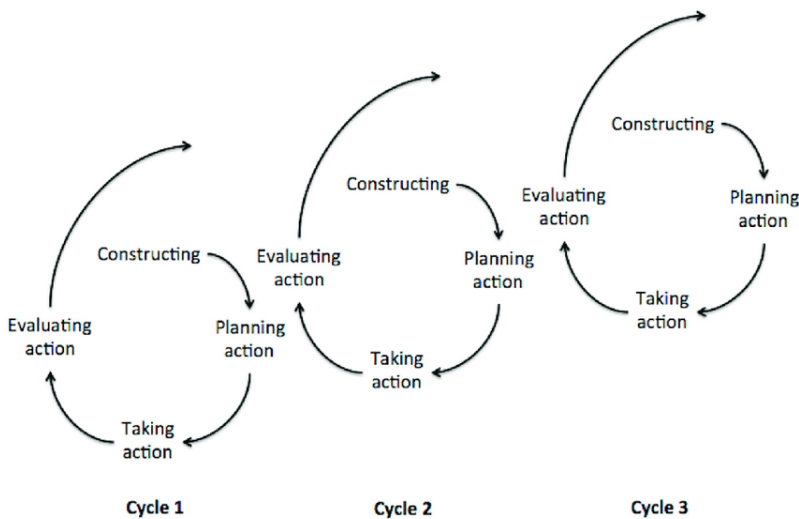
Figure 10. Action research cycle. Source: (Coghlan & Shani, 2018, p. 19).
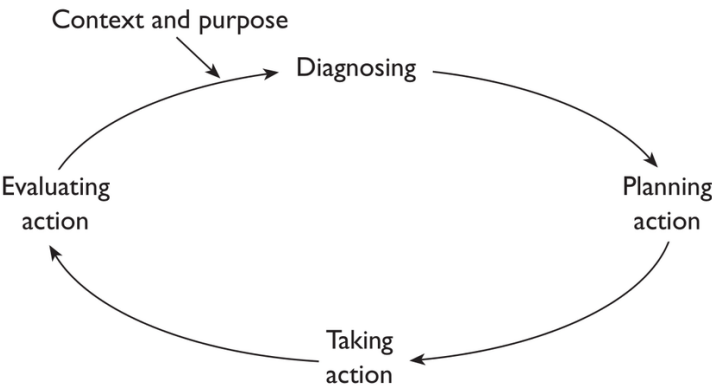
Figure 11. Action research cycle. Source: (Teehankee, 2018. p. 80).
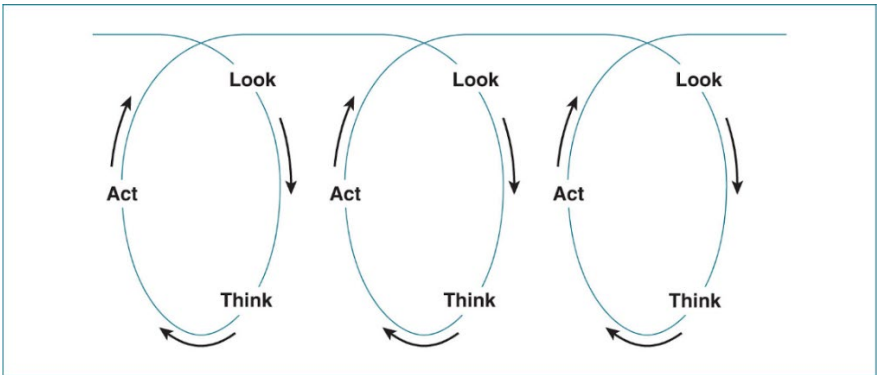
Figure 12. Action research cycle. Source: (Stringer, 2007, p. 30).

Varvara Nikulina
Scaffolding for multistakeholder dialogue-based processes in strategic planning for
transitioning to sustainable mobility
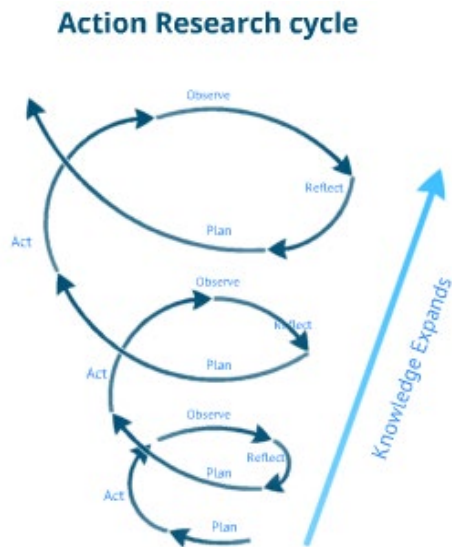
Figure 13. Action research cycle. Source: (Fumagalli, 2013).

Column AN: Definition of TD

If the article meets the inclusion criteria for transdisciplinary research, record the definition used in the article. Copy the definition directly into the box. If there is no definition used, write 'nd'.

Column AO: Citations

If there are any references used for the definition of transdisciplinarity or, if any references are provided for the term, please record them here. Copy-paste the references directly from the reference list. This should include the author name, date, and title of the article, at the very least. If there is no definition used, write 'nd'.

Column AP: Type of TD definition

If there is a definition of transdisciplinarity provided, record whether the definition focuses on (1) creating unity of knowledge, and working across

disciplinary worldviews and practices, (2) critiquing knowledge and education systems, and promoting democratisation of knowledge, or (3) solving concrete problems. If there is no definition used, write 'nd'.

Try to choose one type of definition that is most appropriate, but if necessary more than one can be chosen.

> tc = transcendence: creating unity of knowledge, and working across disciplinary worldviews and practices
>> ex: "Transdisciplinary collaboration. Transdisciplinary problems are uniquely formulated and cannot be captured within existing disciplinary domains. Collaborators accept and adopt epistemological perspectives unique to the collaborative effort and distinct from those of any of the cooperating disciplines. The term metadiscipline can be applied to an emergent and sustained epistemological framework spawned by persistent transdisciplinary effort" (Eigenbrode et al. 2007).
>
> tg = transgression: critiquing knowledge and education systems, and promoting democratisation of knowledge (i.e., this is no singular truth)
>> ex: The transdisciplinary approach [7] sets forth for consideration a multi-dimensional Reality, structured by multiple levels replacing the single level of classical thought — one-dimensional reality (Nicolescu 2000).
>
> p = problem solving: solving problems in concrete situations,
>> ex: transdisciplinary co-production refers to collaboratively based processes where academic researchers and other actors and groups come together to share and create knowledge that can be used to face the sustainability challenges of today, while increasing capacity to societal problem-solving in the future (adapted from Polk, 2016: 35; Hemström et al. 2021, p. 6).

Column AQ: Key articles/further reading

If the article is seminal, offers a particularly notable contribution to the field, and/or is an excellent example of TD or AR, record this by selecting 'yes', otherwise select 'no'.

> yes
> no

Column AR: Does this article need a second reviewer?

If there are columns which you weren't sure how to answer or think your response may be wrong, record this by selecting 'yes', otherwise select 'no'.

> yes
> no

Column AS: Comments

If the answer to Column AR is 'yes', please briefly record the source of confusion. Please also highlight the problematic columns in yellow. Here, you can also record any other comments about the article that may aid in the analysis/write up of the study. If there is no additional information to put in this column, please record 'N/A'.

Quality assurance

Virtual co-working sessions also took place three times a week to allow for emergent discussions about the interpretation of categories and analysis guidance. Articles which were difficult to analyse were flagged for review by a second person. Categories that required additional analysis (e.g., method, journal) were examined for consistency by a single co-author of this article. Two principles were used to guide the analysis in cases where there was subjectivity and uncertainty amongst multiple co-authors: to be inclusive and avoid over-analysing. Therefore, when it was unclear if information should have been included or not, co-authors leaned towards being inclusive if it helped further the purpose of the paper. The second principle meant that, when a paper was unclear, co-authors focused on reporting what was said and avoided over-interpreting the text.

Appendix B. The most cited publications

Table 4. List of the most cited publications in AR.

Authors	Title	Year	Journal	Cited by
Koplin J., Seuring S., Mesterharm M.	Incorporating sustainability into supply management in the automotive industry - the case of the Volkswagen AG	2007	Journal of Cleaner Production	312
Adams C.A., McNicholas P.	Making a difference: Sustainability reporting, accountability and organisational change	2007	Accounting, Auditing and Accountability Journal	308
Cole S.	Information and empowerment: The keys to achieving sustainable tourism	2006	Journal of Sustainable Tourism	268
Kemmis S.	Action research as a practice-based practice	2009	Educational Action Research	262
Cuthill M.	Strengthening the 'social' in sustainable development: Developing a conceptual framework for social sustainability in a rapid urban growth region in Australia	2010	Sustainable Development	189
Bocken N.M.P., Schuit C.S.C., Kraaijenhagen C.	Experimenting with a circular business model: Lessons from eight cases	2018	Environmental Innovation and Societal Transitions	159

Bengtsson F., Gerfalk P.J.	Information technology as a change actant in sustainability innovation: Insights from Uppsala	2011	Journal of Strategic Information Systems	132
Smith P.A.C., Sharicz C.	The shift needed for sustainability	2011	Learning Organization	122
Liedtke C., Baedeker C., Hasselkuß M., Rohn H., Grinewitschus V.	User-integrated innovation in Sustainable LivingLabs: An experimental infrastructure for researching and developing sustainable product service systems	2015	Journal of Cleaner Production	120
Seuring S.	Supply chain management for sustainable products - insights from research applying mixed methodologies	2011	Business Strategy and the Environment	118

Table 5. List of the most cited publications in TDR.

Authors	Title	Year	Journal	Cited by
Lang D.J., Wiek A., Bergmann M., Stauffacher M., Martens P., Moll P., Swilling M., Thomas C.J.	Transdisciplinary research in sustainability science: Practice, principles, and challenges	2012	Sustainability Science	1298

O'Brien K.	Global environmental change II: From adaptation to deliberate transformation	2012	Progress in Human Geography	580
Wu J.	Urban ecology and sustainability: The state-of-the-science and future directions	2014	Landscape and Urban Planning	481
Abson D.J., Fischer J., Leventon J., Newig J., Schomerus T., Vilsmaier U., von Wehrden H., Abernethy P., Ives C.D., Jager N.W., Lang D.J.	Leverage points for sustainability transformation	2017	Ambio	464
Farley J., Costanza R.	Payments for ecosystem services: From local to global	2010	Ecological Economics	429
Kabisch N., Frantzeskaki N., Pauleit S., Naumann S., Davis M., Artmann M., Haase D., Knapp S., Korn H., Stadler J., Zaunberger K., Bonn A.	Nature-based solutions to climate change mitigation and adaptation in urban areas: Perspectives on indicators, knowledge gaps, barriers, and opportunities for action	2016	Ecology and Society	413
Hirsch Hadorn G., Bradley D., Pohl C., Rist S., Wiesmann U.	Implications of transdisciplinarity for sustainability research	2006	Ecological Economics	400

Nevens F., Frantzeskaki N., Gorissen L., Loorbach D.	Urban Transition Labs: Co-creating transformative action for sustainable cities	2013	Journal of Cleaner Production	357
Ahern J.	Urban landscape sustainability and resilience: The promise and challenges of integrating ecology with urban planning and design	2013	Landscape Ecology	325
Broman G.I., Robèrt K.-H.	A framework for strategic sustainable development	2017	Journal of Cleaner Production	288

Table 6. List of the most cited publications in TAR.

Authors	Title	Year	Journal	Cited by
Sipos Y., Battisti B., Grimm K.	Achieving transformative sustainability learning: Engaging head, hands and heart	2008	International Journal of Sustainability in Higher Education	389
Wittmayer J.M., Schäpke N.	Action, research and participation: roles of researchers in sustainability transitions	2014	Sustainability Science	229
Liedtke C., Baedeker C., Hasselkuß M., Rohn H., Grinewitschus V.	User-integrated innovation in Sustainable LivingLabs: An experimental infrastructure for researching and	2015	Journal of Cleaner Production	120

	developing sustainable product service systems			
Ulsrud K., Winther T., Palit D., Rohracher H.	Village-level solar power in Africa: Accelerating access to electricity services through a socio-technical design in Kenya	2015	Energy Research and Social Science	95
Ziervogel G., Cowen A., Ziniades J.	Moving from adaptive to transformative capacity: Building foundations for inclusive, thriving, and regenerative urban settlements	2016	Sustainability (Switzerland)	73
Wittmayer J.M., Schäpke N., van Steenbergen F., Omann I.	Making sense of sustainability transitions locally: how action research contributes to addressing societal challenges	2014	Critical Policy Studies	65
Andersson E.	Turning waste into value: Using human urine to enrich soils for sustainable food production in Uganda	2015	Journal of Cleaner Production	58
Schroth O., Hayek U.W., Lange E., Sheppard S.R.J., Schmid W.A.	Multiple-case study of landscape visualizations as a tool in transdisciplinary planning workshops	2011	Landscape Journal	50

| Christens B., Perkins D.D. | Transdisciplinary, multilevel action research to enhance ecological and psychopolitical validity | 2008 | Journal of Community Psychology | 50 |
| Crowe P.R., Foley K., Collier M.J. | Operationalizing urban resilience through a framework for adaptive co-management and design: Five experiments in urban planning practice and policy | 2016 | Environmental Science and Policy | 53 |

Appendix C. Definitions

Table 7. The most common definitions of action research referenced.

Definition	Source	Number of articles citing this definition	Further information
Action research is a participatory process concerned with developing practical knowing in the pursuit of worthwhile human purposes. It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities.	*The SAGE Handbook of Action Research* (book)	Peter Reason and Hilary Bradbury (2001): 14 Mary Brydon-Miller and colleagues (2003): 1 Peter Reason and Hilary Bradbury (2008): 8 Hilary Bradbury (2015): 2	Multiple editions had minor variations on the same definition. Definition given by Mary Brydon-Miller and colleagues (2003) directly quotes Peter Reason and Hilary Bradbury's

		Total: **24**	(2001) definition.
Action research is an approach to inquiry that assists [researchers] to systematically explore real-life problems they experience in their work and to formulate effective and sustainable solutions that enhance the lives of the people they serve.	*Action research: A handbook for practitioners* (book)	Ernest T. Stringer (1996): 1 Ernest T. Stringer (2007): 4 Ernest T. Stringer (2014): 2 Total: **7**	Multiple editions had minor variations on the same definition.
Participatory Action Research seeks to understand and improve the world by changing it. At its heart is collective, self-reflective inquiry that researchers and participants undertake, so they can understand and improve upon the practices in which they participate and the situations in which they find themselves. The reflective process is directly linked to action, influenced by understanding of history, culture, and local context and embedded in social relationships. The process of PAR should be empowering and lead to people having increased control over their lives.	Participatory action research (article)	Fran Baum and colleagues (2006): **6**	In the *Journal of Epidemiology and Community Health.*

Table 8. The most commonly cited sources for action research definitions that did not quote a consistent definition.

Source(s)	Number of citations in definitions	Further information
Articles by Kurt Lewin	Kurt Lewin (1944): 2 Kurt Lewin (1946): 16 Kurt Lewin (1947): 1 Total: **19**	Many citations were used not to support the definition itself, but as a reference for the term 'action research'.
Introduction to Action Research (book)	Davydd J. Greenwood and Morten Levin (1998): 2 Davydd J. Greenwood and Morten Levin (2007): 5 Total: **7**	Multiple editions of the same book.
The Action Research Planner (book)	Stephen Kemmis and Robin McTaggart (1985): 6 Stephen Kemmis and colleagues (2014): 3 Total: **9**	Most definitions contained references to cycles of action and reflection.
Action research for operations management (article)	Paul Coghlan and David Coghlan's (2002): **5**	In the *International Journal of Operations & Production Management*.
An assessment of the scientific merits of action research (article)	Gerald I. Susman and Roger D. Everett (Susman & Evered, 1978): **5**	In *Administrative Science Quarterly*.
Action Research: Principles and Practice (book)	Jean McNiff and Jack Whitehead (2002): 4 Jean McNiff and Jack Whitehead (2011): 1 Jean McNiff (2013): 1 Total: **6**	Multiple editions of the same book.

Table 9. The most common definitions of transdisciplinarity referenced.

Definition	Source	Number of articles drawing on this definition	Further information
Transdisciplinarity is a reflexive, integrative, method driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge.	Transdisciplinary research in sustainability science: practice, principles, and challenges (article)	Daniel Lang and colleagues (2012): **57**	In *Sustainability Science.*
Transdisciplinarity is a critical and self-reflexive research approach that relates societal with scientific problems; it produces new knowledge by integrating different scientific and extra-scientific insights; its aim is to contribute to both societal and scientific progress; integration is the cognitive operation of establishing a novel, hitherto non-existent connection between the distinct epistemic, social–organizational, and communicative entities that make up the given problem context.	Transdisciplinarity: Between mainstreaming and marginalization (article)	Thomas Jahn and colleagues (2012): **28**	In *Ecological Economics.*
Transdisciplinarity is a research approach that includes multiple scientific disciplines (interdisciplinarity) focusing on shared problems and the active	A review of transdisciplinary research in sustainability	Patric Brandt and colleagues (2013): **14**	In *Ecological Economics.*

input of practitioners from outside academia.	science (article)		
Transdisciplinarity aspires to the efficient use of knowledge by relating different epistemics (i.e., ways of knowing) when dealing with a complex, societally relevant real-world problem. This is done by launching mutual learning among science and key stakeholders from society including local knowledge, scientific knowledge, and the knowledge of concerned industries, businesses, and non-governmental organizations. A transdisciplinary process calls for relating both knowledge and values from practice in science as well as for developing and utilizing science knowledge in and for practice. The goal is the production of socially robust knowledge.	The real type and ideal type of transdisciplinary processes: part I—theoretical foundations And The real type and ideal type of transdisciplinary processes: part II—what constraints and obstacles do we meet in practice? (articles)	Roland W. Scholz and Gerald Steiner (2015): **21**	Definition is rooted in the Zurich 2000 definition. In *Sustainability Science*.
By transdisciplinarity we mean that ecological economics goes beyond our normal conceptions of scientific disciplines and tries to integrate and synthesize many different disciplinary perspectives. One way to do this is by focusing more directly on the problems, rather than the particular intellectual tools and models used to solve them, and by ignoring arbitrary intellectual turf boundaries. No discipline has intellectual precedence in an endeavour as important as achieving sustainability. While	Implications of transdisciplinarity for sustainability research (article)	Gertrude Hirsch Hadorn and colleagues (2006): **16**	In *Ecological Economics*.

the intellectual tools we use in this quest are important, they are secondary to the goal of solving the critical problems of managing our use of the planet.			
Transdisciplinarity is a process of mutual learning and joint problem solving, in which scientists from different disciplines collaborate with practitioners to solve real-world problems.	Transdisciplinary case studies as a means of sustainability learning: Historical framework and theory (article)	Roland W. Scholz and colleagues (2006): **11**	In the *International Journal of Sustainability in Higher Education*.
"Transdisciplinary research, …, aims at identifying, structuring, analysing and handling issues in problem fields with the aspiration "(a) to grasp the relevant complexity of a problem (b) to take into account the diversity of life-world and scientific perceptions of problems, (c) to link abstract and case-specific knowledge, and (d) develop knowledge and practices that promote what is perceived to be the common good" (Pohl and Hirsch Hadorn 2007, p. 20)"	Handbook of transdisciplinary research (book)	Gertrude Hirsch Hadorn and colleagues (2008): **16**	The definition cites another book

Table 10. The most commonly cited sources for transdisciplinary definitions that did not quote a consistent definition.

Source(s)	Number of citations in definitions	Further information
Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society (book)	Julie Thompson Klein and colleagues (2001): **13**	
Principles for Designing Transdisciplinary Research (book)	Christian Pohl and Gertrude Hirsch Hadorn (2007): **16**	The authors do not align themselves with a concise, specific definition, but they do describe principles for designing transdisciplinary research and provide an extensive appendix presenting a wide range of different definitions of transdisciplinarity.

Table 11. The most common definitions of AR in TAR referenced.

Definition	Source	Number of articles drawing on this definition	Further information
Action research is a participatory process concerned with developing practical knowing in the pursuit of worthwhile human purposes. It seeks to bring together action and reflection, theory and practice, in participation with	*The SAGE Handbook of Action Research* (book)	Mary Brydon-Miller and colleagues (2003): 1 Peter Reason and Hilary Bradbury (2008): 6 Hilary Bradbury-Huang (2010): 2 Total: **9**	Multiple editions had minor variations on the same definition.

others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities.			
Was therefore searching for ways to foster collaborative learning among experts and clients, for which he suggests a cyclic or spiral procedure with a sequence of planning-acting-observing-reflecting.	Readings in social psychology (article)	Kurt Lewin (1947): 2 Kurt Lewin (1948): 1 Total: **3**	
Research approach, which seeks to put 'social research to use for democratic social change'.	Sage Publications (book)	Davydd J. Greenwood and Morten Levin (2007): **2**	
Action research is an approach to inquiry that assists [researchers] to systematically explore real-life problems they experience in their work and to formulate effective and sustainable	*Action research: A handbook for practitioners* (book)	Ernest T. Stringer (1999): 1 Ernest T. Stringer (2007): 1 Total: **2**	Editions had minor variations on the same definition.

solutions that enhance the lives of the people they serve.			

Table 12. The most common definitions of TAR referenced.

Definition	Source	Number of articles drawing on this definition	Further information
Transdisciplinary action research (TDAR) as including various types of collaboration as determined by their organizational scope (integration across organizations), analytic scope (integration across disciplines), and geographic scales (moving from local to global).	Toward a Science of Transdisciplinary Action Research (article)	Daniel Stokols (2003): 1 Daniel Stokols (2006): 4 Daniel Stokols and colleagues (2013): 1 Total: **6**	This is the only TAR definition we found

Table 13. The most common definitions of TDR in TAR referenced.

Definition	Source	Number of articles drawing on this definition	Further information
Transdisciplinarity is a reflexive, integrative, method	Transdisciplinary research in sustainability	Daniel Lang and colleagues (2012): **9**	In *Sustainability Science.*

driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge.	science: practice, principles, and challenges (article)		
Transdisciplinarity is the ongoing process of inquiry-driven interaction, engagement of knowledge, and informative action that can assist in addressing the complexities of the world	Manifesto of Transdisciplinarity (book)	Basarab Nicolescu (2002): 3 Basarab Nicolescu (2008): 1 Total: **4**	
Uses a curriculum that integrates knowledge from numerous distinct disciplines, embedding streams of knowledge into one another and integrating them in new ways	Articles	Janet Moore (2005a): 1 (2005b): 1 (2005c):1 Total: **3**	Published in different journals

Appendix D. Geographical locations of studies

There was a number of articles that were not included in the figures above because they described the locations in terms that would be difficult to

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include in the above maps (e.g. macro regions or former independent republics).

a)

© Australian Bureau of Statistics, GeoNames, Microsoft, Navinfo, OpenStreetMap, TomTom

b)

© Australian Bureau of Statistics, GeoNames, Microsoft, Navinfo, OpenStreetMap, TomTom

c)
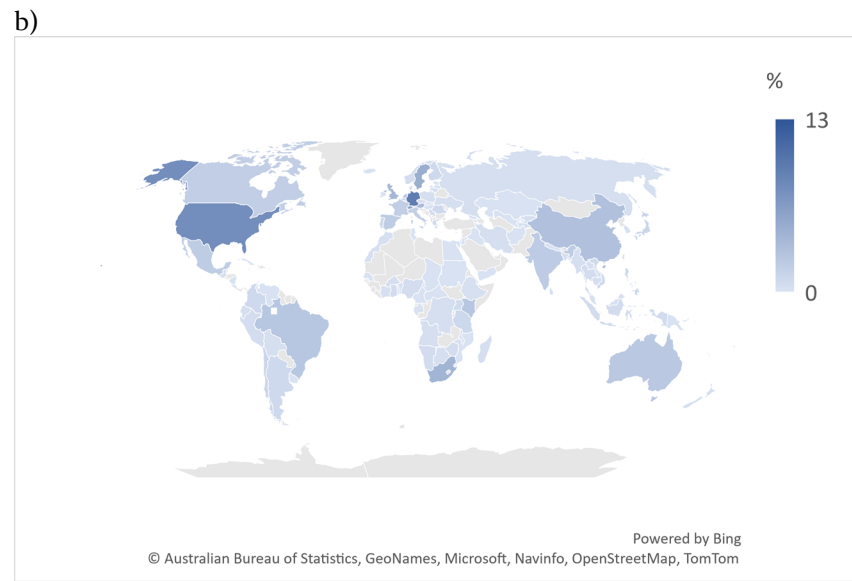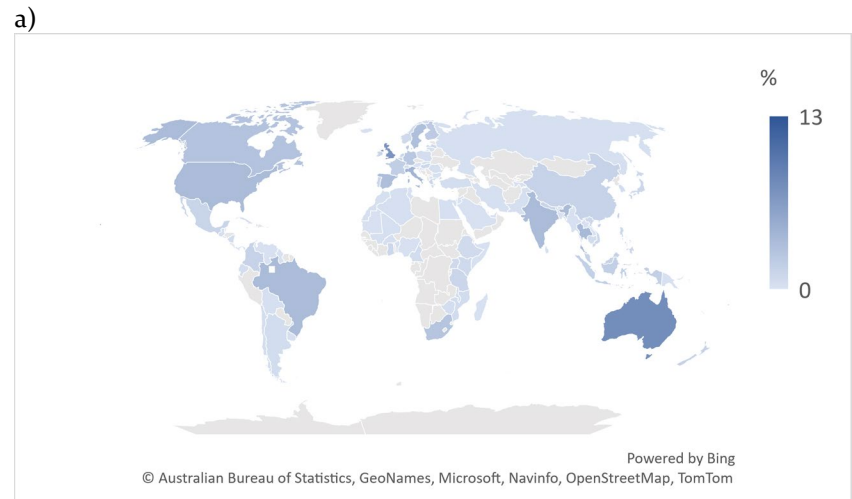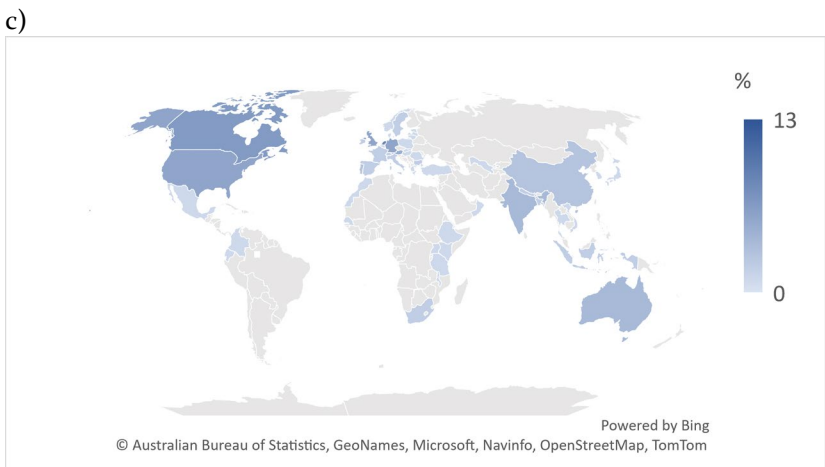
Figure 14. Number of times the study took place in a country for: a) AR; b) TDR, c) TAR.

Table 14. Number of countries studied in TDR, AR and TAR.

Number of countries studied	TDR	AR	TAR
0 countries	286	59	8
1 country	409	527	46
2 countries	46	29	6
3 and more countries	72	29	10
Total number of different countries	112	102	52

Appendix E. Journals analysis

Table 15. Journals analysis of AR publications.

Journal title	Number of articles
Sustainability (Switzerland)	62

Journal of Cleaner Production	33
Action Research	14
Journal of Teacher Education for Sustainability	12
Local Environment	11
Educational Action Research	11
International Journal of Sustainability in Higher Education	11
Systemic Practice and Action Research	10
International Journal of Agricultural Sustainability	8
Sustainability Science	8
Other 342 journals	453

Table 16. Journals analysis of TDR publications.

Journal title	Number of articles
Sustainability (Switzerland)	92
Sustainability Science	74
GAIA	32
Ecology and Society	31
International Journal of Sustainability in Higher Education	29
Environmental Science and Policy	24
Journal of Cleaner Production	24
Futures	17
Mountain Research and Development	14

Ecological Economics	8
Water (Switzerland)	8
Other 304 journals	446

Table 17. Journals analysis of TAR publications.

Journal title	Number of articles
Sustainability (Switzerland)	10
Sustainability Science	6
Systems Research and Behavioural Science	4
Journal of Cleaner Production	4
International Journal of Sustainability in Higher Education	2
Landscape Journal	2
Action Research	2
Other 38 journals	38

Table 18. Inductive coding based on the topic of the journal and the disciplinary focus.

AR	
Topic of the journal and discipline	Article count
Inter- and transdisciplinarity	113
Education	103
Environmental studies and forestry	66
Architecture and design	64
Geography	41
Business	41

Agriculture	38
Engineering and technology	36
Multidisciplinary	26
Methodological	24
TDR	
Topic of the journal and discipline	Article count
Inter- and transdisciplinarity	285
Environmental studies and forestry	153
Education	62
Architecture and design	62
Engineering and technology	38
Geography	26
Multidisciplinary	25
Business	22
Biology	20
TAR	
Topic of the journal and discipline	Article count
Inter- and transdisciplinarity	25
Engineering and technology	8
Education	6
Architecture and design	5
Environmental studies and forestry	5
Medicine and health	4
Geography	4
Methodological	2
Biology	2

Appendix F. Authors network analysis

For AR the software identified 1857 authors and placed them into 189 clusters (Figure 1a). We can see from the figure that researchers work individually or in smaller research groups. They have also produced very few papers per person.

For TDR the software identified 3286 authors and placed them into 48 clusters (Figure 1b). We can see from the figure that researchers tend to collaborate. It means several things. Firstly, the papers have multiple authors. Secondly, people from different institutions create clusters. Thirdly, there is collaboration between clusters: one can see one large network in the middle of Figure 12. Additionally, TDR authors published multiple papers.

For TAR the software identified 280 authors and placed them into 62 clusters (Figure 1c). We can see that researcher work individually or in diverse groups. There is no collaboration between clusters. The authors tend to publish few publications.

a)
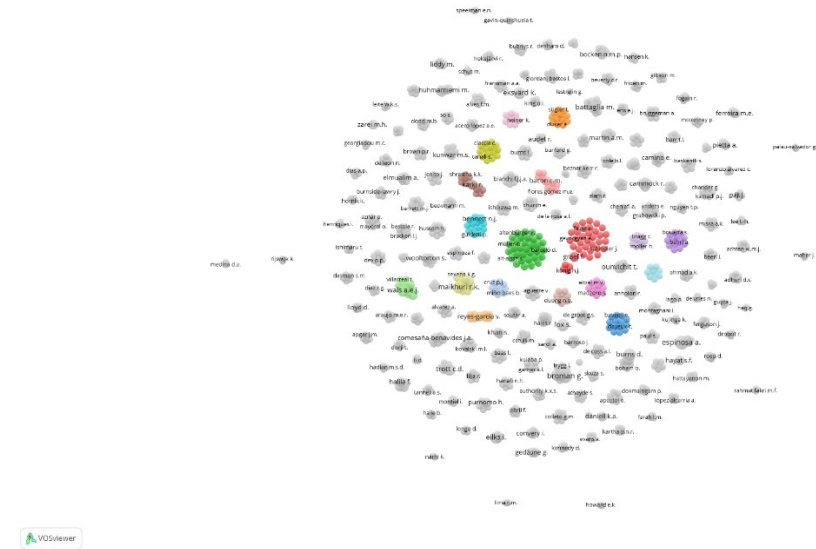
b)
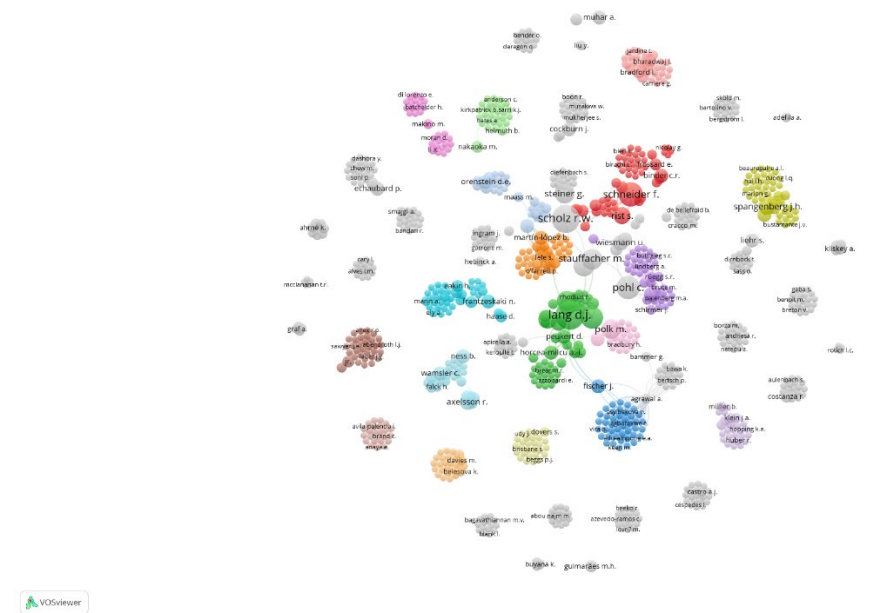
c)
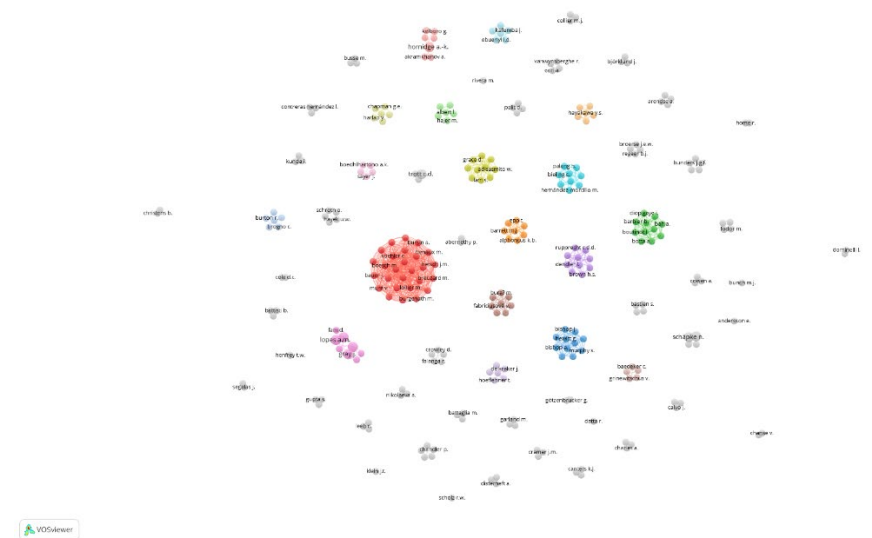
Figure 15. Author network analysis for: a) AR, b) TDR, c) TAR.

Appendix G. Summary of the results

Table 16. Some differences and similarities between AR, TDR, and TAR.

	Action Research	Transdisciplinary research	Transdisciplinary Action Research
History/ development	**Early mentions** 1940s. **Some early theoretical influences:** Kurt Lewin, John Dewey, Paolo Freire. Main **traditions** - pragmatic and critical. Traditionally **employed** within the fields of social psychology, teacher research, development studies. Today **advocated** as a methodology for sustainability science. Many **communities** of practice.	**Early mentions** 1970s. **Rooted** in interdisciplinary studies and/or AR. **Some early theoretical influences:** Jürgen Habermas, systems theory, Ulrich Beck. Main **discourses**: transcendence, transgression and problem-solving and their combinations (the largest discourse is transcendence & problem solving). **Employed** in environmental sciences, landscape management, health, critical development research, community science. **Advocated** as underpinning research approach for sustainability science. Many **communities** of practice.	**Early mentions** 2000s. **Draws** on AR and TDR: **AR** - normative judgements about impacts; **TDR** - integration of disciplines. **No communities** of practice.
Methodology	AR spiral	Ideal type	None
Types of sustainability issues emphasised	Main sustainability **issues**: education, industry, other[1], agriculture. Authors' **keywords**[2]: agroecology (a lot more than other), case studies, climate change	Main sustainability **issues**: research and knowledge production, education, other, governance. Authors' **keywords**: collaboration, case studies, climate change, complexity, education, innovation, interdisciplinarity.	Main sustainability **issues**: research and knowledge production, agriculture, education, landscapes. Authors' **keywords**: agroecology (a lot more than other), education for sustainable development, environment, learning, participatory AR.

[1]'Other' includes 'technology', 'collaboration', 'design', and 'sustainability'.
[2]Excluding 'sustainability', 'transdisciplinarity', 'AR', 'sustainable development', 'transdisciplinary', 'transdisciplinary research', and 'sustainability science'.

Table 16. Some differences and similarities between AR, TDR, TAR (Continued).

	AR	TDR	TAR
Patterns in citation	Core **literature** themes: AR application, aspects of participation, methodological advancement, participatory AR, education for sustainable development, social policy problems. **Schools of thought**: AR theory and methodology, resilience, agriculture, transitions, organisational studies, education, PAR, resource conservation (and 6 more).	Core **literature** themes: TDR theory and methodology, sustainability assessment, learning for problem-solving, citizen participation. **Schools of thought**: TDR theory and methodology, learning to solve sustainability challenges, ecosystems, resilience, transitions, health.	Core **literature** themes: solving sustainability challenges. **Schools of thought**: TDR theory and methodology, learning and transitions, TAR, sustainability studies, urban development, resilience (and 3 more).
Patterns in authorship	**Research networks**: 1857 authors in 189 networks, no collaboration between networks, few papers per person.	**Research networks**: 3286 authors in 48 networks, collaboration between networks, multiple papers per person.	**Research networks**: 280 authors in 62 networks, no collaboration between networks, few papers per person.
Definitions	A lot is published in **books**. 46% **defined** the term. The **most frequent** definition: Peter Reason and Hilary Bradbury's (2001; 2008; Bradbury 2015) Not **framed** for sustainability. Wide variety. Common **theme** – practical solutions to human problems.	A lot is published in **articles**. 52% **defined** the term. The **most frequent definition**: Daniel Lang and colleagues (2012) **Framed** for sustainability. Wide variety. Common **themes**: contribution to science and practice (not only people-related), reflexivity, co-production.	A lot is published in **articles**. 90% contained references to **definitions**. The **most frequent** definitions: **AR** Peter Reason and Hilary Bradbury's (2003; 2008; Bradbury-Huang 2010). **TDR** Daniel Lang and colleagues (2012), **TAR** Daniel Stokols (2006). **Framed** for sustainability. Only one definition of TAR. Common **theme**: contribution to science and practice (not only people-related) on the global level.

Table 16. Some differences and similarities between AR, TDR, TAR (Continued).

	AR	TDR	TAR
Article types	Article **purpose** (ordered): understanding and/or solving a problem, advancing the field and addressing a challenge, methodological, conceptual and/or theoretical advancement. Focus has decreased **over time** to both conceptual and empirical advancement of the field.	Article **purpose** (ordered): methodological, conceptual and/or theoretical advancement, understanding and/or solving problems, advancing the field and addressing a challenge. Focus on methodological advancement of the field and understanding and/or solving problems, decreased **over time.**	Article **purpose** (almost equally): understanding and/or solving a problem, advancing the field and addressing a challenge, methodological, conceptual and/or theoretical advancement. Focus on methodological, conceptual and/or theoretical advancement increased **over time.**
Location of studies	102 different countries **Top 3**: Australia, the UK, Italy. **Lower** interest on African continent compared to TDR. Primarily **single country study.**	112 different countries **Top 3**: Germany, the US, Switzerland. **Higher** interest on African continent compared to AR and TAR. The highest number of studies between 3 and more countries.	52 different countries **Top 5:** Netherlands, Canada, Germany, the US, the UK. **Limited** interest on African continent compared to TDR. Primarily **single country study.**
Methods used	**Data** preference: primary **Methods**: qualitative; more participatory and reflective/reflexive than TDR **Top 5** methods: interview, workshop, questionnaire, participant observation, discussion. Methods used **more than** in TDR and TAR: discussion, focus group, journaling.	**Data** preference: primary **Methods**: qualitative and mixed Top 5 methods: interview, workshop, case study, questionnaire, participant observation. Methods used **more than** in AR and TAR: scenario/forecasting, modelling.	**Data** preference: primary **Methods:** qualitative and mixed equally; more participatory and reflective/reflexive than AR and TDR. **Top 5** methods: interview, workshop, participant observation, discussion, questionnaire. Methods used **more than** in AR and TDR: literature review, meeting, coding.

Table 16. Some differences and similarities between AR, TDR, TAR (Continued).

Stakeholder involvement	**Engagement** 94% **Top 3** categories: professionals (incl. workers and trade unions), local communities, government departments (incl. politicians, policy makers and advisers).	**Engagement** 98% **Top 3** categories: professionals (incl. workers and trade unions), government departments (incl. politicians, policy makers and advisers), local communities.	**Engagement** 77% **Top 3** categories: government departments (incl. politicians, policy makers and advisers), professionals (incl. workers and trade unions), local communities.
Disciplinary distribution	Published in 352 **different journals:** **No1** Sustainability (Switzerland), **No2** Journal of Cleaner Production. Journals' **foci**[3]: Education, Environmental studies and forestry, Architecture, and design.	Published in 316 **different journals:** **No1** Sustainability (Switzerland), **No2** Sustainability Science. Journals' **foci:** Environmental studies and forestry, Education, Architecture and design.	Published in 45 **different journals:** **No1** Sustainability (Switzerland), **No2** Sustainability Science. Journals' **foci:** Engineering and technology, Education, Architecture and design.

[3]Beyond inter- and transdisciplinarity. TDR published more than twice as many articles that AR and 11 times as many than TAR.

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Paper D

Lost in translation: a framework for analysing complexity of co-production settings in relation to epistemic communities, linguistic diversities and culture

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Lost in translation: a framework for analysing complexity of co-production settings in relation to epistemic communities, linguistic diversities and culture.

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Abstract

Planning in modern urban environments requires skills to address complexity in order to move towards sustainability. Co-production of knowledge in transdisciplinary groups represents a useful tool in such contexts. Using the concepts of epistemic communities, linguistic diversity and culture, the article proposes a conceptual framework for analysing complexity of co-production settings, as an indispensable means of managing complex challenges, thus making these complexities visible for the project leader (facilitator) and the participants of the co-production process. We evaluate the framework on the basis of inclusivity, cross-sectoral understanding, applicability in different contexts and time perspectives. Based on the framework, we identify several aspects that a process leader (facilitator) would need to address when preparing for a co-production process: linguistic equality between participants, disciplinary integrity, a working culture of mutual respect, simultaneous mitigation and informed facilitation. Finally, the article suggests possible future research areas related to development of the framework, including (i) identification of levels of complexity and mapping specific tools to address complexity at each level; (ii) integration of other factors of complexity, such as political and institutional contexts, as well as diversity of gender and age in the facilitated group.

Keywords: *transdisciplinary, linguistic diversity, multicultural, epistemic communities, multi-stakeholder dialogue, urban planning*

1.   Introduction

The metaphor 'lost in translation' can be understood in three ways. It applies not only in literal terms – message being lost due to language constructions – but also for transdisciplinary spaces where the languages of different epistemic communities of practice (networks of experts that share a common knowledge-base) (Haas, 1992) become a barrier. The third underlying angle of being 'lost in translation' is the aspect of culture that cannot easily be depicted in words but still plays a crucial role in interpersonal communication of co-production processes. These three aspects therefore also take part in shaping the experience of such processes.

Managing complex problems in complex adaptive systems, such as urban planning with the objective of sustainable development, requires both a reductionist (disciplinary and specialized knowledge) and a systemic (transdisciplinary and co-produced knowledge) perspective (Brouwer, Woodhill, Hemmati, Verhoosel, & van Vugt, 2016, p. 46). As the factors affecting sustainable urban development are too many to be managed simultaneously by one transdisciplinary process, framing the challenge and prioritizing key efforts is essential to the effectiveness with which the process is managed (Wuelser, Pohl, & Hirsch Hadorn, 2012, p. 82). However, being itself part of the complex adaptive system which it attempts to affect, the transdisciplinary process faces challenges of complexity as well.

The common denominator for the chosen concepts of epistemic communities, linguistic diversities ans culture which constitute part of complexity in the given context, is their fundamental importance concerning boundaries of meaning (see for example Benveniste, 1971), communication (see for example Mills, 1997) and recognition (Honneth, 1992; see also Section 3.2). Ultimately, they concern mutual understanding in relation to diversity between stakeholders both on an individual level and between different collectives, but also between individuals within a larger group of collaborating collectives. Aiming for mutual understanding while preserving diversity is considered a prerequisite as well as a challenge for joint production of knowledge (Pohl et al., 2010). Epistemic communities, a diversity of languages, and culture, however, all comprise obstacles to mutual understanding, regardless of other conditions affecting participants in joint knowledge production (such as material inequalities and different schedules). Moreover, epistemic communities, language and culture are closely interrelated and affect one another constantly. Different thought styles through the interpretation and use of concepts exist even within the

same language but are usually more pronounced between languages (Haas, 1992). In the context of multiple languages, participants in a transdisciplinary process are exposed to even more potential ambiguities and misunderstandings (Weber, 2018). Furthermore, epistemic communities and linguistic diversity are affected by the cultures of the particular organizational and working environments to which participants of transdisciplinary urban planning processes belong, as well as the combination of individual participants' cultural background regardless of their employment (Somerville, 2005).

1.1.   Epistemic communities

Modern cities face increasing complexity in relation to planning necessary to address the imperative of moving towards sustainability. Our society's present capacity to do so is inadequate (Brown, 2008). This challenge is relevant in local, national and international contexts, meaning that policymakers are in ever greater need of expert knowledge to be able to make well-informed choices. Experts are now found in diverse areas within and outside of academia. Their joint efforts are necessary to tackle such complex challenges, as exemplified by co-production of knowledge in transdisciplinary groups (Polk & Kain, 2015). These groups are represented by a range of epistemic communities (Haas, 1992). In Western tradition, specialised knowledge became a barrier for social learning necessary to address complexity (Brown, 2008). This also affected non-Western countries whose local knowledge has become inaccessible through the increasing dominance of Western discourses and technologies (Simon, Palmer, Riise, Smit, & Valencia, 2018). In transdisciplinary teams, challenges of knowledge diversity are accelerated for a number of reasons such as different contexts within and between regions of the world; less shared epistemological understanding or theory of knowledge (Creswell & Poth, 2018); power relations between diverse actors and societal sectors, and culture in terms of practice, traditions, values and norms (Simon et al., 2018). The challenges of unequal dispositions and power relations in co-producing knowledge are evident and need to be managed if the outcomes are to match the purpose of combining diverse expertise. As a starting point, one discipline must not be favoured over another (Pohl et al., 2010).

Being part of the same epistemic communities is argued to support a dialogue in transdisciplinary co-production of knowledge through a shared systemic view of the challenge, enabling the identification of local needs, the

framing of debate and negotiation, and, finally, the identification of suitable solutions and policies (Simon, McGregor, Nsiah-Gyabaah, & Thompson, 2003). At the same time, local context can play a key role in co-production processes as even within the same epistemic community, challenges may arise if other variables separate participants.

The level of complexity in transdisciplinary planning is severely increased when language barriers are present. Still, English is generally used as the everyday language as if virtually unproblematic, although it is certainly acknowledged that language is intimately linked to relations of power. This challenge has recently been highlighted by the German linguist Tilo Weber as a major obstacle for equal participation in transdisciplinary processes (Weber, 2018).

1.2.   Linguistic diversity

Linguistic diversity (a concentration of unique languages in one context) is a widespread phenomenon in many contemporary states and urban areas. Canada, for example, has a long experience of mitigating the linguistic differences between French and English speaking citizens (Sullivan 2004, p. 991). Sweden also has five official minority languages, Finnish, Jiddisch, Romani, Meänkieli and Sámi, each with its own historical legacy and legislative protection as well as some guaranteed administrative support to its speakers (Sundberg, 2013). Kenya has two official languages – English and Swahili, however there are many local languages and dialects, and even within the same city it is difficult to facilitate a dialogue (Nikulina, Baumann, Simon, & Sprei, 2018). One can also find many other examples of such contexts around the world.

Today, the need for multilingual dialogue is greater than ever. Different linguistic communities within the same region or stakeholders from regions in different countries need to co-operate in order to tackle complex societal problems, the UN and the EU being major examples of a much wider and everyday-based development. For example, the Sustainable Development Goals (see: https://sustainabledevelopment.un.org) invite nations to collaborate in addressing a number of challenges formulated as goals. The challenges and possibilities of multilingual dialogue are essential elements in an era of globalization, multicultural societies and linguistic pluralism. Linguistic diversity is influenced and challenged by a still widespread universalist ideology of one common language (or lingua franca) claiming lingua franca as a prerequisite for maintaining vivid democratic dialogue

(Lüdi, 2015, p. 214). This is accompanied by increasing provincialism and nationalism throughout the world while the need for co-producing solutions to complex societal challenges within and across nation-borders is evident.

> Georges Lüdi (2015, p. 215) says:

> *"The steady increase in the numbers of migrants, expatriates, exchange of scientists, etc. and the globalisation of communication through electronic media entail many forms of social multilingualism at the workplace, i.e. people with very different linguistic and cultural background are brought to work together in mixed teams".*

Taking into account the challenges described above, solving issues across different scales will require both local and general expertise, which entails encountering both linguistic and epistemic differences (Haas 1992, pp. 12-13).

1.3.   Culture

Working in a shared space of co-production in multi-stakeholder transdisciplinary groups can lead to a culture shock: entering a group different from yourself (Leslie and Storey 2003, pp. 122-127), where, based on personal and working culture, a new group culture should emerge in the process. While personal culture is often subdued, working culture can become a barrier, for example, when certain stakeholders are not accustomed to participatory approaches and feel uncomfortable openly sharing their opinions and thoughts. Cultural awareness both on a personal and on a working level becomes another condition for creating an inclusive environment for the participants in the dialogue (Brouwer et al., 2016; Simon et al., 2003).

1.4.   Aim and target audience

The three concepts epistemic communities, linguistic diversity and culture that form the focus of this article are not novelties and they are used separately by different scholars and practitioners. Based on the literature review, we could not find effective frameworks that support the process of simultaneously managing these concepts. This risks creating major obstacles for bringing matters forward in some of the most complex and pressing contemporary and future problems and thereby it also risks not creating sufficiently well-informed decisions in ongoing change processes. Therefore,

the aim of this paper is to present a framework for analysing complexity of co-production settings in relation to epistemic communities, linguistic diversities and culture, thus making their diversities visible to the project leader (facilitator) and the participants of the co-production process.

The paper is mainly intended for facilitators, itself a diverse and ambiguous group (Mackewn, 2008). Facilitators here refer to professionals taking on the role of guiding diverse working groups, such as the cases of multicultural, linguistically diverse transdisciplinary urban planning groups observed here. Providing facilitators with developed frameworks for such settings enables them to exercise their role and skills in a more productive way.

2.   Methodology

In order to improve the ways for dealing with the challenges of understanding each other in co-production settings, a multidimensional framework that enables the analysis of translational, epistemic and cultural problems was developed.

2.1.   Framework development

In order to develop a framework, we first undertook a literature review of three concepts that contribute to complexity, namely epistemic communities, linguistic diversity and culture and then synthesised the findings. The theoretical reasoning behind the choice of these three dimensions was outlined in Section 1. Another reason for choosing these particular concepts contributing to complexity arises from the experience of designing the three workshops (described in Section 4.1) and from reflecting on the previous experiences with facilitation of transdisciplinary groups in similar contexts. The results are outlined in Section 3.

2.2.   Application of the framework

The developed framework was tested in three geographical locations across the South Baltic area. There, multi-stakeholder workshops for sustainable public transport were observed (see Section 4 for more details) and followed by interviews with the local table leaders (people who were managing small group discussions, often in their mother tongue). A list of four interviewees

that were selected since their input was the most insightful can be found in the Table 1 (see Appendix A).

Observation enables systematic documentation of events in a chosen context (Agar, 1996; Scheyvens, 2014). It creates a "textual picture" of the situation. For this specific study, the observer as participant stance was selected (Kawulich, 2005). It means that the observer can take part in the event, but priority in the process is given to the observation. During the workshops described below, the role of observer was combined with the role of facilitator. The limitations of this approach can be seen in researcher bias (Kawulich, 2005). As suggested in the literature, the reflexivity approach (May & Perry, 2017) was used to reflect upon the observations. Moreover, a set of short interviews with table leaders was conducted shortly after the events.

For the purpose of this study, semi-structured interviews were used (Agar, 1996; Flowerdew & Martin, 2005; Mikkelsen, 2005). In the qualitative interviews with the table leaders, the main themes were predetermined, whereas specific questions were raised in the process. The advantage of this approach was that an interviewee could lead the discussion and reveal information that might not have been foreseen by the interviewer.

The proposed framework was used to evaluate the transdisciplinary co-production processes in relation to epistemic communities, linguistic diversity and culture in the given contexts.

2.3.   Evaluation of the framework

After its application tests in the workshops, the framework was evaluated in relation to inclusiveness of co-production processes, cross-sectoral understanding, applicability in different contexts and time perspective, which constitute some of the main aspects of the co-production approach (see Section 5.1).

3.   Framework development

The framework that is proposed below is based on previous research and practical experience, and takes its origins in the literature related to epistemic communities, linguistic diversity and culture. These concepts are therefore described below.

3.1.   Epistemic communities

Epistemic communities (Haas, 1992), or thought collectives (Fleck, Trenn, Merton, & Bradley, 1979), are to be understood as groups with shared and agreed forms of knowledge, thought styles, differing from or even fundamentally opposing those of other groups. Examples are engineers vis-á-vis social scientists in academia and public servants vis-á-vis entrepreneurs in other societal sectors. Due to various contextual, historical and contemporary reasons, these groups share specific knowledge often difficult to integrate into other fields. Moreover, members of the same epistemic community spread around the world often work together more effectively than people of different epistemic communities living or working in the same locality (Simon et al., 2003). When successfully integrated, however, co-production of knowledge through collaborating thought collectives provides a more balanced understanding of a specific complex problem in the local context and its solutions, while also enabling more integrated research (Baumann, 2009; Haas, 1992; Pohl et al., 2010).

Even within the same epistemic community, challenges may arise and change according to local context (Simon et al., 2018). No single thought style is able to derive the same results and knowledge everywhere, especially from a global perspective, as stated by James Esson and his colleagues (2016, p. 40) in a study of Accra's mobility systems:

> *"The overarching argument that emerges from bringing a holistic approach that combines transport, mobility and livelihoods into conversation with the empirical findings is that conceptual frameworks such as the new mobility paradigm derived entirely based on conditions in the global North, are inherently limited, despite their implicit claims of global relevance".*

3.2.   Linguistic diversity

Sue Wright (2011) has argued for a lingua franca – that is English – in order to promote equal opportunity to evaluate information and make judgements and decisions in a European democratic context. This is based on a monolingual ideology with its roots in 16th century Europe, reaching its breakthrough during the late 18th century revolutions and Enlightenment (Lüdi 2015, p. 214). According to this ideology, communicative problems are

to be mitigated through the use of one single language, whereas linguistic diversity is problematic and undesirable.

There are several reasons why this attempt at a solution is deceptive. Language acquisition is not merely a matter of a teaching and learning effort, but it is affected by ideologies, social identities, power and agency. In a socially and economically unjust urban environment, policing a diverse population to communicate using the same second language becomes, at best, a privilege reserved for the most prosperous communities. As Peter De Costa and Bonny Norton (2017, p. 8) conclude: "Language learning is situated and attentionally and socially gated". In addition, multilingual individuals experience obvious benefits that are particularly valuable to knowledge production, such as enhanced cognitive functions and a higher likeliness of gaining new and creative insights (Yanaprasart & Lüdi, 2017).

Linguistic inequalities and its effects concern questions of recognition, identity, and, ultimately, morality. In the scientific tradition emanating from German philosopher George Wilhelm Friedrich Hegel (1977 [1807], pp. 113-114), recognition is either mutual – and therefore equal – or non-mutual and therefore unequal. An individual's lack of recognition with regard to their identity is considered a form of oppression or negation of the self's expected rights (Honneth 1992, p. 190). Due to a historical paradigm shift of class or estate partly losing its significance in favour of other foundations for social identity, such as ethnicity, gender and sexuality, language is today considered more intimately connected to recognition than before (Taylor 1994, pp. 31-32; 53-55). Not being equally recognized as a speaker means not being fully recognized as a conscious being.

A significant share of studies on linguistic diversity has been conducted in the educational sphere. Some findings state that in multilingual regions, such as Barcelona and Switzerland, enabling the use of multiple languages in education is not only possible but also adds value to students. Universities in both regions use innovative ways of teaching, team work and interaction – such as communicative applications and instant translation tools – required to make multilingualism productive and feasible in an organisational environment (Yanaprasart & Lüdi, 2017). In the case of the private and public transnational trade sector, Amy Artelt and Judith Sawaf (2013) observe a vast range of auxiliary devices supporting various European partners in successfully conducting multilingual operations.

One of the tools aiding multilingual dialogue is interpretation. The challenges of interpretation are well documented. First, naturally, the extra

time spent on interpretation is roughly double that of a 'normal' dialogue. Second, data loss, for example, when data showing essential sociological variables – such as dialects and sociolects – are being translated into a standard version of the language being interpreted. Third, using a non-professional interpreter from the local area or a particular ethnic group during field work can often result in the researcher staying unsure of whether they have thoroughly understood the purpose of their research or if there has been a misunderstanding. Fourth, the nuances of irony, humour, rhetoric and politically ambiguous concepts all run a severe risk of being lost in translation (Bujra 2011, pp. 5-6). Finally, the perception of time could be a challenge. Indo-European languages have past, present and future tenses (with some variations), whereas many other language groups do not. This aspect can be easily lost in translation. Another side of the coin is 'economic time' vs 'social time', often creating misunderstandings in the development of co-operations (Mikkelsen 2005, p. 329).

3.3. Culture

Culture, in terms of working and personal culture, for example traditions, procedures and perspectives, has large implications for the interrelations and interactions between the collective and the individual. An individual's behaviour is often dramatically affected by the working group and workplace they are a part of or interacting with due to institutionalized cultural practices associated with that place and group. However, individuals themselves are also capable of affecting workplace culture to a certain extent, since they carry with them personal attributes, of which some are in turn affected by outside norms and identities such as gender (Somerville, 2005).

There is no one answer to questions of whether increased diversity between individuals is beneficial or restraining to working cultures. Indeed, there exist certain benefits of linguistic and/or ethnic homogeneity in work teams such as reduced misunderstandings and increased consensus and efficiency, whereas mixed teams can contribute to stress and anxiety. Simultaneously, known positive outcomes of mixed teams include reduced prejudice (Offermann, Matos, & Basu DeGraaf, 2014). In any case, many parts of today's workforce are becoming increasingly diverse by design or by default, partly as a necessity and partly as a deliberate attempt at tackling challenges of discrimination. In the end, the main issue is therefore not to define whether diversity is beneficial, but rather how to optimize management of an urban

environment of unavoidable linguistic diversity and its consequent communication challenges (Yanaprasart & Lüdi, 2017).

As experience from an international project between researchers and practitioners from Ghana and the UK shows, there is a need for reassessment in addressing multiple or conflicting world views even within the same epistemic community in order to help support intended beneficiaries of such projects to meet their needs and fulfil aspirations (Simon et al., 2003). Patchareerat Yanaprasart and Georges Lüdi (2017) conclude that, in the case of academia, little is yet known about how to manage diversity challenges in general, as the objectives in diversity policies are mainly set at a strategic level, such as to favour gender mainstreaming. Managing linguistic diversity is not expected to be an exception from the rule and could therefore be considered a blind spot for academic institutions.

3.4. Framework for analysing complexity of co-production settings in relation to epistemic communities, linguistic diversity and culture

Based on the literature review, we suggest the following framework. It combines the concepts of epistemic standpoint that participants have (see more in Section 3.1), language(s) they speak to a varying degree (see Section 3.2) and culture they more or less share (see Section 3.3). Each of these concepts has three categories that we differentiate – individual, group and working. When analysing a specific facilitated group, one would look at all the concepts simultaneously with their respective categories.

Since, for example, the concept of culture would be difficult to assess numerically, one would look at the level of diversity (i.e. its range) within each category in the facilitated group. The level of diversity would be subjectively assessed by the user of the framework (facilitators and/or process leaders as we recommend). It could have only high and low diversities or high, medium and low, or more, for example. To avoid numerical representation, we recommend to use the shades of one colour to illustrate the level of diversity – where the diversity increases with darker shades. Fig. 1 illustrates the template that one can fill out based on the facilitated group of assessment.

Concept / Category	Epistemic standpoint	Linguistic diversity	Culture
Individual			
Working			
Group			

Figure 1. Matrix for complexity assessment of transdisciplinary co-production settings in relation to epistemic communities, linguistic diversity and culture with respective categories: individual, working and group.

Adrian Snodgrass and Richard Coyne (1997) discussion on the hermeneutic aspects of designing, we acknowledge workshop design, facilitation and process management to be pervaded by subjective presuppositions influencing all design processes; namely, the pre-conceived understandings of the process leader regarding the studied object (in our case, the participants) will inform the process design (Snodgrass & Coyne 1997, p. 13-14; 26), then follow a learning process guided by a series of enquiring dialogues between the process leader (or facilitator) and these objects, ultimately transforming the former's understanding of the latter beyond that of initial subjectivity (Snodgrass & Coyne 1997, p. 21-22). Therefore, according to the proposed framework, interpretation and assessment of a workshop will initially be understood by the process leader based on their previous knowledge of the participants and from previous experiences of workshops, epistemic communities, linguistic diversity, and cultural diversity. Gradually, however, this understanding will transform as the framework is used in the planning of several workshops, thereby providing more answers to the questions that the framework poses onto the various constellations of participants.

Epistemic standpoint is here characterised in relation to the categories individual, working and group. The individual epistemic standpoint is the school of thought to which each individual in the facilitated group belongs. The level of diversity will define how many different individual epistemic standpoints are present in the group – the more individual standpoints, the higher the level of diversity would be. The working epistemic standpoint is closely related to the occupation that the participant of the workshop has and the diversity of epistemic standpoints in their daily work situation. The more diverse working standpoints are present in the facilitated group, the higher the level of diversity. The epistemic standpoint of the facilitated

group as a whole is closely related to the potential shared standpoint participants have within the facilitated group or depending on the design and length of the facilitation process – the shared standpoint they obtain in the process. The diversity would be high when participants come from very distant epistemic communities and there are low chances of building a shared standpoint.

Similarly, linguistic diversity is differentiated between the individual, the working and the group. The linguistic diversity of the individual category is related to the number of mother tongue(s) that are spoken by the individual participants of the workshop. The diversity is high when there are many mother tongues present in the facilitated group. If a lingua franca is spoken at the workplaces of the facilitated group members (everybody is sharing the same working language), then the linguistic diversity of the working category is low. If there are several languages used as working languages – the diversity is high (the more languages spoken at work, the higher the diversity). The linguistic diversity of the group category relates to the mono- or multilingualism of participants: they might speak several languages to some extent, however, not to be proficient enough to use them as working languages. The more of such languages that are present in the facilitated group, the higher the linguistic diversity for the group category.

Finally, we differentiate three categories of culture – individual, working and group. Individual culture is what each participant of the facilitated group brings into the room with them, such as norms, customs, personal identity, etc. High diversity in this regard would be if the group represents many different types of backgrounds. Working culture can be defined by norms and customs at the workplaces the participants of the facilitated process belong to and bring with them to the event of analysis. High diversity in this regard would be when a facilitator and/or process leader can identify man such working cultures and subcultures. Group culture is the one that (has a possibility to) emerge in the facilitation process and thereby apply to the facilitated group as a whole. High diversity in this regard is when participants can bring in and to a lesser extent adjust their individual and working cultures.

One can use this framework to see the average level of complexity related to epistemic communities, linguistic diversity and culture (the average shade of the matrix). This could be done both at the preparatory stages of the event and as evaluation at the end of the transdisciplinary facilitation process. However, identifying the levels of diversity in each category of each concept would help raise awareness about the complexity of the context in which

they are working in relation to epistemic communities, linguistic diversity and culture in more detail. Assuming that the facilitator has previous experience or at least knows where to look for facilitation tools and methods, the increased awareness should help to make a better selection. In case of high linguistic diversity, for example, one might want to consider to have additional facilitator(s) who speak the local language(s) (for examples, see Section 4.1) and/or have an interpreter. Further studies are necessary to map specific tools and methods to exemplify how the levels of diversity in the selected concepts of the proposed framework would affect the selection of tools and methods.

4. Empirical application and findings from the three selected locations

4.1. Context of empirical studies and testing of the proposed framework

The context of the empirical study is three workshops (WS) within the INTERCONNECT project (see http://interconnect.one/) an ongoing international project (2017-2020) that received a flagship status on the European level. The project aims to reduce car dependency in the South Baltic area by providing user-oriented sustainable public transport in and between the participating regions and in cross-border commuting. There are nine main partners and 11 associated partners from the Blekinge region (Sweden), the Guldborgsund municipality (Denmark), the Rostock municipality (Germany), the Tricity metropolitan area (Gdansk, Gdynia, Sopot, Poland), the Klaipeda municipality (Lithuania), and the Viimsi municipality (Estonia). Within the project, three main areas are in focus – demand, supply and governance of public transport. One of the project working packages called "Evidence, knowledge and experience" aims to assist local stakeholders of the partner areas in identifying current and future needs of the passengers, to facilitate co-production of a vision for sustainable public transport in the region, to identify a selection of sustainable solutions in order to address current and future challenge and to create a pathway to achieve it.

Through a co-production process between Blekinge Institute of Technology (the hosting institution that provided the project with the team of facilitators) and Region Blekinge (the project manager, for more details, see

Thematic Report for the project (Borén & Ny, 2018). the format to support a working package with stakeholder workshops in focus was defined and agreed upon. It was based on a community planning process model (Robèrt, Borén, Ny, & Broman, 2017) which aims to define an approach to sustainable transport planning. Development of this model was guided by the Framework for Strategic Sustainable Development (Broman & Robèrt, 2017) with its backcasting from principles approach (Holmberg & Robèrt, 2000). The model is based on four interdependent planning perspectives: resource bases, surfaces, technology and governance.

To get a better understanding of the local context of three selected partner locations, Karlskrona (Sweden), the Tricity metropolitan area (Gdansk, Gdynia, Sopot, Poland), and Klaipeda (Lithuania), local partners of the project were invited to a dialogue that was ongoing for several months before the workshops. Local stakeholders as well as international partners got an invitation to attend the event. The main language of the workshops was English, while in each location different interpretation services were implemented.

As mentioned by Barbara Kawulich (2005), an observer can be excluded from the process due to the language of certain epistemic communities to which the observer is unfamiliar. In all three workshops, an additional layer to the risk of exclusion was the lack of a common spoken language that all participants were fluent in. A facilitator understanding both Swedish and Polish was at hand in two of the three workshops that occurred in Sweden and Poland, respectively. This enabled not only observation of the process and participants' behaviour, but also understanding of the content of the discussion. In the last workshop, taking place in Lithuania, however, interpretation of the content was achieved only through oral presentation of summaries during the day and written forms with the notes from the discussions that were translated into English. However, nuances related to language as metalanguage (expressing underlying meanings) (Agar, 1996) could have been 'lost in translation' in all workshops.

We tested the proposed framework in each location post factum, in order to evaluate the outcomes of the workshop designs done through a transdisciplinary co-production process. However, if the framework had been used in the preparatory stages of the workshop, it could have been used as supportive materials for development of workshops.

In the first workshop (WS1) in Karlskrona, in February 2018, there were 43 participants originating from different countries, speaking different mother

tongues and representing diverse epistemic communities. Most of the participants were local stakeholders living and working in the Blekinge region, with the exception of those project partners living and working in Germany and Poland. There were representatives from academia, public and private sectors, all working with questions of transport from different angles. English was spoken as a lingua franca in the large group discussions and presentations. However, when it came to break-out sessions in small groups, Swedes preferred to speak Swedish if the group was linguistically homogeneous. This meant that multilingual table leaders were collecting information delivered orally in Swedish and documenting it on flipcharts (for later presentation) and other reporting forms in English. The experience seemed not to have affected the group dynamics much, although, as one of the table leaders said: "In the mixed group participants were a bit more hesitant to express themselves [than in the native language groups]" (Wälitalo, 2018). Despite the diversity of thought collectives, participants came to the same or very similar conclusions in regard to the future of transport in the region. Many of these participants had worked together in the past, which might help to explain their resembling ways of thinking.

When applying the framework, the facilitated group can be evaluated in the following way. WS1 (see Fig. 2) had participants representing several working epistemic standpoints. This we could assess from the participants' list and information regarding their current occupation. As for individual epistemic standpoints, it could be challenging to make a detailed assessment without accessing further information about the participants. However, based on the diversity of the working epistemic standpoints, one can estimate that individual epistemic standpoints would also be of a bit higher diversity. As for group epistemic standpoint, this can also be seen as similar diversity to individual and working, however, perhaps, a bit higher diversity than working and lower diversity than individual, as most of the participants were working with questions of transport.

Category \ Concept	Epistemic standpoint	Linguistic diversity	Culture
Individual			
Working			
Group			

Figure 2. Complexity assessment of transdisciplinary co-production settings of WS1 in relation to epistemic communities, linguistic diversity and culture.

Participants of WS1 spoke several languages, both mother tongues and secondary languages, including the lingua franca. Individual linguistic diversity could be assessed as lower than individual epistemic standpoint, as more than a half of the participants had Swedish as their mother tongue. However, group linguistic diversity could be assessed as quite high, as most of the participants spoke at least 2 languages. The working languages could be assessed as similar to individual, as most of the participants spoke lingua franca.

Individual culture was quite diverse, as participants came from different cultures. However, with the exception of the partners from Germany and Poland, the rest were accustomed to Swedish working culture, so it can be seen as relatively low diversity with regard to working culture. The cultural diversity of the facilitated group as a whole had an increase throughout the day as the workshop was designed to particularly highlight Swedish traditions of, for example, fika (coffee break) and celebration of semla day (the day of special pastry called semla, a cream-filled bun). By celebrating this diversity and welcoming all the different thoughts and opinions, however, the workshop design was meant to reunite everyone in a traditional way and help them to get to know each other better rather than dividing them.

In the second workshop (WS2) in Gdynia, in February 2018, there were 53 participants coming mainly from Poland, in particular from Pomerania, Warmia and Mazury, represented by stakeholders from the local government, municipalities, service providers, academia and other relevant institutions. Most of them spoke Polish and only some of them understood or spoke English. Moreover, there was one participant who spoke English and French, but not Polish. It was the first time that many of the participants met and worked together. For the duration of the workshop, an interpreter was hired who performed simultaneous (whisper) translation in smaller groups and consecutive interpretation for the entire audience. Simultaneous interpretation saved a lot of time; however, it was often a summary of what had been said. Consecutive interpretation doubled the time of the sessions, at the same time delivering interpretation paragraph after paragraph, which created the additional challenge of keeping the attention of the audience.

From the working culture perspective, workshops are not commonly used in Poland to facilitate multi-stakeholder dialogue. In order to attract

participants, local organisers decided to change the title of the event from 'workshop' to 'seminar', which could be seen as misleading. During the event itself, participants were visibly uncomfortable with the format: they were unwilling to express their opinions during the sessions or ask questions at the presentations; when the question for discussion was not perceived as important for them, the session went very quickly, as not many people wanted to participate actively. Some of them left at different stages throughout the day. However, the questions of direct relevance that were identified as 'burning issues' (challenges they are facing right now at work) created very lively discussions, expressing different, sometimes contrasting opinions (Kuik, 2018; Wolniarska-Roszak, 2018).

Using the proposed framework for average complexity assessment, one can see that WS2 was characterised by a high diversity of epistemic standpoints, languages and culture (Fig. 3). It was pervaded by linguistic diversity (with no common individual, working and group languages), multicultural (representing different cultures and working in different contexts – high diversity, with a limited possibility to develop a common group culture) and involved different epistemic standpoints as participants represented a wide range of stakeholders with different cultural and working backgrounds with a limited possibility to develop a common epistemic standpoint throughout the day. Such a context was very demanding from the organisers' side as they also came with their own cultures, epistemic standpoints and linguistic diversity. The size of the group created additional pressure of keeping the attention and motivation throughout the day.

Concept / Category	Epistemic standpoint	Linguistic diversity	Culture
Individual			
Working			
Group			

Figure 3. Complexity assessment of transdisciplinary co-production settings of WS2 in relation to epistemic communities, linguistic diversity and culture.

In the third workshop (WS3) in Klaipeda, in March 2018, there were 17 participants representing the Klaipeda region. They were all either working for the municipality or for the city authorities. Most of them spoke Lithuanian and some spoke and/or understood English. As a solution to the multilingual challenge here, simultaneous translation through headphones

was provided. Although it seemed like an optimal solution for saving time and providing sufficient interpretation, some words got lost in translation, for example, 'accessibility' ("accessibility is the ability of people to reach goods or services as measured by their availability in terms of physical space, affordability and appropriateness. But accessibility also refers to the provision of services and facilities, job opportunities, education and housing, as well as the means of reaching them" (Simon, 2016; Waters, 2016)) in Lithuanian was translated as 'prieinamumas' and back into English as 'reachability' (according to Oxford Dictionary, reachable means "able to be reached; accessible or achievable", as well as "able to be contacted", purely in terms of being able to reach something: "a lush tropical island only reachable by seaplane" or "make sure that you set goals that are reachable" ('reachable | Definition of reachable in English by Oxford Dictionaries', n.d.)). These two terms can have different definitions and underlying assumptions and can therefore not be assumed to be used interchangeably. Moreover, in the process of simultaneous translation it was difficult to monitor whether the intonations were kept to underline certain statements. As culture and background of the participants were if not the same, but very similar, the discussions were calm, and conclusions corresponded to one another (Valadka, 2018).

The WS3 (see Fig. 4) was quite homogenous among participants (low diversity in relation to epistemic standpoints, linguistic diversity and culture), but the organisers came from very different contexts, which created a challenge in facilitating the day as the language barrier (no common working language between participants and organisers) was the strongest obstacle. One cultural element that united them all was the International Women's Day that was widely celebrated in the past, but only seldom nowadays. It was used as a starting point for the day to share a cultural tradition with all participants and provide a platform for strengthening the group culture.

Concept / Category	Epistemic standpoint	Linguistic diversity	Culture
Individual			
Working			
Group			

Figure 4. Complexity assessment of transdisciplinary co-production settings of WS3 in relation to epistemic communities, linguistic diversity and culture.

These three observations illustrate how epistemological, cultural and linguistic diversities intersect and interact in the shaping of a transdisciplinary multilingual urban planning dialogue. When applying this framework to the three selected cases, we had the comparative aspect in mind (the shades of grey can be compared between the cases). However, what it doesn't show is the relation between, for example, the number of working languages spoken in the room and the number of participants speaking all those individual languages. For example, out of 53 participants in Poland, all except one spoke Polish. On average, they did not have a common working language. However, there were not so many different working languages in total. The diversity of epistemic standpoints was especially evident during the first and second workshops, when conversations were ongoing at the breaks, but these had quite different outcomes nonetheless. The co-production process at these workshops provided a good platform for knowledge co-creation, as diversity of epistemic communities in small discussion groups was encouraged (both on voluntary basis – participants were invited to create discussion groups with people they have never worked with before; and through planned distribution of participants based on their affiliation). The third workshop, however, does seem to indicate that linguistic and cultural diversities do not categorically endanger transdisciplinary group work when intentionally managed. However, the presence of 'calm' discussion and absence of differing conclusions and critique may equally so be viewed as a lack of co-production of knowledge, in which a certain degree of critique and conflicts can be beneficial (Brouwer et al., 2016; Perry & Atherton, 2017).

Discussions in all three workshops were facilitated by a common understanding of the issue, but this was dependent on efficient communication between participants. When language barriers emerged, common understanding decreased somewhat. The first workshop, on the other hand, maintained a lingua franca ideal of English while Swedish was being used as an informal majority language, apparently leading to some participants being less active. In that way the questions of recognition, identity and morality were addressed by the organisers for the formal part of the event. However, in the breaks the participants were left without an interpreter, which means that networking and socialising were affected by it and the group naturally fell apart into smaller groups of those speaking one common language or lingua franca (mainly, English, Swedish and Polish).

Furthermore, throughout all three workshops, cultural norms – such as the presence versus absence of workshops as part of the professional routine – contributed to challenging the degree to which discussion matters were treated. The professional cultural background was one of relative familiarity during the first and third workshops, whereas participants in the second workshop experienced a clash of both epistemic and cultural collective values while simultaneously facing the challenge of linguistic diversity. Participants of the third workshop had more in common epistemically, linguistically and culturally than those of the second.

4.2. Additional findings from the framework application

The starting point of this article was to investigate whether providing proper means for equal possibility of using one's language in linguistically diverse dialogue should be considered essential although insufficient in the context of multicultural transdisciplinary urban planning groups. Furthermore, each particular context needs to be addressed beforehand on its own terms with regards to its diversity challenges. The three observed geographical locations experienced only minor differences regarding official content and purpose but were significantly affected by nuances in culture and linguistic diversity, on top of the aforementioned general challenges of epistemic diversity. All things considered, the workshops displayed a relative awareness and preparedness regarding linguistic diversity challenges, but were less concerned with the sum of linguistic, epistemic and cultural clashes. As we see through the lens of the framework, multicultural, multilingual transdisciplinary groups require thorough preparation for co-production facilitation in order to address the topic of discussion and acknowledge diversity yet in a just way. It was found that the following elements should be taken into consideration to promote effective co-production:

4.2.1. Disciplinary integrity

The prerequisites for each participating discipline or profession need to be taken into account. Some may have less access to intellectual content than others, and others may have limited experience of practical problem-solving. Regardless, maintaining an equal ground for each discipline and profession to partake in group work, discussion and knowledge production is essential.

This challenge may risk being overlooked in situations also facing linguistic diversity.

4.2.2. Linguistic equality between participants

Participating actors, stakeholder groups and individuals need to be able to speak a language of their choosing, rather than a predetermined lingua franca. One language must not be favoured above others and participants must still be prepared to work together rather than in enclosed linguistic communities. This principle needs to be routinely reinforced and acknowledged, in order to secure the active participation of all stakeholders in mitigating a complex issue. Different types of interpretation can be at hand in this process, especially when moving towards a higher complexity, however the organisers need to weigh all the pros and cons of different forms of interpretation and be ready to compensate for risks.

4.2.3. A working culture of mutual respect

Whereas participants hail from diverse normative conditions and traditions of working, that is working culture, it is essential that an additional culture of mutual respect needs to be fostered in a multicultural, multilingual and transdisciplinary group. This requires both understanding and a certain level of attention paid to the background of various participants. Naturally, however, facilitators of workshops, meetings and other urban planning contexts have limited access to information regarding the background of the participants.

4.2.4. Simultaneous mitigation and informed facilitation

The main challenge is to combine and tackle the aspects of epistemic communities, linguistic diversity and culture during the same event or situation. This challenge needs to be mitigated by introducing awareness-raising models, as described in 3.4. If facilitators are made aware of the complexity partly related to group diversities when preparing for the event, the likeliness of them being able to manage such diversities is significantly increased.

5. Evaluation of the framework

5.1. Critical assessment

There are several aspects of co-production that we can assess the framework upon (Polk, 2015), such as inclusiveness, cross-sectoral understanding and applicability to different contexts. Additionally, we assess the framework from the time perspective.

The proposed framework accounts for potential differences in a transdisciplinary group to prepare process leaders (or facilitators) to conduct more inclusive workshops or meetings. Enabling every participant to express themselves and understand others fully empowers an individual to contribute to the process and confirms their recognition.

One could argue that there are other aspects that could be included in the framework. We are not suggesting that the framework is comprehensive. Adding more aspects would not necessarily increase its usefulness, though. On the contrary, it might become counterproductively complex. Alternatively, we suggest that there could be supporting tools and methods that could go along with the framework to, for example, quantify the assessment of the situation that process leaders are concerned with and recommend concrete steps to change their process.

One of the underlying purposes of co-production is to increase the understanding between different sectors in a transdisciplinary context. Addressing complexity of transdisciplinary groups could lead to more inclusive processes and provide a platform for a more open and efficient sharing of knowledge and experiences. Of course, using this framework does not ultimately mean that a better understanding between the sectors will immediately occur. However, not addressing aspects discussed in the above framework might hinder mutual understanding substantially.

Finally, the aspect of time can be evaluated differently using this framework. On the one hand, time is money, and in a Western planning model (Mikkelsen, 2005) 'economic time' plays an important role in the planning of processes. We intend to do more within a shorter period of time: in other words, to be more efficient. In this case, an increase in complexity would require more time for preparation of the workshop or event and the workshop or event itself would last longer, for example, due to the chosen type of interpretation (see Section 3.2). On the other hand, time can be seen as an asset in the process – the more time is put into dialogues (considering

there is a well-prepared process and content), the greater are the chances for understanding the situation and each other's perspectives and for avoiding segregation in the group. It is suggested by Britha Mikkelsen (2005) that in a Western tradition 'social time' has lost its value while this is not true for indigenous peoples, for example.

Since it is based on the literature and empirical studies, we anticipate that the framework developed here will be useful in assisting preparation for the facilitation and evaluation of many different kinds of dialogues, not only in transdisciplinary contexts of complex problem-solving. It could also be a potentially useful assessment framework for participatory processes in a wide range of contexts such as kindergartens, schools, governance and businesses in which diversities pose communicative challenges. The framework could perhaps also be used as a basis for the development of new and innovative communication tools, applications and strategies for facilitating groups encountering these diversities. We further believe that such a framework could be used as a complementary tool to a certain community planning process model (Robèrt et al., 2017), as a starting point for the planning of transdisciplinary co-production work on local, national and international levels.

5.2.   Comparison with other studies

In our literature studies we have not been able to find a framework for the assessment of complexity in multilingual multicultural multi-stakeholder transdisciplinary environments. However, we found several publications to be interesting to refer to here and we analyse them in more detail below (Armitage, Berkes, Dale, Kocho-Schellenberg, & Patton, 2011; Barreteau, Bots, & Daniell, 2010; Dafouz & Smit, 2016; König, Diehl, Tscherning, & Helming, 2013; Schuttenberg & Guth, 2015; Wuelser et al., 2012).

The identified publication that was the closest in relation to the context of this paper was written by Derek Armitage and colleagues (Armitage et al., 2011). There, they describe the challenges they have been facing during the co-production process – the role of power, the varying degree of shared understanding and the normative context. The role of power in their work was defined as the "willingness to recognise and accept existence of different systems of understanding and practices" (Armitage et al., 2011, p. 997). Compared to the aspects of our framework, it is somewhat similar to the combination of disciplinary integrity and a working culture of mutual

respect (see Section 4.2). In relation to that, Derek Armitage and his colleagues write about shared understanding in terms of acceptance of different schools of thought. We, on the other hand, view normative context – shared desire to use knowledge – as an embedded value of co-production and as more related to the content of the workhop or event rather than to the work with participants in its own.

Another study that our framework could be compared to is dealing with multilingualism in education. Emma Dafouz and Ute Smit suggest the ROAD-MAPPING framework with six relevant components (Dafouz & Smit, 2016, pp. 403-409): "Roles of English, Academic Disciplines, (language) Management, Agents, Practices and Processes and Internationalisation and Glocalisation" (glocalisation – "the practice of conducting business according to both local and global considerations" ('glocalization | Definition of glocalization in English by Oxford Dictionaries', n.d.; Robertson, 2014)). The authors address academic disciplines (closely related to epistemic communities in co-production processes) and language management (using similar concepts as we do) similarly to our approach, analysing the participants' side of the process. Furthermore, they look at factors – agents, practices and contexts – that we view as external and that could be monitored but do not affect the complexity of transdisciplinary environments.

A framework for structuring interdisciplinary research management (König et al., 2013) has a broader focus on all the roles and processes related to the management of research than we have in the proposed framework. In relation to the framework by Bettina König and her colleagues (2013), we focus on the interdisciplinary culture quadrant, focusing on the facilitator (or process leader as we suggest here) and what aspects of complexity should be taken into account when preparing for a transdisciplinary process. We see our framework as complementing the one proposed by Bettina König and her colleagues (2013).

Two of the frameworks focus on knowledge co-production (Schuttenberg & Guth, 2015; Wuelser et al., 2012), while the framework developed by Gabriela Wuelser and colleagues (2012) is also considering the notion of sustainable development and the policy process. These frameworks are in line with ours as some of the aspects discuss overlap, for example, elements of sustainability objectives (Wuelser et al., 2012), which correspond to some of our additional findings, and facilitated collaboration (Schuttenberg & Guth, 2015) as a platform for knowledge co-production that we develop further in our framework.

Finally, the framework that created additional afterthought reflecting back on the workshops analysed in this paper was devoted to communication about participation to and with the participants (Barreteau et al., 2010). The authors claim that transparency about participation being "upfront and precise" should prevent participants from rejecting the participation in the event. Based on the long discussion with the local organisers of the workshop in Poland about their working culture, customs and practice, the decision was made to replace the word 'workshop' with 'seminar' (see Section 4.1). The local organizers doubted the willingness of participants to join a workshop format as it is not common in the local culture and practices. On the one hand, this might have resulted in inactive participation in the process during the day; on the other hand, for the local organizers it was important to have all those participants present in the room in order to initiate further dialogue. In the case of this workshop, being precise was not enough to ensure the expected outcomes. Perhaps it is a cultural change that needs to happen to accept a workshop format there? To answer this question, further research would be necessary.

What is interesting to note is that studies performed by six different groups of scholars, whose research is described in this section, and us, are attempting to increase inclusiveness in co-production processes. This underlines the importance of the work that we present in this article.

6.   Concluding remarks and further work

In line with its purpose, this article has presented a framework for analysing complexity within urban planning by integrating three significant factors of contemporary diversity challenges: varying epistemology, linguistic diversity and multiculturalism. These three factors play major roles when present in dialogue and need to be approached to create the best conditions for moving forward with the issues that such dialogues are supposed to manage. The framework is aimed at the process leaders, mostly facilitators of workshops or co-production processes. It was found that, while being skilled in mitigating conflicting interests and ideas between participants, facilitators need further developed techniques for dealing with wider multiple challenges of diversity within groups.

Future studies on the subject also have the potential of further developing the here suggested framework by identifying levels of complexity and mapping specific tools to address complexity at each level, as well as by

integrating other factors of complexity, such as political and institutional contexts, as well as diversity of gender and age in the facilitated group.

CRediT author statement

Varvara Nikulina: Conceptualization, Methodology, Validation, Investigation, Writing – Original Draft, Writing – Review & Editing, Visualization. Johan Lindal: Conceptualization, Methodology, Validation, Writing – Original Draft, Writing – Review & Editing. Henrikke Baumann: Conceptualization, Writing – Review & Editing, Supervision. David Simon: Conceptualization, Writing – Review & Editing, Supervision. Henrik Ny: Conceptualization, Writing – Review & Editing, Supervision.

Declaration of Competing Interest

None

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Appendix

Table A1. List of interviewees.

Name	Date	Location of the WS	Role in the WS
Lisa Wälitalo	March 18, 2018	Karlskrona, Sweden	Table leader
Anna Wolniarska-Roszak	March 26, 2018	Gdynia, Poland	Table leader
Rokas Valadka	May 28, 2018	Klaipeda, Lithuania	Table leader
Jarosław Kuik	May 31, 2018	Gdynia, Poland	Table leader

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Paper E

'Rapid Scenario Planning' to Support a Regional Sustainability Transformation Vision: A Case Study from Blekinge, Sweden

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'Rapid Scenario Planning' to Support a Regional Sustainability Transformation Vision: a Case Study from Blekinge, Sweden.

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Abstract

This paper presents a case study of a transdisciplinary scenario planning workshop that was designed to link global challenges to local governance. The workshop was held to improve stakeholder integration and explore scenarios for a regional planning project (to 2050) in Blekinge, Sweden. Scenario planning and transdisciplinary practices are often disregarded by practitioners due to the perception of onerous resource requirements, however, this paper describes a 'rapid scenario planning' process that was designed to be agile and time-efficient, requiring the 43 participants from 13 stakeholder organizations to gather only for one day. The process was designed to create an environment whereby stakeholders could learn from, and with, each other and use their expert knowledge to inform the scenario process. The Framework for Strategic Sustainable Development (FSSD) was used to structure and focus the scenario planning exercise and its subsequent recommendations. The process was evaluated through a workshop participant survey and post-workshop evaluative interview with the regional government project manager to indicate the effectiveness of the approach. The paper closes with a summary of findings which will support those wishing to conduct similar rapid scenario planning exercises to inform policy planning for complex systems.

Keywords: *strategic sustainable development; scenario planning; transdisciplinary; regional development; sustainability governance; sustainability transformation; urban planning*

1. Introduction

Uncertainty caused by the complex interactions of the numerous 'grand challenges' of the Anthropocene makes visualizing and planning for unknown futures difficult. Yet government agencies and other organizations are routinely called upon to provide robust planning responses to ensure resilient, livable and sustainable societies. Scenario planning is increasingly seen as a useful strategic tool for preparing policy in times of uncertainty [1–3]. This paper describes a scenario workshop, and related activities designed to (i) envision alternative future(s) that could support more concrete subsequent planning [4], and (ii) improve stakeholder integration and knowledge sharing for a regional planning project that had sustainability at its core. The scenario approach was used to better understand the values and needs of the stakeholder participants within the previously agreed strategic direction of their respective organizations. The challenge was to make the most of the scarce time resource in busy professional's work lives, and provide a way to learn from, and with, each other. We are describing this process as 'rapid scenario planning' because, contrary to many scenario planning approaches, this case was designed to be agile and time-efficient so that the participants were required to gather for only one day. The authors hope that by sharing details of this case study, others will find our approach helpful, particularly if they are tasked with designing a time constrained workshop, comprising of diverse stakeholders, with uncertain planning outcomes and an aspiration to move strategically towards sustainability.

The paper has three objectives:

1. To describe the role of transdisciplinary research in this case study as applied to policy creation,

2. To evaluate the success of a 'rapid scenario planning' process to support a well-informed stakeholder group in an efficient workshop process, and

3. To offer recommendations to those seeking to design a similar process to inform sustainability transformation policy.

The following background section describes the rationale of the researchers for engaging in a transdisciplinary scenario process with the local government organizations.

1.1. Background

Society faces the immense socio-ecological challenge of both "decreasing ecosystem quality and increasing risk of tipping the biosphere into a state where it would be difficult or impossible to maintain the human civilization" [5] (p. 17). The increasing scale of human activity is having a profound impact on the natural environment [6], the imbalance between human-nature interactions is expressed in multiple environmental challenges such as water scarcity, epidemics, climate change—among many other persistent and complex challenges which threaten the viability and integrity of global societies [7]. Dominant societal models are unsustainable "as the results of ignorance of the consequences of consumption, inattention to human dependence on ecological realities" [8] (p. 860), which combined make staying within the safe operating space of planetary boundaries a global problem [9] and a challenge for all levels of government to manage, at national, regional and local levels due to their 'wicked' nature. 'Wicked problems,' developed in planning research by Rittel and Webber [10], are characterized as multidimensional, path-dependent and unpredictable in nature. Planning itself is complex, but it needs to additionally include the global, interconnected and uncertainty aspects surrounding planetary sustainability that compound pressure upon local planners, who must now consider their traditional planning role within a broader need for sustainability transformation. The sustainability challenge itself has even been identified as a 'super wicked' problem as it includes four further challenges to planners, which include that: time is running out, those seeking to end the problem are also causing it, there is no central authority for decision making, and that policies discount the future irrationally [11]. These create an immense contemporary crisis with little defined process to guide constructive future pathways. City and regional planners create policy that is highly impactful on human-nature interaction, yet rarely are they offered a reflective space to consider these implications [12].

Despite this, the pressure for sustainable transformation exists within all regional and municipal governments, because the local level plays a crucial role in facilitating the sustainability transformation needed to address multiple national and international agreements, such as the Paris Agreement [13], Agenda 2030 [14] and the New Urban Agenda [15]. The Agenda 2030 [14], Sustainable Development Goals (SDGs) were developed to help nations plan for sustainability, and regular assessments against the goals offer an indication of nation-state performance showing that some countries are doing better in terms of progress toward sustainability. For example,

according a 2020 SDG assessment, Sweden is leading the world in progress toward the goals [16], but even Sweden is struggling to progress in certain areas. In 2019, the Swedish Climate Policy Council [17] highlighted that sustainability action is progressing too slowly to meet current national and international carbon reduction goals—particularly for transport and built environment sectors. It has been documented by others that there is a geographical unevenness of sustainability transformation processes [18], indeed within Sweden much sustainability innovation and infrastructure investment is focused on major population centers. For example, Blekinge receives relatively less rail investment from the central government than many other regions. Funding on some planned rail links (e.g., the Southeast Link in Blekinge) has been delayed numerous times while investment in other central projects around the bigger cities gets funding, and current plans for future investment in Swedish high-speed trains will not prioritize more remote regions like Blekinge. Unequal investment concentrated around the largest centers with regional areas lagging behind is not unusual [19], but it does pose a challenge for regional areas. This unequal power concentration and dispersion in multi-level governance shapes local agency for sustainability transitions and has been discussed in detail by others who indicate that insufficient coordination and other obstacles embedded in wider political-institutional contexts between the national, regional, and local planning efforts is a key factor behind the failure of many regions to meet high-level sustainability goals [20]. Yet regardless of their resources, all governments, large and small, are under pressure to transform towards greater sustainability.

These interconnections are exacerbated by the "fact that many of the current socio-environmental problems connected to sustainability transcend spatial, temporal, sector and disciplinary boundaries" [21] (p. 439). Governing these challenges while attempting to redesign unsustainable societies and manage a sustainability transformation in light of increasing challenges is immensely difficult. The goals to become sustainable are often mandated by high-level and often vaguely prescribed inter-/national policy and guidance to achieve these goals is often lacking, instead interpretation to meet goals falls to those responsible for land use decisions and community activities—largely local governments. So where should local governments start within participatory planning processes?

Current responses are most often compartmentalized and addressed by separate sectors, decision-making levels and disciplines. The construction of siloed knowledge cultures over time have segregated world views into

individual, community, specialized, organizational and holistic modes of thinking and understanding that inhibit collaboration [22]. These 'knowledge cultures' provide varied understanding of issues that provide different version of the same reality, and use "different languages to describe the same issue, chose different avenues of action, worked to different action times and were directed towards different outcomes" [22] (p. 5). Instead, what is needed are methods that both consider and remove the obstacles and limitations of monodisciplinary and compartmentalized management to allow integrated approaches to societal problem solving for sustainability [21]. Transformation to "a sustainable society is obviously a complex endeavor, requiring, among other things, extensive coordinated collaboration across disciplines and sectors" [5] (p. 17). Overcoming sustainability challenges requires new forms of knowledge production and decision making [7] that acknowledge the overlapping nature of socio-ecological issues.

Transdisciplinary approaches can achieve this through the creation of "knowledge production for social change which is based not only on the integration of knowledge from different disciplines" and sectors [21] (p. 440). Sustainability challenges, by their nature, affect or engage a variety of stakeholders, whereby 'no single actor has the capacity or power to fully grasp or address this complexity' [23]. This understanding has led to various models of transdisciplinary, community based, interactive action and/or participatory approaches that are appropriate (and effective) models that meet the requirements posed by real world sustainability challenges [7]. This paper describes one such model and details of the case study follow.

1.2. The Case Study

This paper deepens previous analysis [24] of a case study revolving around a transdisciplinary scenario planning workshop involving a focused stakeholder group to explore possible alternate futures for Blekinge. Blekinge is one of 25 provinces in Sweden, it lies in the south east of the country and within its borders are five municipalities—Karlskrona, Ronneby, Karlshamn, Olofström and Sölvesborg (see Figure 1).

The case study workshop was led by academics on behalf of the regional authority, Region Blekinge, to support the preparation of a regional planning process—Strukturbild Blekinge 2.0 (hereafter Strukturbild 2.0). Strukturbild 2.0 aims to increase collaboration and strengthen the link between

municipal spatial planning, regional development issues by building consensus on Blekinge's most important development issues over a 30-year horizon to 2050. The scenario workshop was an important step in the process as it was hoped it would reveal shared values to support future collaborations for a regional sustainability transformation. Collectively, the stakeholders represent all communities and several interest groups in the province, as a network of networks involved in collaborative participation that is fair, representative, well-informed and transparent, in the manner called for by Innes and Booher as necessary to build trust in planning for the 21st century [26], something Sweden has a long history of doing well and that would be of interest to many other democratic societies.

Figure 1. Map of Blekinge and its five municipalities and major urban areas (map source Länsstyrelsen/Lantmäteriet, geodata license I2018/00075).

Most sustainability science is grounded in the normative world view that recognizes the preservation of the biosphere as a central value [26], but in pluralist societies, such as Sweden, where values are diverse, the assumption of this central value cannot be assumed – views and definitions of sustainability are contested. Similarly, while population is increasing in Sweden, there is an urban-rural divide. In Sweden the majority of population growth can be observed in existing larger urban areas rather than in more rural regions like Blekinge. This is also true for economic growth which is also disproportionally greater in the larger population centers, a steady in-flow of talent from the hinterlands that further exacerbates rural-urban divides [27]. However, it was recognized that promoting growth for growth's sake presents uncertain consequences for regional development. Therefore, Region Blekinge determined that it would be beneficial with scenario planning with key stakeholders to explore the risks and opportunities associated with a range of alternative futures. The development and testing of such a scenario planning process is laid out in the following sections.

1.3. Pre-Workshop Background

Generally speaking, municipalities in Sweden have a relative planning monopoly, while the regional government is relatively underdeveloped in terms of spatial planning. It is therefore difficult for regions and municipalities to cooperate on spatial planning issues. Regions traditionally describe regional visions and outline economic development and transport strategies while the municipalities develop concrete policies and spatial plans. In Blekinge, the political will to grow in a sustainable manner was already established by the regional actors, but the responsibility for such a transformation is dispersed across several organizations including Region Blekinge, Blekinge's five municipalities, the County Administrative Board, the Swedish Transport Administration and allied organizations.

The Strukturbild 2.0 project was developed to address such coordination shortcomings and to facilitate a collaborative strategic policy direction. Outputs of Strukturbild 2.0 include regional maps, assessments and joint strategies for development in Blekinge that public actors can use as a basis in the upcoming planning or as a basis for decision making. In 2018, prior to the engagement of the researchers in this project, the participating public actors together identified that Strukturbild 2.0 should focus upon four key regional development areas:

- Infrastructure and transport,
- Blekinge development at large,
- Labor market, business, and tourism,
- Attractive cities and living environments.

The collaborating public actors also pointed out approximate targets and measures for each of the issues. Population growth in Blekinge lags behind the national average and the potential benefits of a larger population in Blekinge, to maintain or improve the productivity of the economy and workforce, were also emphasized.

1.4. Aim and Scope of the Workshop

This study can be considered an action research project revolving around a participatory transdisciplinary workshop which was conducted in close cooperation with regional stakeholders, particularly planners. It is worth noting that, although many aspects of sustainability are linked to land use and are impacted by land use planning policy, rarely are planners given the

space to consider the impact of their decisions upon regional or global sustainability. Planners rarely have interest or scope to consider transformative practices focusing instead on ensuring that formal planning processes and outcomes are legally correct [28]. Action research is very useful for addressing our sustainability crisis [29] and exploring transformative processes that actively seek to question the way we produce and use knowledge in learning, education and research [29,30]. It is of the pragmatic philosophy that "knowledge is assessed by its practical consequences and not only by its explanatory power" [30] (p. 5).

Bradbury et al. [30] highlight the importance of the collaborative nature of action research and its ability to enable social/organizational or community learning through a process of dialogue and scaffolding—helping learners learn together by linking experience with sense-making and reflection to action [31]. This action research project consists of two distinct strands, firstly to support Region Blekinge develop scenarios to inform future policy, and secondly to research this transdisciplinary process and better understand how to do this effectively and share those findings.

The project was initiated when Region Blekinge engaged the authors to facilitate a scenario-planning process with local, regional and national stakeholders. The idea was to develop an approach to consider alternative futures over a 30-year horizon (to 2050). Region Blekinge emphasized that the scenarios should include the four identified regional focus areas as mentioned above and relate to the overall targets and measures already pointed out by the public actors.

Initially, Region Blekinge sketched out two significantly different preliminary scenario descriptions as a starting point:

"Planning as usual" (nollalternativ) showing what happens if the region continues to work on the same path as it does today. How many houses will be built? How will the business sector develop? What types of transport will be used, etc.?

"Fully developed Blekinge" (fullt utbyggt läge) showing what Blekinge will look like when all the overarching targets have been fulfilled in the four identified key areas of Strukturbild 2.0. What will Blekinge look like in a high population growth scenario (assuming 300,000 inhabitants by 2050 from 159,000 inhabitants in 2019) with happy inhabitants that can live, work and transport themselves in a sustainable way?

The practical implementation of the workshop was divided into a few separate tasks:

• To make at least three different scenarios for Blekinge 2050, including specified measures within the four identified key areas of Strukturbild 2.0 (described in the previous section),

• To arrange and lead a workshop in Swedish with public actors in Blekinge,

• To present the scenarios and the measures in a written report, and

• To have continuous contact and regular follow-up and involvement with Region Blekinge during the whole process.

2. Methods

2.1. On Scenarios and Scenario Methodology

A scenario is often defined as a description of a possible future [32] and a scenario may also be used to describe a pathway to a certain future. It is also important to distinguish scenarios from a likely future. Rather than a prediction, scenarios should allow for a new perspective(s) on a situation, coming to non-conventional conclusions and posing new questions [33]. Often, scenarios are used instead of or alongside visioning statements and support the development of the pathways towards desirable futures [32,34–36]. This workshop utilized an 'explorative' or 'exploratory' scenario approach [4,37]. Explorative scenarios aim to assess the range of future options and they usually employ two fundamental and largely independent variables in order to systematically map parallel, possible future scenarios [34]. In this case, the scenarios show four possible futures based on different development drivers over a medium term (30-year) horizon. The idea is to broaden perspectives of the future, to embrace uncertainties and inspire different actions than those foreseen in the present. In this sense, the scenarios assist decision-makers to compare possible implications of different strategic decisions and to adjust policy direction accordingly to increase the likelihood of a preferred future being realized. Region Blekinge placed a criterion on the workshop to assemble stakeholders for only one day—we refer to this as a 'rapid scenario' planning workshop. While we refer to it as 'rapid', this relates to the time input for the participating

stakeholders. The organizing team still put in considerable time both for preparation prior to the one-day event and for a post-workshop theming and analysis of stakeholder input. The entire process can be considered as three phases—pre-workshop, workshop, and post-workshop, see Figure 2. The study phases are described in detail in section 2.3.

PRE-WORKSHOP (6 months)	**POLICY PROBLEM STATEMENT**
	↓
	Policy review & mapping exercises
	↓
WORKSHOP (7 hours)	**SCENARIOS WORKSHOP**
	↓
POST-WORKSHOP (3 months)	**Stakeholder survey / evaluation interview**
	↓
	Workshop summary report & scenario development
	↓
	SCENARIOS INFORM POLICY
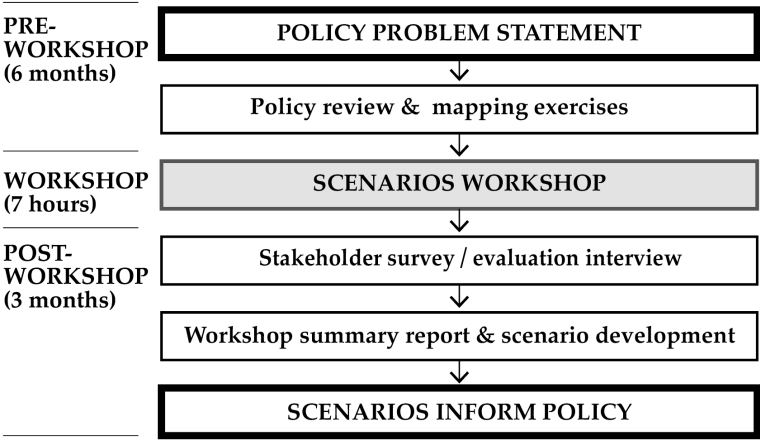
Figure 2. The three main phases of the scenario process.

Compared to a typical explorative scenario planning approach [34], the rapid scenario planning process requires more extensive preparation (in this case by the researchers) to develop scaffolding techniques that compress the workshop time requirements by allowing the participants to quickly focus on the key issues for exploration. Detailed description of the steps the research team has performed, and the scaffolding techniques used, can be found in section 3.1.

2.2. Using the Framework for Strategic Sustainable Development (FSSD) to Define the Sustainability Boundary

To ensure that the workshop considered sustainability beyond currently hot topics like climate change and resource efficiency, the study used the Framework for Strategic Sustainable Development – FSSD with its eight socio-ecological sustainability principles that act as a holistic boundary object to define sustainability [5]. This framework has been tested and used in both public and private sectors [38–40]. It has also been used in previous

related studies involving some of the same stakeholders from Blekinge. This includes the multi-stakeholder GreenCharge project that studied how electric vehicle systems could contribute to faster transition to sustainable passenger transport [41].

Practical application of the FSSD is facilitated by an ABCD planning procedure that revolves around generic and operational sustainability principles (SPs) that provide a robust sustainability definition [42] (see Figure 3).

•   Step A. Define a sustainable vision within constraints set by sustainability principles (SP1–8). This includes that:

> - Nature should not be subject to systematic poisoning (meaning not allowing increased concentrations of substances from the Earth's crust (SP1) or from society (SP2)),
>
> - Nature should not be subject to other systematic physical destruction (SP3),
>
> - People should not be subject to systematic structural social obstacles to meet their needs (SP4–8).

•   Step B. Scrutinize current situation in relation to the vision.

•   Step C. Identify possible future solutions.

•   Step D. Combine strategically prioritized solutions into roadmaps for sustainability transition/transformation that bridges the gap between the current situation and the future sustainability vision.

The scenario planning approach of this paper mainly aims to draw from and add value to step A of the ABCD procedure.

Sources: Broman & Robert (2017), Ny (2019), based on an illustration by Stefan Borell
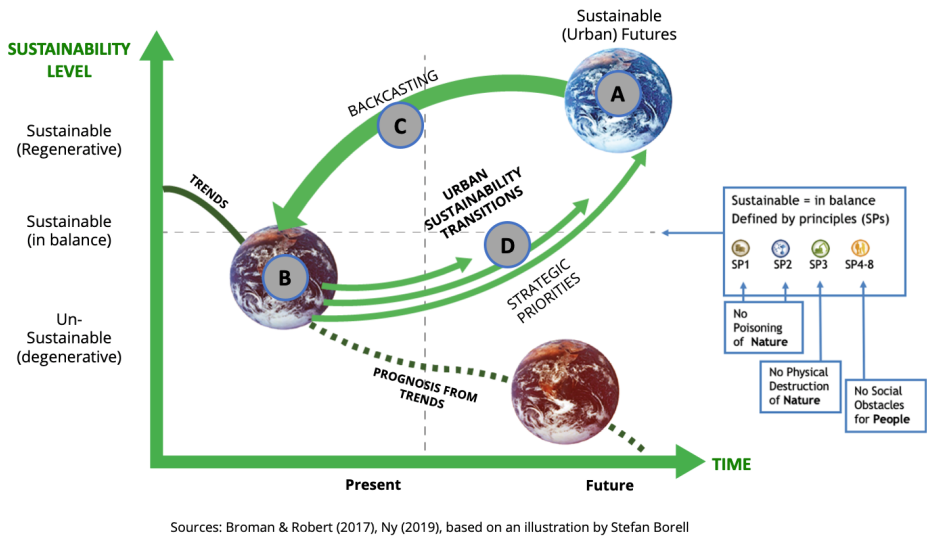
Figure 3. The ABCD process summary diagram (based on an illustration by Stefan Borell).

2.3. Study Phases

An outline of the three study phases—pre-workshop, workshop and post-workshop are detailed below.

Phase 1 involved pre-workshop preparation activities by the research team with support from Region Blekinge in the six months leading up to the workshop. Activities included understanding the policy context through an existing policy review, and consideration of scaffolding approaches to aid with stakeholder understanding and to make the workshop event more efficient. Development of appropriate scaffolding approaches is the key to compressing the workshop timeframe to enable a 'rapid scenario planning' approach. The urgent and unpredictable nature of wicked problems will require agility in planning responses, input from diverse stakeholders in short time frames and quick turnarounds of plans to address the rapidly evolving global world we live in. Scaffolding approaches in this context included the identification of scenario factors and speculative spatial mapping; these are described below.

•   Policy review and policy problem statement: To prepare for the workshop the research team analyzed relevant policy documents from the six main authorities responsible for the governance of Blekinge (five

municipalities and Region Blekinge). In particular, the research team looked for common themes in the existing vision statements. The synthesis of these values informed the policy problem statement summarized by the question: 'How can we deliver an attractive and sustainable Blekinge in 2050?' This was the calling question for the event and shaped the workshop planning. Key themes from policies were noted and summarized into a series of prompt cards for use by facilitators on the workshop break-out tables.

• Development of scenario factors: Secondly, the researchers identified possible key external factors and drivers for Attractive and Sustainable Blekinge. The researchers used the policy review, an iterative brainstorming approach around possible key external factors and drivers that would influence an attractive and sustainable Blekinge in 2050. Following a confirmation with Region Blekinge, regional population development and sustainability performance came out as two key independent variables for the explorative scenario matrix in Figure 4 and as used in the workshop. On the population axis 'same population' means little variation from the current 159,000 residents, whereas 'larger population' means around 300,000 residents. For the sustainability axis we refer to the framework for strategic sustainable development (FSSD) as described earlier.

• Speculative spatial mapping: Blekinge is renowned for its forests, especially oak, which is the region's symbol, and also for its coastline with the Blekinge archipelago, where the 'oak forest meets the sea'. Blekinge's geographic setting is highly valued (forest, sea and archipelago) and was seen as a key component of the regional identity and an attractor. Therefore, the research team saw land use, spatial planning and access to nature as a central component of any successful future vision. Speculative mapping diagrams were also prepared to visualize the likely land-take implications of urban development due to population increase in the region. The maps were developed with the support of the County Administrative Board (Länsstyrelsen) Blekinge and their GIS mapping team. The speculative spatial mapping exercise and how they were used as a pedagogic tool to support the workshop participants is discussed in detail in the next section.
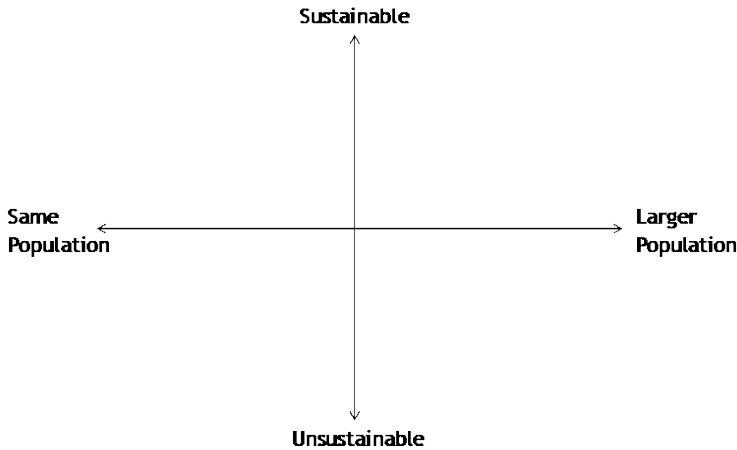
Figure 4. The explorative scenario matrix and variable axes used for the Strukturbild 2.0 workshop.

Phase 2 involved the seven-hour workshop event itself. The workshop was centered around the explorative scenarios as described in section 2.1, using the variable axes in Figure 4. Ensuring sufficient time for participant discussion and interaction was seen by Region Blekinge and the researchers as critical. Even though also considered important, time was trimmed from presentations and introductory material to give room for more discussion time and feedback opportunities for the participants. The workshop activities are summarised in Appendix B.

Phase 3 involved a post-workshop data collation, analysis, background report and evaluation surveys and interviews over a three-month period. Details follow:

• Background report: The material was collated by the research team and workshop responses themed into brief scenario statements (Section 3.2.2). A 24-page summary report was prepared for Region Blekinge and shared with other local actors. The report is available on the Region Blekinge website (in Swedish) [43],

• Post-workshop survey: Following the workshop, an evaluation survey consisting of eight questions to be answered, using a 5-point Likert scale to rate aspects of the workshop and one open-ended question, was emailed to the 43 participating stakeholders. The survey had a 37% response rate (n = 16), the results are described in the evaluation section, and

• Post-workshop interview: following the workshop, a one-hour evaluative interview with the Strukturbild 2.0 project manager was conducted using video call and recorded. Key quotes from this call are used in the evaluation section to provide some indication of the effectiveness of the rapid scenario planning approach from the perspective of the end user.

3. Results

3.1. Pre-Workshop

The time constraints on the workshop was a concern to the research team, as a longer workshop provides greater flexibility. But an advantage was that many within the stakeholder group had previously worked together and all the stakeholders were practitioners with considerable and broad existing knowledge of Blekinge. In this sense they can be described as a 'community of practice', which can be defined as "networks of people who share the same professional practice and who come together as a community to create shared knowledge to develop individual members' capabilities, and to work together" to solve shared problems [44] (p. 642). In addition, there was an agenda with practical aims—to explore what an 'attractive and sustainable Blekinge' might look like in 2050. The policy review revealed existing vision statements; the existing regional development strategy vision statement is "An Attractive Blekinge—where more people want to live, work and visit". Each authority also has its own vision, aligning visions is important to ensure that all actors in a whole region are working towards a shared outcome. A key function of this workshop was to improve co-ordination and collaboration in achieving the overarching aspirational goal of 'Attractive Blekinge'. The document synthesis of existing vision statements was conducted and found varying emphasis upon sustainability. There was some variation between the various municipality visions but there were also some strong common themes including: 'utbildning' (education), 'invånarna' (the inhabitants), 'attraktiv livsmiljö' (attractive living environment), 'näringsliv' (the business sector), 'unika läge' (unique locations) and 'kultur' (culture). From an action research perspective, developing shared understanding in partnership with practitioners is critical as it means practical aims are more likely to be met [45]. But to support the practitioners in their goal within the short workshop timeframe the educational concept of 'scaffolding' techniques, i.e., tools that support student (or participant) learning in project-based work [46] "to develop learners' capacity for linking experience
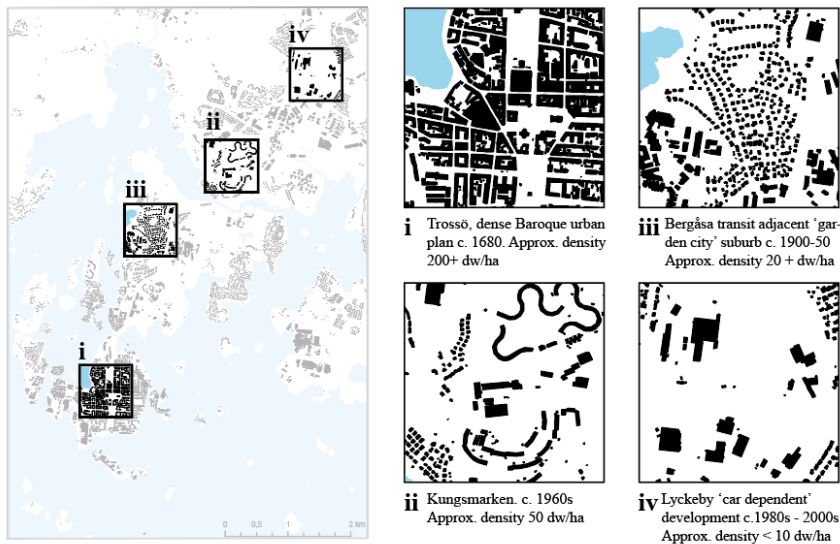
with sense making and reflection to action" [30] (p. 6). The research methodology was designed to include scaffolding, for example the scenario quadrants—to focus attention when developing the four possible future visions, and in the description of the ABCD process, as a way to operationalize the preferred vision (step A). However, research indicates that the role of spatial configurations and geography in sustainability transitions is often overlooked, and consequently there is a need to make this connection more explicit [18,47]. Therefore, the research team decided that developing supporting material to visualize land use implications resulting from population increases could also assist as a scaffolding tool, as described in the next section.

3.1.1. Speculative Spatial Mapping to Visualize High Population Growth Development Alternatives

In a report to the Swedish Government Region Blekinge identifies increased attractiveness for residents, visitors and businesses as the overarching growth priorities for Blekinge 2021–2027 [48]. The stated reason for working with increased attractiveness is to get more people to choose to settle in Blekinge, to establish and develop companies in the region and to come for visits. Summarized in the policy problem statement: How can we achieve an 'attractive and sustainable Blekinge'? The current status of Swedish sustainability transformation is also relevant here. One of the persistent challenges facing Sweden and outlined by the Swedish Climate Policy Council [17] is reducing transport related emissions. The report states [17] (p. 12), "With present conditions and decisions, the transport sector will only reach halfway to the target of decreasing emissions by at least 70% by 2030. This demands powerful political actions during this mandate."

Addressing emissions reductions will have implications—particularly for the carbon intensity of vehicle fuels, vehicle use and for land-use planning [49]. Co-location of services and public transport to population concentrations can greatly assist transport emissions reduction. Residential proximity to social infrastructure and services (shops, schools, etc.) reduces the distances people must travel for daily needs and encourages walking and cycling instead of driving [50]. Similarly, clustering population and services along public transport corridors increases ridership, which creates a virtuous cycle of higher public transport frequency and increased convenience. An additional benefit of higher density development is a reduced development footprint which preserves agricultural and ecological land [50]. An added

benefit to municipalities of compact urban footprints is the reduced public realm area (e.g., streets and parks) and a corresponding reduction in public authority costs associated with the 'maintenance burden' because there are more rate payers per hectare of land and less surface area to maintain. Yet current development trends in Blekinge are going in the other direction. Figure 5 gives some indication on how changing planning policies from the C20th onwards have supported increasingly lower density development in Karlskrona, this is typical for all major urban settlements in Blekinge.

i Trossö, dense Baroque urban plan c. 1680. Approx. density 200+ dw/ha

iii Bergåsa transit adjacent 'garden city' suburb c. 1900-50 Approx. density 20 + dw/ha

ii Kungsmarken. c. 1960s Approx. density 50 dw/ha

iv Lyckeby 'car dependent' development c.1980s - 2000s Approx. density < 10 dw/ha

Figure 5. Figure ground showing the urban spatial pattern evolution over four time periods in Karlskrona: from 1680 (i), to 1900s–1960s (ii and iii) and to 1980s–2000s (iv). Urban development in the latter half of the 20th century is increasingly dominated by inefficient low density car-oriented sprawl (map data source: Länsstyrelsen/Lantmäteriet, geodata license I2018/00075).

Given the above-listed potential benefits, there are valid reasons for planners to consider shifting focus towards denser future city development for Blekinge. Different settlement patterns have different sustainability implications in a region, with high density development typically having less adverse effects than low density sprawl [51]. Therefore, in an attempt to illustrate the spatial effects of various potential future development paths, Figures 6 and 7 compare the current land take (urban footprint) area of the five major urban settlements in Blekinge (Figure 6), to four alternative urban footprints of different density to accommodate 300,000 residents, i.e.,

approximately 150,000 new inhabitants or about 68,000 new dwellings (Figure 7). Calculation details and assumptions are given in Table 1.
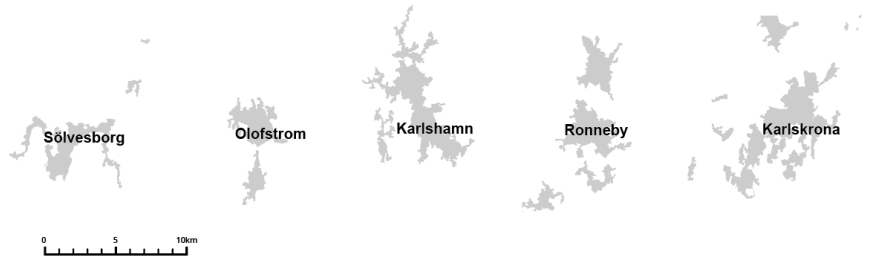
Figure 6. Comparative urban footprints for the five major settlements in Blekinge (2019). All are at the same scale for the correct geographic position of the towns, see Figure 1.
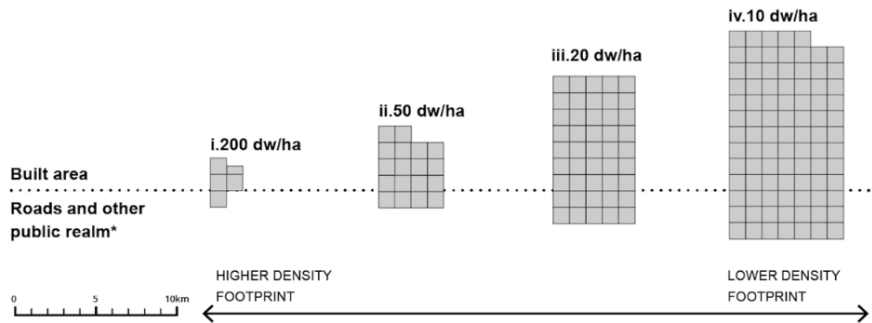
Figure 7. Representation of the 'Total minimum footprint' alternatives for 150,000 new residents (approx. 68,000 dwellings), see Table 1 (same scale as Figure 6).

Table 1. Additional land (footprint) needed for 150,000 new residents (approx. 68,000 dwellings) at four alternative future population densities (i–iv).

Future Alternative (Figure 7)	Added Population (People)	New Dwellings *	Population Density (dw/ha)	Development Footprint (km²)	Public Realm Footprint ** (km²)	Total Min. Footprint (km²)
i	150,000	68,182	200	3.4	1	4.4
ii	150,000	68,182	50	13.6	4.1	17.7
iii	150,000	68,182	20	34.1	10.2	44.3
iv	150,000	68,182	10	68.2	20.4	88.6

* Assuming 2.2 people/dwelling

** Public realm footprint includes roads and open space, it is assumed at 30% of development footprint (min.)

The urban footprints in Figures 6 and 7 are all drawn to the same comparative scale. The future alternatives range from high density of around 200 dwellings per hectare (dw/ha) (the type of density commonly found on central Trossö) to low density sprawl of approximately 10 dw/ha (typical of new suburban development in Blekinge). Implications from the alternative spatial planning policies include the following:

- Lower density allows more villas which are currently perceived as more attractive for residents,

- Lower density development displaces agricultural and ecological land,

- Higher densities provide greater proximity benefits bringing people closer to services or amenities (e.g., shops, schools, health, public transport, forest, sea etc.),

- Higher densities allow more cost-effective services such as public transport, maintenance budgets (due to both higher land tax density and less public realm), district heating, and so on.

These urban footprint comparisons give an indication of how land use decisions might impact the region's sustainability performance. The next section describes general planning considerations for sustainability.

3.2. The Workshop

Starting from actors involved with the project Strukturbild 2.0, a list of key stakeholders was identified. The workshop took place on June 11, 2019 at Militärhemmet in Karlskrona (see Figure 8). The workshop was attended by a total of 43 participants representing 13 organizations in Blekinge and two outside of Blekinge (an external facilitator and a researcher) (See Table 4, Appendix A). There were representatives of all municipalities and several organizations that work across the region, representing strategic societal development and spatial planning in the public sector.

In the workshop, the stakeholders worked in smaller groups to first identify what attractive and sustainable Blekinge meant to them today and then to give their input on how they envision the four potential futures of the scenario matrix and what might need to happen or not happen for them to become reality. The researchers then synthesized the workshop results into four scenario narratives.

Figure 8. The Stakeholder Workshop (picture by G. Thomson).

The picture of what makes Blekinge attractive and sustainable to live in, run businesses and visit has been sketched out in the regional development strategy (Region Blekinge, 2018) and this includes:

- Proximity to European growth markets, good communications and commuting opportunities;
- A unique coastal landscape and archipelago offers great recreation opportunities;
- A good innovation climate and closeness between people creates collaboration opportunities.

The public stakeholders in the workshop also listed the factors they thought might contribute to or hinder an attractive and sustainable Blekinge in 2050 (see Table 2).

Table 2. Contributing and hindering factors for an attractive and sustainable Blekinge in 2050 according to key public stakeholders.

Contributing Factors	Hindering Factors
History and World heritage empowers the brand	Aging population => less tax revenue
Geographic contact with international trade	In the corner of Sweden = far away from large cities
Close to nature (e.g., farming and forestry, hiking paths, archipelago, tourism)	Restrictive beach access, world heritage nature/cultural values and sea level rise limits new residential areas.

Close to everything—a small county	Limited cultural offers
In general, cheap housing and attractive (natural) locations compared to large cities	A relative lack of cheap housing in the cities (e.g., for students) due to urbanization
Generally good infrastructure (e.g., railroads, highways, ports, and an airport)	Relatively worse communications and infrastructure outside the cities
Linear coastal cities enable good public transport	
New efforts for public transport by sea	
Large world-class employers	Dependency on a few large employers, small job market
Blekinge Institute of Technology (BTH) and Science Parks and their expertise	BTH research focus on technology limits growth in other subject areas
Competence development instead of recruitment	Niched education does not always meet local needs
Security through navy- and air force bases	Military training causes noise, emissions
New influences and ideas	Weak small business spirit
Growing Blekinge spirit and pride	Local patriotism and conservatism counteract community collaboration and can be resistant to change
Support for a regional rather than a local perspective	Difficult to develop the countryside
Transformation towards sustainability together	In general, a low level of competence in sustainability
Big potential for local renewable energy	Opposition from the defense hinders new wind power
	Non-equal society with alienation among elderly, loners and recent arrivals

3.2.1. Scenario Descriptions and Drivers behind Them

This section starts with a summary of the scenario descriptions gathered from the workshop (see Figure 9) and then follows a series of further developed scenario narratives and likely drivers behind them that the research team developed (see section 3.2.2).
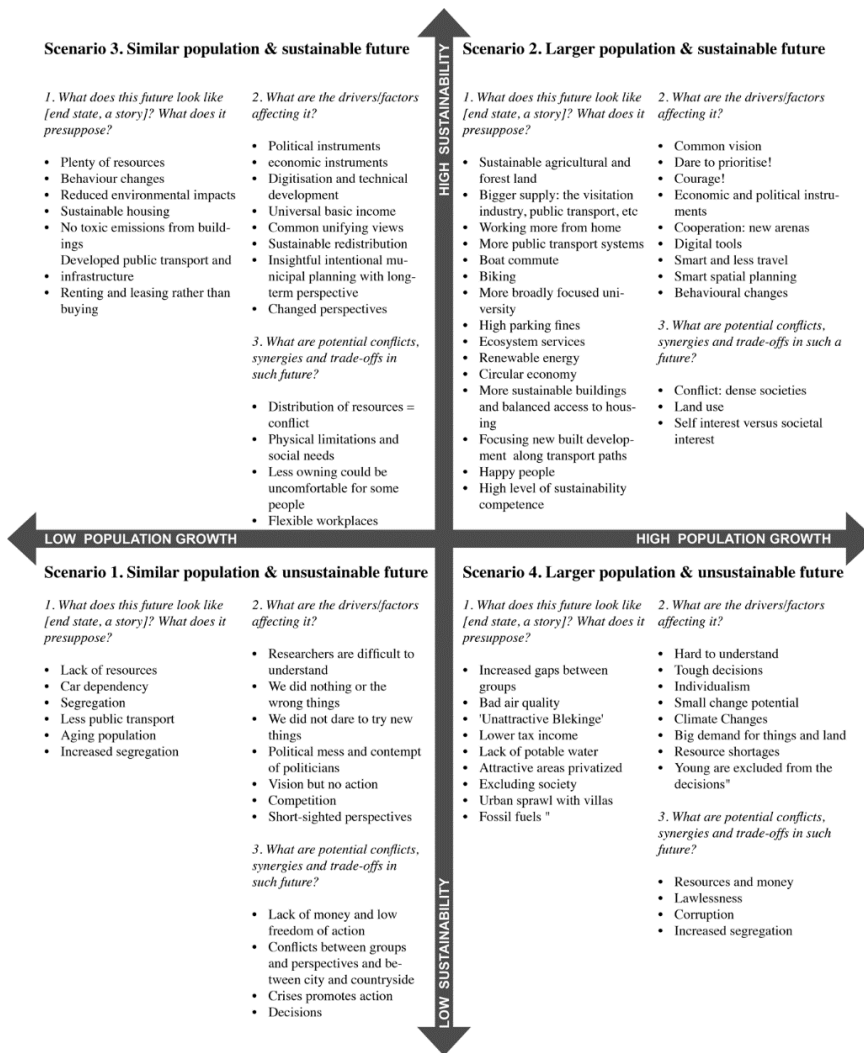
Scenario 3. Similar population & sustainable future

1. What does this future look like [end state, a story]? What does it presuppose?

- Plenty of resources
- Behaviour changes
- Reduced environmental impacts
- Sustainable housing
- No toxic emissions from buildings
  Developed public transport and
- infrastructure
- Renting and leasing rather than buying

2. What are the drivers/factors affecting it?

- Political instruments
- economic instruments
- Digitisation and technical development
- Universal basic income
- Common unifying views
- Sustainable redistribution
- Insightful intentional municipal planning with long-term perspective
- Changed perspectives

3. What are potential conflicts, synergies and trade-offs in such future?

- Distribution of resources = conflict
- Physical limitations and social needs
- Less owning could be uncomfortable for some people
- Flexible workplaces

HIGH SUSTAINABILITY

Scenario 2. Larger population & sustainable future

1. What does this future look like [end state, a story]? What does it presuppose?

- Sustainable agricultural and forest land
- Bigger supply: the visitation industry, public transport, etc
- Working more from home
- More public transport systems
- Boat commute
- Biking
- More broadly focused university
- High parking fines
- Ecosystem services
- Renewable energy
- Circular economy
- More sustainable buildings and balanced access to housing
- Focusing new built development along transport paths
- Happy people
- High level of sustainability competence

2. What are the drivers/factors affecting it?

- Common vision
- Dare to prioritise!
- Courage!
- Economic and political instruments
- Cooperation: new arenas
- Digital tools
- Smart and less travel
- Smart spatial planning
- Behavioural changes

3. What are potential conflicts, synergies and trade-offs in such future?

- Conflict: dense societies
- Land use
- Self interest versus societal interest

LOW POPULATION GROWTH — **HIGH POPULATION GROWTH**

Scenario 1. Similar population & unsustainable future

1. What does this future look like [end state, a story]? What does it presuppose?

- Lack of resources
- Car dependency
- Segregation
- Less public transport
- Aging population
- Increased segregation

2. What are the drivers/factors affecting it?

- Researchers are difficult to understand
- We did nothing or the wrong things
- We did not dare to try new things
- Political mess and contempt of politicians
- Vision but no action
- Competition
- Short-sighted perspectives

3. What are potential conflicts, synergies and trade-offs in such future?

- Lack of money and low freedom of action
- Conflicts between groups and perspectives and between city and countryside
- Crises promotes action
- Decisions

LOW SUSTAINABILITY

Scenario 4. Larger population & unsustainable future

1. What does this future look like [end state, a story]? What does it presuppose?

- Increased gaps between groups
- Bad air quality
- 'Unattractive Blekinge'
- Lower tax income
- Lack of potable water
- Attractive areas privatized
- Excluding society
- Urban sprawl with villas
- Fossil fuels "

2. What are the drivers/factors affecting it?

- Hard to understand
- Tough decisions
- Individualism
- Small change potential
- Climate Changes
- Big demand for things and land
- Resource shortages
- Young are excluded from the decisions"

3. What are potential conflicts, synergies and trade-offs in such future?

- Resources and money
- Lawlessness
- Corruption
- Increased segregation

Figure 9. Summary of the input on the four scenarios from the Scenario Workshop (translated from Swedish).

3.2.2. The Four Scenarios

The following sections describes the four scenarios resulting from the workshop (translated from Swedish).

3.2.2.1. Scenario 1: 'Business as Usual' with Similar Population and Low Sustainability

In this potential future, 'business as usual' has prevailed. The region has become known as quaint with its 'old fashioned' ways while its reputation as a desirable region to live in has suffered. Regional problems such as car dependency, segregation and the aging demographic remain. The population has also stagnated regionally despite increasing in most parts of Sweden. As a consequence, societal economy has also deteriorated. People have lost respect in politicians and the general level of conflict is high in the region.

The main drivers behind this future include poor communication between science and society with a lack of evidence-based political leadership and long-term sustainable policy direction. This shortcoming would be compounded if there was an insufficiently strategic systems approach to formal decision making processes to manage sustainability work across disciplines and societal sectors. Parallel ongoing work at the Blekinge Institute of Technology has identified these shortcomings as a barrier to municipal and regional sustainability progress at the moment (see upcoming licentiate thesis by Lisa Wälitalo in 2020). National and international goals (e.g., Paris Agreement, SDGs) were also low on the agenda. This meant a lack of investment resulting in unsustainable environmental, social and economic outcomes across the region and reduced capacity to address these areas as they worsened.

In this future, the main conflicts are between city and countryside and between the politicians and sections of society seeking more action on economic, social and environmental problem areas.

3.2.2.2. Scenario 2: 'Blind Growth' with Larger Population and Low Sustainability

In this potential future, a high and unlimited 'blind growth' has been assumed, based on the notion that 'bigger is better' regardless of what it is that grows. Houses are relatively cheap compared to other parts of Sweden and most new residents have moved to villas with large gardens on the edge of existing urban areas. Population growth has brought new life to the economy and a larger tax base. People are better off economically but social isolation and chronic disease such as obesity has grown as people spend more time in cars and must travel further to access recreation facilities and

forests. In the coastal cities, few people get to live by the water as most development land is to the north. Public transport also struggles to effectively service a dispersed population and traffic congestion is more common. The environment has suffered with loss of local amenity (e.g., forest cover) but also with considerably increased greenhouse gas emissions.

3.2.2.3. Scenario 3: 'Greener Blekinge' with Similar Population and High Sustainability

In this potential future, a 'Greener Blekinge' has a stabilized population and considerably improved sustainability performance at the local level. Considerable advances have been made for achieving the national and international sustainability goals through reductions of emissions, reduced waste, water and energy demand per capita while quality of life has remained high. EV car share schemes are common for longer trips to areas not serviced by public transport. As a consequence, societal economy has improved moderately.

The main driver behind this future was that the region developed a strong shared vision and found it relatively easy to implement because it did not also need to accommodate many new residents. A contributing factor behind this was probably that the region more systematically used a strategic systems approach to manage sustainability work and established a formalized meeting culture across disciplines and societal sectors. Priority was given to measures that increased efficiency and community capacity to reduce long-term running costs. Local ecological areas and farmland near the major urban centers were preserved to maintain access to the picturesque areas within short distances of most residents. Building stock was rebuilt or retrofit to be highly sustainable. Public transport, walking and cycling initiatives reduced reliance upon private cars. A strong emphasis on collective action and the introduction of a universal basic income led to a comfortable and socially supportive environment. Historic buildings and heritage structures were celebrated and preserved to help build the Blekinge brand as a quiet, sustainable and beautiful place to be in.

In this future, the main conflicts happen around some residents who find collectivist ideals, collaborative consumption and new general flexibility challenging. Still, the changes have benefitted most people.

3.2.2.4. Scenario 4: 'Restart Blekinge' with Larger Population and High Sustainability

In this potential future, called 'Restart Blekinge', the region is reborn with a high population and new flourishing emerging sectors such as green technology, ICT, marine environments, education and tourism. Blekinge has a reputation as a leading region for sustainability and innovation for 21st century societal transformation. A place where the creative classes can find good work opportunities while also finding a great living environment within dynamic urban centers that have excellent access to nature. Digital tools monitor and optimize performance and great advancement has been made towards fulfilling (inter)national goals. With most residents, employment areas and services close to high frequency public transport, fewer cars are needed. As a consequence, very little forest or agricultural land is needed for new development and the societal economy has improved considerably.

The main driver behind this future is courageous leadership towards innovative green entrepreneurship. As in scenario 3, a probable contributing factor behind this was that the region used a strategic systems approach to manage sustainability work and established a formalized meeting culture across disciplines and societal sectors. Strong regional policies have also attracted investment and population and this has, in turn, been channeled into further improvements in a virtuous cycle. Planning policy clustered land uses to improve walking, biking and boating options, while also integrating public transport viability and frequency. Historic buildings and heritage structures were celebrated and preserved to help build the Blekinge brand as a future-oriented center for sustainable innovation that also celebrates its cultural heritage. Balancing both opportunity and lifestyle, Blekinge is the place people want to move to.

In this future, the main conflicts are around land use and lifestyle as some people miss the small-town 'vibe' that has been replaced with more of a city 'vibe' in the new denser areas. Still, the focus on 'growing within the existing urban footprint' means that most people have high quality natural areas nearby.

3.3. Post-Workshop

3.3.1. Post-Workshop Stakeholder Survey

A survey was emailed to all participants after the workshop. The survey questions and results (Likert 5-point scale) are summarized in Table 3.

Table 3. Post-workshop stakeholder survey summary results.

	Survey Question	Average Score out of 5 (Range)*
SQ1	Overall impression of design and content	3.0 (1–4)
SQ 2	Overall impression of moderator and speakers	3.4 (2–4)
SQ 3	Overall impression of the venue, lunch and fika	3.1 (2–4)
SQ 4	Overall impression of the workshop	3.2 (2–4)
SQ 5	Workshop design of the different phases	3.0 (2–4)
SQ 6	Workshop design: participants' possibilities to	3.8 (3–4)
SQ 7	Workshop design: organization	3.5 (2–4)
SQ 8	Workshop design: results	3.1 (2–4)
		* n = 16 (37%)

Our interpretation of the survey was that respondents thought that the workshop was positive overall. However, as might be expected from the diverse range of disciplinary backgrounds, there was considerable variation with some responses being more negative than others. Generally speaking, responses to questions 1, 2 and 5 were most relevant to the performance of the research team and facilitators on the day, lower scores for question 1 and 5 indicate that the overall design, different phases, and content could be improved. However, the impression of moderators and speakers was broadly positive. Encouragingly, it was SQ6, the highest score relating to the participants' possibilities to contribute, that received the highest score, even amongst respondents with a more negative view of the workshop as a whole. In terms of capacity building within a transdisciplinary collaboration, the perception of participants about their ability to contribute is a very positive result, which combined with the high degree of transparency of the process is likely to increase the acceptance and ownership of the final scenarios [37]. Specific comments were provided by some of the respondents in response to the open question what was 'most interesting to discuss during the workshop'. A summary of key findings includes the following:

• There seemed to be general interest in the creation of scenarios with interest in 'the scenarios for sustainability and population growth', particularly the 'positive scenarios' and 'positive topics'; the views of others were important—'interesting to hear how others are reasoning', and the role of individual organizations—'my organization's role in the solution',

• Broad systems thinking was alluded to in terms of interest in upstream factors i.e., 'how one can look at what can cause sustainable development',

• There was interest in ecological sustainability, but two respondents highlighted a desire for more on 'social sustainability' and 'social and economic sustainability in Blekinge'.

• Given that urban planners were participating, it is not surprising that the role of land use and planning at the local level was seen as an important topic, e.g., 'Local sustainable solutions for Blekinge', 'spatial planning and sustainability', 'residential and transport issues… (and) where population growth can occur mainly outside the three major metropolitan areas in Sweden',

• However, there was some dissatisfaction with the level of resolution, with some wanting 'concrete proposals' and '…real results', or interested in 'What will happen to make a certain scenario to happen', or asking 'What is needed for the important but maybe less popular decisions to be taken?'

• Some respondents clearly felt the process was incomplete, with interest in scenarios: "scenarios … show opportunity, and it is important, despite being the first step. The second step is to gather these actors and talk about their purpose/goals and how related work can be gathered. What synergy there is, etc. … I think it is not finished. Looking forward to the report and even more to the next steps."

Future survey questions would benefit from understanding the participants' disciplinary backgrounds and how comfortable they were with the exploratory scenario process. It would be interesting to see if there were disciplinary differences. Furthermore, an open-ended question about what might be improved would offer useful insights about areas to refine for future workshops.

3.3.2. Post-Workshop Evaluation Interview

Following the workshop, an evaluation interview was held with the project manager from Region Blekinge, from whom direct quotations are included in this summary. When asked how useful the scenarios and subsequent summary report were, the project manager mentioned that "scenarios were not initially planned" but were seen as an opportunity in the Strukturbild 2.0 process "because demands came from the municipalities that the region should also be able to work with scenarios... The Regional Growth Agency (Tillväxtverket, who fund Strukturbild 2.0) accepted this and they seem satisfied with the result". The Growth Agency have requested that they receive and disseminate the scientific publications based on the workshop work.

The scenarios developed in the workshop have been used in subsequent meetings and workshops centered around future directions for Blekinge. "In the regional development strategy we have worked with the ABCD methodology... the scenarios in particular have helped the region to define their desired future destination" (i.e., the 'A-step' of the FSSD—a desirable vision that adheres to the sustainability principles). Region Blekinge are working with the high growth sustainable scenario 'Restart Blekinge' as the preferred future, and also exploring the low growth sustainable 'Greener Blekinge' scenario. "It was important for us to be able to link population development to sustainability."

Regarding useful results from a one-day event, the workshop process was seen "to quickly insert large blended target groups into the scenario context", but it was most useful for the initial stage of the ABCD process of the FSSD (A-step) "where several actors want to find out together which way they want to go." Subsequently, over a longer period, a more concrete sustainable transformation roadmap could be developed using the ABCD procedure, backcasting from the preferred future and prioritizing appropriate actions.

The scenario approach was seen as a useful tool to "get more from different players' 'skills'. Given that Strukturbild 2.0 is an interdisciplinary project with diverse participants, the 'scenario four-fielder can be a good tool for framing ... (considerations for) ... future visions." The scenario approach was easy to grasp and aided participants in the envisioning exercise.

When asked how this scenario planning process could be improved, the recommendation was to ensure greater coverage of "social sustainability" as "at some tables, the focus was on environmental sustainability". It was also

suggested that "future scenario workshops take some table leaders from the client organization, but it was good that BTH (Blekinge Institute of Technology researchers) had a meeting with the table leader before and that there was a structure to relate to."

Finally, it was seen as important that the scenario process was informative to a real planning process— "The scenario methodology should be linked to a concrete strategy or planning process or action selection study for best results."

4. Discussion

The combined evaluation (survey, interview and researcher reflection) suggests that a rapid scenario planning process is possible, but the experience of the research team indicates that considerable planning is necessary to create the conditions to enable this. Many hours of preparation fed into the workshop, and even so, the participant survey indicates considerable variation in stakeholder experience of the day.

One observation that is consistent with findings from other studies is that authorship matters, and focus will change depending upon who leads and designs the process [23], as different actors have different priorities, and this is equally true for the participants. The research team attributes some of the considerable variation in participant feedback scores to the diverse group. Some participants were clearly more comfortable with the creative scenario planning exercise than others, and the influence of participant receptivity to the scenario process deserves further study.

The importance of who should design the workshop was a consideration of the research team from the outset. As mentioned previously, the case study offered in this paper was instigated by a regulatory authority—Region Blekinge, but the workshop process was designed independently by a university research team (the authors). The authors intentionally designed the process to separate the various actors' roles.

The different role of each actor is summarized visually in Figure 10, where the activity and priority of each actor is shown in separate columns:

• Region Blekinge ensured that the scenario process had agency. Without agency, a scenario process is little more than an exercise in collective dreaming. Potential for impact was important to the researchers as previous transdisciplinary studies [52,53] describe how the perceived

burden of collaboration, unclear added value and negligible real-world impact detract from the stakeholder experience,

• The BTH researchers gave the process independence from local politics and freed the exercise from the shackles of existing policies or other preconceived limitations. Governing is a deeply political process, but administrative bureaucrats have considerable agency that also enables them to affect change [31]. Hence, engaging policy makers in a long horizon scenario planning process enables them to think beyond politics overcoming the problem of connecting transformation narratives to policy process [54], and

• Finally, the central actors of the workshop process, the stakeholder participants. This 'community of practice' collectively forms a vast repository of local institutional and community knowledge. The workshop design emphasized strategic activities, that is, formation of alternative long-term scenarios [5,55]. An exploratory scenarios process allowed the workshop to proceed without participants becoming stuck on technical details. Once the preferred scenarios have been selected (post-workshop), the challenge for the stakeholders will be to own the vision and collectively design the policies, strategies and tools that can move them toward that shared vision. Ultimately, this ownership will determine the overall impact of the process.
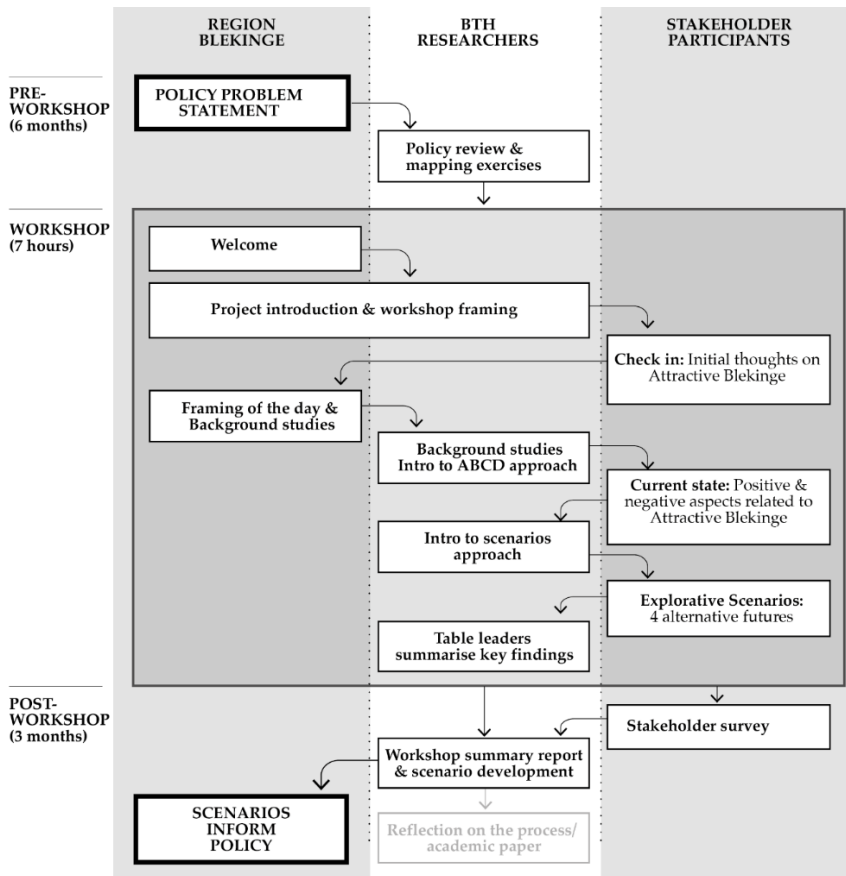
Figure 10. Summary diagram of the research phases and actor roles in the scenario process.

The time spent in the pre-workshop phase developing scaffolding approaches was seen as critical to the success of the workshop in achieving its objectives in the short time period. The scaffolding approaches used included:

•   Arriving with a predetermined scenarios quadrant with its two independent variable axes (sustainability and population). In traditional scenario workshops that run over several days, determining the axes may be part of the stakeholders' shared deliberation. But in this case, pre-testing and confirming the axes saved considerable workshop time,

•   Introducing the ABCD process from the FSSD methodology as a way to operationalize a preferred scenario (A-Step i.e., vision),

•   Introducing a summary of relevant background studies and preparing prompt cards for use by facilitators to keep the participants focused upon the key issues relevant to the scenario formation, and

•   Preparation of speculative spatial mapping to show potential impacts of different development patterns resulting from a high population growth, to allow participants to reflect upon the spatial implications of business-as-usual development, particularly the impact of high population growth and typical unbridled low-density urban expansion upon the highly valued geographic (forest, sea and archipelago) that form the current attractive identity of Blekinge.

Of the scaffolding techniques, the scenario axes seemed to be the most comprehensively understood, but comments from the post-workshop survey suggest the connection between the scenario exercise and an ongoing dialogue between all stakeholders to translate scenarios into policy was not so well understood by all workshop participants. Particularly the request for more concrete outcomes; this was after all intended primarily to synthesize stakeholder views around desirable futures for the region and how a preferred future could inform policy direction. It was an exercise in knowledge exchange, between the administrative 'silos' of public sector divisions and adjoining or overlapping governance bodies to inform a shared visioning process. Greater explanation of this bigger picture may have helped participants contextualize the day better, but equally more input could risk information overload. In a time-constrained workshop there will always be trade-offs about what information to include and exclude. However, given the bigger picture of translating scenarios into visions and using visions to inform policy, it was clear to the coordinating organization (Region Blekinge) that this gap in understanding may be rectified in subsequent stages of policy co-ordination.

In addition to facilitating the creation of scenarios to inform policy, the research team found the evaluation process to assess the efficacy of the project (through surveys and post-evaluation interviews) and their own subsequent reflection to be a valuable exercise in learning and process refinement. Through this evaluation process, the initial concern relating to the short workshop timespan was somewhat allayed, but success was dependent upon a good working relationship with the coordinating organization (Region Blekinge), the right scaffolding tools, and a

knowledgeable stakeholder group. The scaffolding techniques presented in this case study were designed as a pedagogic tool to focus participants upon the key issues for exploration. They were instrumental to reducing overall time commitment from the participants, and the resulting compressed time frame (i.e., a one-day workshop) enabled good attendance levels. The project manager warned that a longer multi-day event was unlikely to attract a good turnout. Keeping the workshop length relatively short was seen as critical for success as this ensured good attendance, including senior managers. Attendees were also curated to maximize diversity, in terms of both sectoral interests and disciplinary backgrounds, to enhance the learning opportunities through exposure to new perspectives amongst participants. The use of an academic research team provided a neutrality in the process that may not have existed if the process was 'owned' by one of the several organizations that were participating.

The facilitated scenario process effectively became a collective exercise in sustainability foresight, working towards consensus on a future sustainability vision(s) for the region, in both high growth and low growth alternatives. This allowed a shared understanding by finding common ground for future action between a range of related organizations (1). The emphasis was on maximizing the output from the workshop through minimal time input from participants—'rapid' relates to the workshop length—but there is a transfer of time burden to the pre-workshop phase undertaken by the workshop development team. Extensive upfront preparation saves time for participants in the workshop. There is a risk, of course, that the pre-workshop preparation limits exploration; to minimize this risk the scaffolding techniques used in this case study were appropriate to Region Blekinge's specific context.

This case study represents a small intervention in the grand scheme of a regional policy planning process. However, it does represent a relatively powerful leverage point in a larger transformation journey, by showing how a time-efficient rapid scenario planning approach can be useful to shape a shared vision, thus providing strategic direction to help align future collaboration between a range of organizations that are collectively responsible for developing sustainability transformation policy. At the outset of this case study, the research team were concerned that a one-day workshop may be insufficient to achieve a meaningful outcome capable of influencing the regional policy direction. However, despite the relatively small investment of time by participants at the workshop, the post evaluation interview with the project manager suggests that in this case even

a rapid scenario planning workshop can have a considerable lasting impact—the evaluation indicated that it was perceived as reasonably successful by participants and Region Blekinge. Region Blekinge have since used the scenarios to inform further stakeholder discussions and inform strategic policy direction.

5. Conclusions

Transformation requires collaboration. Rarely, if ever, is one organization tasked with, or even capable of, guiding a transformation process in isolation. Rather, multiple actors drawn from many societal sectors are required, and they must work together. To be strategic, collaborative processes benefit from an alignment of direction across and between organizations. A transdisciplinary scenario process can facilitate this by allowing disparate actors to learn from one another through a dialogic process. In the rapid scenario planning approach, we describe how this can be done in a compressed time period (e.g., a one-day workshop).

Critical to the success of a rapid scenario planning process is the considerable preparation in a pre-workshop phase to develop various scaffolding approaches, e.g., in this case:

- pre-established variable axes for the scenarios (i.e., sustainability, population),

- explaining the FSSD to participants as a common definition of sustainability,

- preparation of a list of key issues to focus workshop discussions, and

- speculative mapping to indicate possible spatial impacts of various growth options.

In more conventional exploratory scenario planning approaches, the identification of the scenario variables (i.e., the axes), mapping exercises and other exploratory exercises would be prepared by the stakeholders themselves, thus allowing participating experts and other stakeholders much deeper engagement with the scenario content. This greater engagement requires more time, with conventional scenario processes typically held over multiple days. The evaluation of this case study shows that there is still value in conducting a 'rapid' scenario planning process that

involves multiple stakeholders in a collaborative process in a shorter time frame.

This paper began by describing the importance of transdisciplinary approaches to ensure more holistic (sustainability policy) outcomes. Scenarios are a transdisciplinary tool that can reduce risks and maximize opportunities associated with alternative development paths [2], but perhaps even more powerful than this is the reflexive process scenarios require—the individual and organizational learning that results from dialogue and debate between participants. The results from this scenario case study support existing literature, in that participants were observed to:

- share knowledge and reflect upon the limits of their own disciplinary or organizational silo [30],

- learn from each other through a dialogic process to consider impacts at a broader systems level [55,56],

- think over a long-term horizon (to 2050) and creatively reflect on the needs of the future [57], and

- link abstract global issues such as climate change and sustainability to local place-based values and needs.

A major recommendation to those seeking to conduct a similar rapid scenario planning process to inform sustainability transformation policy would be the importance of well-considered scaffolding techniques. The scaffolding techniques in this case study should certainly not be treated as an exhaustive list, nor are they necessarily transferable. Scaffolding techniques should be context-dependent and tailored to best support participants to focus upon the key issues for scenario development.

This hints at a future research direction - a systematic exploration of scaffolding approach typologies to support scenario planning processes. A typological study of approaches would complement existing studies that describe typologies related to scenario planning [4]. Scaffolding approach typologies would assist workshop designers in instances where time constraints might otherwise preclude scenario planning as a tool, and 'rapid' approaches would be beneficial. This is particularly true for smaller organizations (e.g., small regional governments) that are rarely as well-resourced as larger organizations and time away from core work has a greater negative impact upon the organization.

Ultimately, this case study used scenario planning to insert a reflexive exercise into a traditional planning process, thus allowing the participants to envision possible alternative futures, rather than just adhering to narrow path-dependent policies that also limit change by creating structural barriers to sustainability transformation. The evaluation demonstrated that even a rapid scenario planning process can engage participants in a collaborative learning exercise; in this instance, one that improved the collective understanding of a community of practice to help align stakeholder interests as they embark upon a regional sustainability transformation.

This paper was limited to one case study, but we expect some of the approaches to be generalizable to similar contexts, although this is beyond the paper's scope. However, we imagine that similar rapid scenario planning processes could be useful for planners and policy makers to explore other complex issues where there is great uncertainty, limited participant time resources, and where the topic would benefit from broader transdisciplinary dialogic exploration of possible futures, e.g., pandemic response, climate change adaptation, etc.

This case study, along with any future development of 'rapid' scenario approaches, may help overcome the perception that scenario planning is always resource-intensive for participants, and therefore that 'rapid' variants may have increased appeal as a tool for use where policy must be developed to guide change for uncertain futures.

As a final note, the promising result of this specific case study can only be seen as a first step. There are regional limits to growth that are difficult to estimate with the limited type of qualitative assessments possible in this study. Greater elaboration, comparisons and quantitative modelling would be needed to make comprehensive policy roadmaps. While policy roadmaps are typically developed within a professional planning context, we would argue that this more detailed work would also benefit from the broader perspective that transdisciplinary collaboration brings. Such a future research agenda could also explore the potential of an educational approach within and across municipalities focused upon strategic sustainable development to help link sustainability science to policy action, thereby supporting the translation of the 'rapid' scenarios into detailed sustainability transformation policy.

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description section borrows heavily from the post-workshop report (in Swedish) 'Scenarier för Blekinge 2050' prepared by H.N., V.N., G.T. and S.B.; conceptualization and framing by J.B., J.A. and G.T.; evaluation interview by H.N.; review and editing by all authors. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: Region Blekinge funded the workshop and played an active role in framing the day. The BTH research team independently prepared the post-workshop conclusions, scenarios and this paper. The funder (RB) played no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Appendix A

Table 4. List of participating stakeholder organizations.

Swedish Organization Name	English Translation
Energikontor Sydost AB	Energy Agency Southeast
Länsstyrelsen Jönköping	County Administrative Board Jönköping
Länsstyrelsen Blekinge	County Administrative Board Blekinge
Karlshamns kommun	Karlshamn Municipality
Region Blekinge	Region Blekinge (regional authority)
Blekingetrafiken	Blekinge Public Transport Authority
Tillväxtverket	Swedish Agency for Economic & Regional Growth
Sölvesborgs kommun	Sölvesborgs Municipality
Ronneby Kommun	Ronneby Municipality
Blekinge tekniska högskola	Blekinge Institute of Technology
Karlskrona kommun	Karlskrona Municipality
Openlab, Kungliga Tekniska Högskolan	Openlab, Royal Institute of Technology
Blekinge Arkipelag	Blekinge Archipelago

Appendix B

Summary of workshop activities:

o   Pre-meeting with table facilitators that discussed ground rules and the workshop plan.

o   First participant exercise: A five-minute real-time interactive 'mentimeter' exercise with all participants invited to use keywords to describe their initial thoughts relating to 'Attractive Blekinge' with results projected for the whole room to see.

o   Framing of the day: International, national and regional goals introduced. Summaries of local visions captured in a word cloud. Description of the ABCD approach, sustainability challenges in Blekinge and presentation of speculative spatial mapping implications of future urban growth.

o   Participants divided into eight break-out tables with a facilitator (5–8 people per table).

o   Participant break-out exercise 1: group work in a World café style to capture positive and negative perceptions relating to 'Attractive Blekinge'.

o   Participant break-out exercise 2: scenario development corresponding to the four scenarios with pre-defined axes.

o   There were four scenario development rounds so everyone could contribute to each of the scenarios (30 min + 20 min + 20 min + 20 min).

o   When the discussion started to die out or slow down, the facilitators were provided with thematic cards on issues raised in earlier policy documents as discussion prompts. They could be taken one by one and related to the questions at hand.

o   Group feedback: facilitators offered summary report on key factors arising, major conflicts, synergies and trade-offs. No repetition from other tables.

o   Wrap-up and next steps.

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Paper F

**Grasping MUltiple SusTainability goalS (MUSTS):
a tool for supporting dialogue-based processes of
multi-level governance in transport planning**

Paper F is submitted to journal as:

Grasping MUltiple SusTainability goalS (MUSTS): a tool for supporting dialogue-based processes of multi-level governance in transport planning

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Abstract

A tool that provides an organised overview of sustainability goals for relevant stakeholders at different levels is proposed. The MUSTS tool was developed and prototyped, then tested within a multistakeholder collaborative project for sustainable transport planning in Sweden. By applying the tool, this study managed to sort and organise 179 goals in 30 documents at five levels into 109 goal categories and help stakeholders identify the goals relevant to their work. An exemplification of the results from the tool shows that different aspects of 'health' are aimed for by the goals in the various policy and planning documents. It also shows the different stakeholders with mandate and legitimacy to act on these goals. The usefulness of the tool for various contexts and for other purposes, such as sustainability assessment of the goals in policy and planning documents, monitoring and reporting of the goals, and supporting dialogue-based processes is discussed.

Keywords: *sustainability, planning, transdisciplinarity, stakeholder, policy, tool, goal*

Introduction

There are global sustainability challenges that society needs to deal with urgently. One of the main contributors to unsustainability is the transport sector. According to Eurostat, in 2017 transport (including aviation) was responsible for 27% of total greenhouse gas equivalent emissions in 28 European Union countries (EEA 2020). The emissions drastically dropped by ca 12,7% in 2020 due to the COVID-19 pandemic (EEA 2021), so as countries start slowly coming back to life after the pandemic, the transport sector has a chance for major improvements. However, environmental challenges are not the only ones facing the transport sector. Social sustainability brings in aspects of accessibility, justice, health-related issues, and equity while providing services to meet the needs of the people (Curtis 2008; Gössling 2016; Parnell 2016; Simon 2016).

These challenges have led to responses at different levels. Some international examples are the Paris Agreement (United Nations 2015), the Sustainable Development Goals, SDGs (United Nations 2015), the European Green Deal (European Commission 2019), and the European Union Taxonomy (European Commission 2020). Additionally, national and local governments in each country might define their own strategies and plans. Each policy, strategic and/or planning document comes with clearly defined or embedded goals that are specific for or related to transport. However, it is not easy to obtain an overview of the relevant goals across the documents. Moreover, when looking at the goals, for example, the SDGs, in a systemic way, one can see that some of these goals overlap and some even conflict (Miola et al. 2019). Yet, there is a need for a way to practically obtain an overview of all these goals.

Furthermore, on the local level (e.g., in the region or municipality), there are actors, who have the power and legitimacy to act upon the goals – dominant and definitive stakeholders (Mitchell et al. 1997). Sandra Valencia and colleagues (Valencia et al. 2019) found in their research that the local actors often focus and report on selected goals based on their interests. Moreover, by using a multi-level governance framework in transport planning, one can see that coordination of work is taking place between stakeholders who act according to their constituencies (Baldersheim and Ståhlberg 2002), which adds even more complexity to working with the goals. Thus, there is a need for a tool that helps researchers and practitioners to understand what sustainability goals need to be addressed in their context and what the interconnections between the goals are, and to identify stakeholders who

have the mandate and legitimacy to act upon these goals. This would support the dialogue-based processes of multi-level governance to achieve better goal alignment.

Therefore, the aim of this paper is twofold: (i) to present a tool that provides an organised overview of sustainability goals for relevant stakeholders at different levels; and (ii) to illustrate its application to a case of sustainable transport planning in Sweden.

Background

Looking for literature on tools for an organised overview of sustainability goals for relevant stakeholders at different levels, the study found no tools that provide an overview of goals that come from various policy and planning documents, nor any that help identify the goals of the dominant and definitive stakeholders. To develop a tool that combines these tasks, it needs to be useful in a multi-level governance setting, address sustainability comprehensively, and help steer the transition process.

Multi-level governance

Multi-level governance is a framework that allows seeing arrangements of policy-making activities within and across institutions at different geographical scales (Stephenson 2013). This framework has been used for various purposes, such as its original purposes (legal jurisdictions of efficiency and authority, regionalisation and Europeanisation), functional uses (to study policy and implementation, for problem-solving, learning and coordination), combined uses (multi-level governance as a new mode of governance; new theory), and normative uses (to reflect upon legitimacy, democracy and accountability, to analyse the identity of politics) (Stephenson 2013).

A multi-level governance framework could be used to understand Nordic countries' central-local relations (Baldersheim and Ståhlberg 2002). It is a characteristic feature of these countries that public services are provided by the local authorities. Additionally, close collaboration between central and local governments shows that the latter have a certain autonomy in their decision-making. Norway, Sweden, Denmark and Finland share an attempt

to reduce rule-oriented control in central-local governmental relations. Therefore, this gives responsibility to local authorities to develop actions to address goals at various levels. However, policy documents usually do not have guidelines for contextualisation, it is often left for national and local authorities to define guidelines for that (Valencia et al. 2019). The Swedish government, for example, created an action plan for the Agenda 2030 implementation (Regeringskansliet 2018). However, it has been suggested that this action plan tends to lack the ability to guide decisions in practical settings (e.g., Aktuell Hållbarhet 2021a; 2021b). Therefore, it is difficult for local authorities to plan for actions addressing various sustainability goals in policy and planning documents at multiple levels.

The quality of the outcomes of dialogue-based planning processes is highly dependent on those who take part in these processes. Participants of such processes are often referred to as stakeholders – those who are affected by a problem or can affect the solution of this problem (Mitchell et al. 1997). Ronald Mitchell and colleagues (1997) suggest differentiating stakeholders based on their power, legitimacy and urgency. By *power*, they mean 'a relationship among social actors, in which one social actor, A, can get another social actor, B, to do something that B would not have otherwise done' (Mitchell, Agle, and Wood 1997, p. 869). One type of power that is relevant to this paper is utilitarian power. Stakeholders with *utilitarian power* have the means to act and inspire action (Mitchell, Agle, and Wood 1997, p. 869). *Legitimacy* is defined as 'a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, definitions' (Mitchell, Agle, and Wood 1997, p. 869). Finally, *urgency* is defined as 'the degree to which stakeholder claims call for immediate attention' (Mitchell, Agle, and Wood 1997, p. 869). Various intersections of these aspects create different groups of stakeholders. For this paper, two groups of stakeholders are relevant – dominant and definitive stakeholders. *Dominant stakeholders* are those who have the power and legitimacy to act upon something, whereas *definitive stakeholders* are those who additionally experience urgency (Mitchell, Agle, and Wood 1997, p. 869).

Felix Rauschmayer and colleagues (Rauschmayer et al. 2009) suggest that multistakeholder dialogue-based processes could improve multi-level governance by enhancing the legitimacy of governance. When such processes focus on sectoral planning, such as transport planning, it is important to have an overview of various sustainability goals that could be further integrated and contextualised (Hrelja 2011; Elmqvist et al. 2018).

Additionally, stakeholders with utilitarian power need to be part of these dialogue-based processes. However, it is not always clear who such stakeholders are (Valencia et al. 2019). This is important to identify because the implementation of activities to reach the goals needs to overcome short-terminism in planning often related to political cycles. Therefore, there is a need for an organised overview of which stakeholders within multi-level governance can act upon various sustainability goals. However, there are no tools that show clear connections between these stakeholders and sustainability goals, which makes it difficult to invite the relevant actors into the dialogue processes.

Framework for Strategic Sustainable Development

The Framework for Strategic Sustainable Development (FSSD) was specifically developed to navigate complexity in planning for sustainability (Broman and Robèrt 2017), which can be useful to address challenges of multi-level governance. One of the components of the framework is a definition of sustainability which, when used in a participatory way, allows for the co-creation of a desired future in a given context using sustainability principles as boundary conditions. These principles are (Broman and Robèrt, 2017, p. 23):

'In a sustainable society, nature is not subject to systematically increasing...

SP1 ... concentrations of substances extracted from the Earth's crust [...];
SP2 ... concentrations of substances produced by society [...];
SP3 ... degradation by physical means [...];

and people are not subject to structural obstacles to...

SP4 ... health [...].
SP5 ... influence [...].
SP6 ... competence [...].
SP7 ... impartiality [...].
SP8 ... meaning-making [...]'.

The framework also includes a process for the development of strategic plans in a co-production manner with an emphasis on a continuous reassessment of the plans as conditions in a context that constantly changes. Since no one can ever predict all the context-relevant circumstances and plans never go

fully as planned, it makes a principled definition of sustainability (like the one provided by the framework) and iterative participatory reassessment of the plans key elements of strategic sustainable development. The framework is rooted in a transdisciplinary research approach. Application of this framework has been documented in various contexts and systems (Hallstedt et al. 2010; Bratt et al. 2013; Wälitalo and Missimer 2022), including some urban transport planning cases (Borén et al. 2017; Ny et al. 2017).

Transdisciplinary co-production of knowledge in urban transport planning

Transdisciplinary co-production of knowledge is a participatory research approach that is widely used by researchers and practitioners (Fokdal 2021; Hemström et al. 2021; Simon 2016; OECD 2020). It emphasises the need for collaborative and inclusive processes and is used in multi-level governance contexts, such as urban planning and, in particular, mobility/transport planning. Here this paper uses the following definition (Hemström et al. 2021, p. 6): 'transdisciplinary co-production refers to collaboratively based processes where academic researchers and other actors and groups come together to share and create knowledge that can be used to face the sustainability challenges of today while increasing the capacity for societal problem-solving in the future'. This definition was chosen because it is the most relevant for the context of this study, and the work builds on the studies of those who created this definition.

Three types of knowledge are commonly distinguished by transdisciplinary researchers (e.g. Hirsch Hadorn et al. 2006; Kueffer, Schneider, and Wiesmann 2019): target knowledge, systems knowledge and transformation knowledge (see Figure 1). All three of them need to be employed for research to be regarded as transdisciplinary. *Target knowledge* answers the question 'what ought to be?'. It represents the pluralism of values and norms. An example of this type of knowledge is a set of goals as part of a policy document. *Systems knowledge* answers the question 'what is?'. It describes the origin of a problem, possible developments of this problem and its interpretations. An example of systems knowledge is a description of a holistic understanding of socio-ecological systems related to the transportation of people. Finally, *transformation knowledge* answers the question 'how to?. The focus is on different types of options for change, such as technical, social, legal, and other. An example of transformation

knowledge is a result of a strategic plan created by a strategic planner. All three types of knowledge in transdisciplinary research are interconnected and affect each other, for example, depending on interpretations of a problem within a system, a set of goals can be created and based on those, possible solutions can be identified.
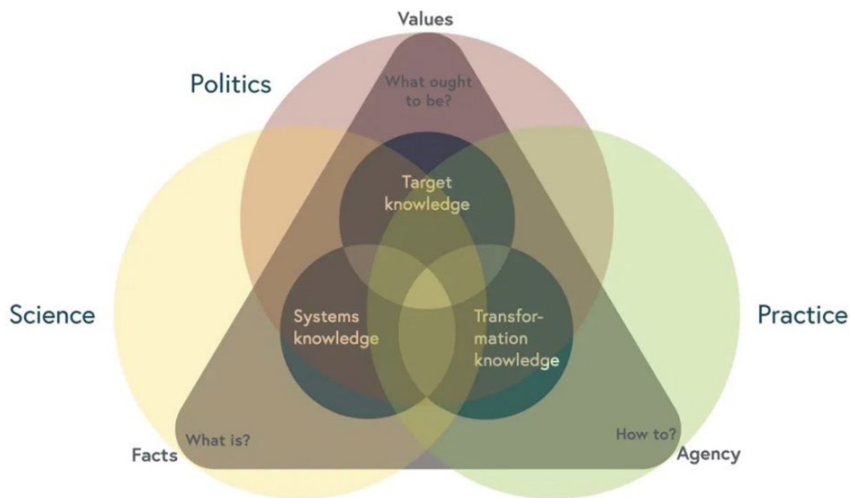

Figure 1. Intersecting spaces between three types of knowledge, the relationship with facts, values and agency, and the three spheres of influence (created by Flurina Schneider and the University of Basel New Media Center, CC BY 4.0).

Conducting transdisciplinary research comes with a set of challenges, which creates pressure upon the quality of such research. Some of the quality criteria are presented by Kerstin Hemström and Merritt Polk (Hemström et al. 2021; Hemström and Polk 2021). These criteria outline considerations that need to be made at the initiation and design phases of the transdisciplinary research processes. Knowledge is usually considered or mediated through the active participation of the local authorities and other stakeholders. *Active* in active intermediation refers to the continuous engagement of participants in the process, where the amount of effort put into it by all involved is reflected upon and recognised. *Intermediation* refers to acknowledging one's own and moving between epistemic communities and communities of practice. Co-production does not occur between isolated epistemic communities; it happens in a safe space where participants are willing to join a dialogue (Nikulina, Larson Lindal, et al. 2019). Thus, intermediation is one of the key factors for the co-production of knowledge. The second condition for the co-production of knowledge, reflexivity, is closely related to active

intermediation. *Reflexivity* is about reflecting on oneself as a researcher: what choices of research questions and partners one makes, who one is and what roles one plays in a research process (May and Perry 2017). Finally, *knowledge integration* is at the core of knowledge co-production. Here, it refers to 'the act of combining and integrating different perspectives and expertise to generate comprehensive and solution-oriented knowledge in relation to a real-world problem' (Hemström and Polk 2021, p. 46).

Gaps in the literature

The literature suggests that there are no tools that provide an organised overview of sustainability goals that could be further integrated and contextualised for the relevant stakeholders at multiple levels within the same tool (Hrelja 2011; Elmqvist et al. 2018). There is an example, though, of a method that shows interlinkages of the SDGs (Miola et al. 2019). This method uses literature review to identify linkages, as well as connecting SDGs to the European Union legislation. However, this method does not connect SDGs to other policies and does not provide flexibility for adding new documents to identify and illustrate the linkages.

There are multiple ways of identifying stakeholders, for example, through investigating the problem or building a mind map (Durham et al. 2014). There are also more elaborated ways of stakeholder identification (Mitchell et al. 1997). All these tools help identify relevant stakeholders for a certain problem or a project. However, they do not identify stakeholders with power and legitimacy in relation to individual goals or policy and planning documents. Therefore, there is a need for a tool that could provide an organised overview of sustainability goals for dominant and definitive stakeholders.

Methods and conceptualisations

To develop the tool, this study used principles of design research (Hevner et al. 2004): developing an artefact that adds to the knowledge base and that can be used in an appropriate environment. Additionally, an instrumental approach to tool development was applied (Romme and Holmström 2023). First, practical needs of an organised overview of sustainability goals for relevant stakeholders with a theoretical grounding in transdisciplinary co-

production of knowledge, strategic sustainable development, and stakeholder categorisation were combined. Target knowledge of transdisciplinarity was used as a principle for organisation of sustainability goals. Then, the tool was developed, prototyped, and tested.

The development process

At the start of the development process, the co-authors of this paper, reflected upon the relevance of their expertise, capabilities and roles in the project – the environment of the application (Hevner et al. 2004). Then, the knowledge base was discussed, starting with constructs of what sustainability goals are within this project and how they can be found and selected. The research recognised the theoretical foundations for the tool development, namely the three types of knowledge of transdisciplinary research and the benefits of the possibility to produce them within a project and that target knowledge could be used as a principle for organisation of sustainability goals. This study also acknowledges the usefulness of sustainability principles within the FSSD in the sustainability assessment of the goals as well as their applicability as target aspects. Moreover, stakeholder categorisation was found useful. This led to a step-by-step procedure through which the research could acquire data for illustrating an organised overview of sustainability goals for relevant stakeholders at different levels. A choice was taken to make the tool highly iterative, allowing for reassessments and reflection, thereby increasing rigour. This was done by creating multiple opportunities for revisiting the context and existing analysis. The study also chose to embed four opportunities for stakeholder engagement to enhance the societal relevance of the outcomes of the tool.

Additionally, this research included opportunities to produce the three types of knowledge (Kueffer et al. 2019) outlined in background section. It is suggested that the target knowledge can be acquired through the assessment of policy and planning documents concerning the target aspect(s) that the user of the tool ought to decide upon. The transformation knowledge can be produced by identifying who has the power and legitimacy to act upon a goal from a policy or a planning document. Finally, the systems knowledge can be produced through engagement with stakeholders and literature studies to understand the current state of the system or the context where the tool is being used. Three types of knowledge in transdisciplinary research were used to inform the tool to ensure that all the necessary knowledge would be produced through its application.

Testing the tool in a project

The tool was worked out practically and its presentation in this paper is a generalisation of the approach. In the results section, an application of the tool will be outlined to provide more clarity on its usefulness and relevance for planning sustainable transport in Sweden.

The proposed tool was applied between March and December 2021 in a project. The project focuses on the sustainability transition of the entire regional transport system in Sweden. The project applies the FSSD (Broman and Robèrt 2017), outlined in background section as the core methodology.

Through previous collaborations (e.g. Ny et al. 2017; Nikulina, Simon, et al. 2019; Thomson et al. 2020; Borén et al. 2017), the co-authors of this paper had existing relationships with stakeholders from the regional and municipal authorities and other transport authorities who were involved in trialling this tool. The study also identified further stakeholders through a modified stakeholder analysis (Reed et al. 2009), who were part of the testing of the tool.

More details on the tool application can be found in results section, where the description of how the procedure of the tool was used is presented and an example of its outcome is shown.

Results

The proposed tool is presented in the two following ways. First, key concepts and the procedure, including optional stakeholder engagement moments, are described. Second, an illustrative application of the tool in the field of transport planning is presented.

The proposed tool is called MUSTS. The acronym MUSTS comes from the abbreviation of MUltiple SusTainability goalS. The main purpose of the MUSTS tool is to relate sustainability goals (elements of the target knowledge of transdisciplinary research, see Figure 1) to stakeholders who have the power and legitimacy to act upon them (Figure 2). One could choose to show the direct connection between a sustainability goal and a host of administration officials (e.g. purple connecting lines) or to illustrate the complexity of goals that each stakeholder has to deal with without

showing the direct connection (e.g. by using the same colour for all connecting lines).
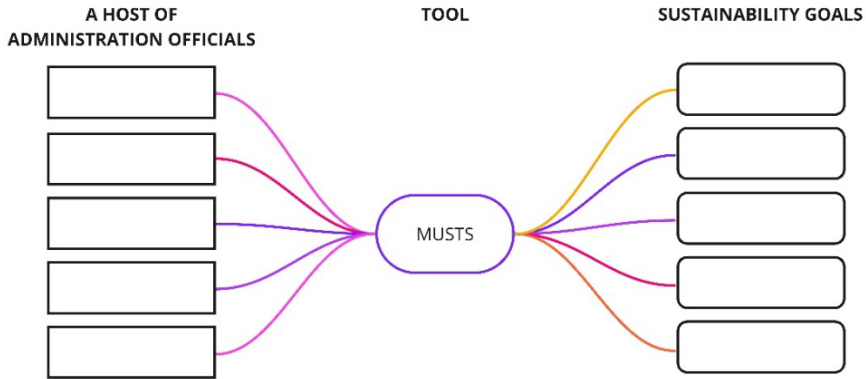
Figure 2. The MUSTS tool connects sustainability goals and administration officials of stakeholder organisations who have the power and legitimacy to act upon the sustainability goals.

Key concepts and terms of the tool

In the tool, several concepts and terms are used. They are briefly described below.

The term *goal* refers to a statement within a policy or a planning document that indicates a future state of the transport system or a recommendation or regulation that the transport planners need to fulfil. Whether the goal leads to sustainability is assessed through sustainability principles analysis (Broman and Robèrt 2017). It is distinct from the term target aspect. The target aspect relates to the target knowledge of transdisciplinary research (see background section). The *target aspect* indicates the values and/or norms or their elements within a specific context; it shows what is the issue that needs to be addressed in this process.

As a part of the tool, this study recommends stakeholder engagement and reflexivity. By *stakeholder engagement*, two-way communication and collaboration between researchers and practitioners is emphasized. *Reflexivity* has been defined in background section. This study does not provide specific tools for using reflexivity here; however, there are examples provided in the literature (see, for example, May and Perry 2017; Sultana 2007; Wittmayer and Schäpke 2014).

In the tool, the research refers to a process leader; therefore, it is important to define both a process and a process leader. A *process* means 'a series of things that are done to achieve a particular result' (Oxford Advanced Learner's Dictionary). In the context of this tool, a process is a series of steps taken as a part of the project, where the tool application takes place. A *process leader*, then, is one or several people who lead the process within a project.

System in this paper means 'a group of interacting, interrelated, or interdependent elements forming a complex whole' (Kim 1999, p. 19). Description of the system relates to the creation of systems knowledge of transdisciplinarity, described in background section. The system in the tool is referred to as *context*.

Finally, this study uses bottom-up and top-down groupings of the goals. The *bottom-up grouping* refers to the creation of categories of goals based on the content of the goals. The *top-down grouping* refers to assigning goals to a pre-defined set of goal categories, for example, sustainability principles within the FSSD.

A procedure to provide an organised overview of sustainability goals for relevant stakeholders at different levels

Based on the literature review and empirical work described above, a procedure for creating an organised overview of sustainability goals for relevant stakeholders at different levels is proposed (Figure 3).

The procedure can be applied within a wider transdisciplinary process (as indicated by a grey arrow in Figure 3) or on its own. If there is no prior collaboration, existing methodologies and extra engagement activities could be useful for the process, see, for example, (Sørensen and Torfing 2018; Horcea-Milcu et al. 2022).
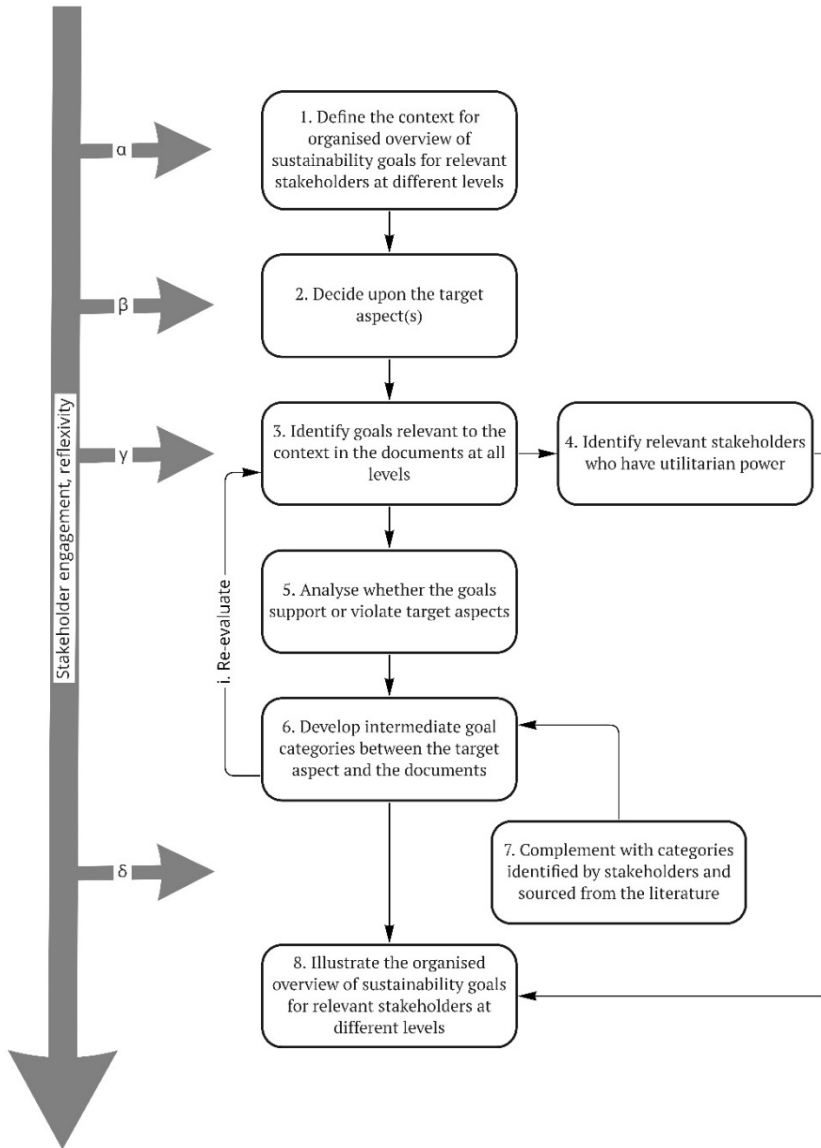
Figure 3. A procedure to provide an organised overview of sustainability goals for relevant stakeholders at different levels.

The proposed procedure consists of eight steps (1-8 in Figure 3) with one loop (i). Collaboration between the process leader(s) and other stakeholders is shown through four recommended engagement points (α - δ). Below this study describes each element in detail.

Step 1: Define the context for an organised overview of sustainability goals for relevant stakeholders at different levels. It is important to set clear boundaries of the system one works with, which is referred to as 'context'. An example of the context could be transport planning in a municipality.

Step 2: Decide upon the target aspect(s). In the defined context, it is necessary to identify one or several target aspects. For example, it could be health, meaning how human health is being affected by transport.

Step 3: Identify goals relevant to the context in the documents at all levels. Given the context, relevant documents (both from policy and planning) should be selected. Documents at all levels should be considered: international, macroregional, national, regional, and municipal (and/or other levels). Within these documents, identify goals that are relevant to the context.

Step 4: Identify relevant stakeholders who have utilitarian power. Each of the identified goals will have to be considered and acted upon by an organisation (or several organisations) and a certain person within each organisation at the local level. All organisations and respective roles in the organisations for each goal need to be identified through expert knowledge and/or stakeholder engagement.

Step 5: Analyse whether the goals support or violate target aspects. It is done by completing sustainability principles analysis by interpreting the goal statement in relation to the target aspect (sustainability principle(s) of the FSSD). For example, if the goal is to reduce CO_2 equivalent emissions from land transport by 50% by 2030, it means that the goal supports the target aspect 'nature is not subject to systematically increasing concentrations of substances extracted from the Earth's crust' (Broman and Robèrt, 2017, p. 23). However, if the goal states, for example, to fully digitalise the transport ticketing system, it would violate the target aspect of impartiality (Broman and Robèrt, 2017, p. 23), since not everyone has access to digital means at all times. If there is more than one target aspect, group the goals by using a top-down approach, where the target aspects are a pre-defined set of goal categories.

Step 6: Develop intermediate goal categories between the target aspect and the documents. This step is necessary for clarifying how target aspects are interpreted in the policy and planning documents. To develop goal categories, the goals should be grouped bottom-up, by creating a key term

or a short phrase that summarises the meaning of the goal based on the interpretation of the goal. This step can be combined with *Step 5*.

Step 7: Complement with categories identified by stakeholders and sourced from literature. The bottom-up grouping process should be complemented by seeking out further potential goal categories together with stakeholders and in the relevant literature, both academic and grey.

Loop i: Re-evaluate. Additional goal categories that were identified with stakeholders and in the literature need to be compared to existing ones if necessary adjusted, grouped or split and renamed. Afterwards, the goals need to be (re-)grouped utilising a top-down approach, where the goal categories are used as a pre-defined list.

Step 8: Illustrate the organised overview of sustainability goals for relevant stakeholders at different levels. Visualise the relations between the documents (source of the goals) by connecting them through the common goal categories and target aspect(s) and who would have utilitarian power to address these goals, including a host organisation.

There are at least four engagement moments with stakeholders that this study recommends in the procedure. They can be combined, if necessary, as long as the purpose of engagement is fulfilled and the data is collected. Below the study describes the purpose of each of these and give examples of the means of engagement.

Stakeholder engagement (α). A better understanding of the context should be gained. Research suggests that system boundaries are necessary for the definition of the problem, identification of whom to include in participatory processes, and development of possible solutions to the problem (Kim 1999; Parnell 2016b; Valencia et al. 2019). Therefore, an interview, for example, a semi-structured interview (Savin-Baden and Major 2012), would be the most relevant means of engagement at this step of the procedure.

Stakeholder engagement (β). A vision and possibly goals for a certain context should be co-created. The literature suggests that the target aspects identified in a dialogue with the relevant stakeholders have more weight regarding commitments to actions (Holmberg and Robèrt 2000; Robinson et al. 2011; Soria-Lara and Banister 2017), therefore early engagement is necessary. An example of means of engagement could be a visionary workshop. This step could lead to the replacement of sustainability

principles as target aspects; however, it might lead to the inability to make a sustainability assessment of the goals.

Stakeholder engagement (γ). The relevant policy and planning documents and the relevant stakeholders should be identified or confirmed. If researchers are leading the process, working together with practitioners can make it easier to identify relevant policy and planning documents. Additionally, practitioners would likely know (about) relevant stakeholders who have utilitarian power to address each of the goals in their context. Therefore, this study recommends involving practitioners at this stage. This can be done as a workshop, in case of a lack of practitioners' capacity, an interview or a questionnaire could be sufficient.

Stakeholder engagement (δ). Stakeholder input in reviewing/complementing goal categories between the target aspect and the documents should be collected. This will ensure that all necessary aspects relevant to the context are included, as often policy and planning documents do not have a systemic perspective. A suitable setting for this engagement would be a workshop. Ideally, several workshops would be used to engage different groups of actors, such as fellow researchers on the topic, practitioners who have utilitarian power, and even policymakers.

Illustration of an organised overview of sustainability goals for relevant stakeholders in relation to one target aspect

As an outcome of the procedure in Figure 3, it is possible to illustrate an organised overview of sustainability goals for relevant stakeholders in relation to target aspect(s). It can, however, be messy to show all the connections at the same time; therefore, one example of what such an illustration could look like for one target aspect is presented (Figure 4).
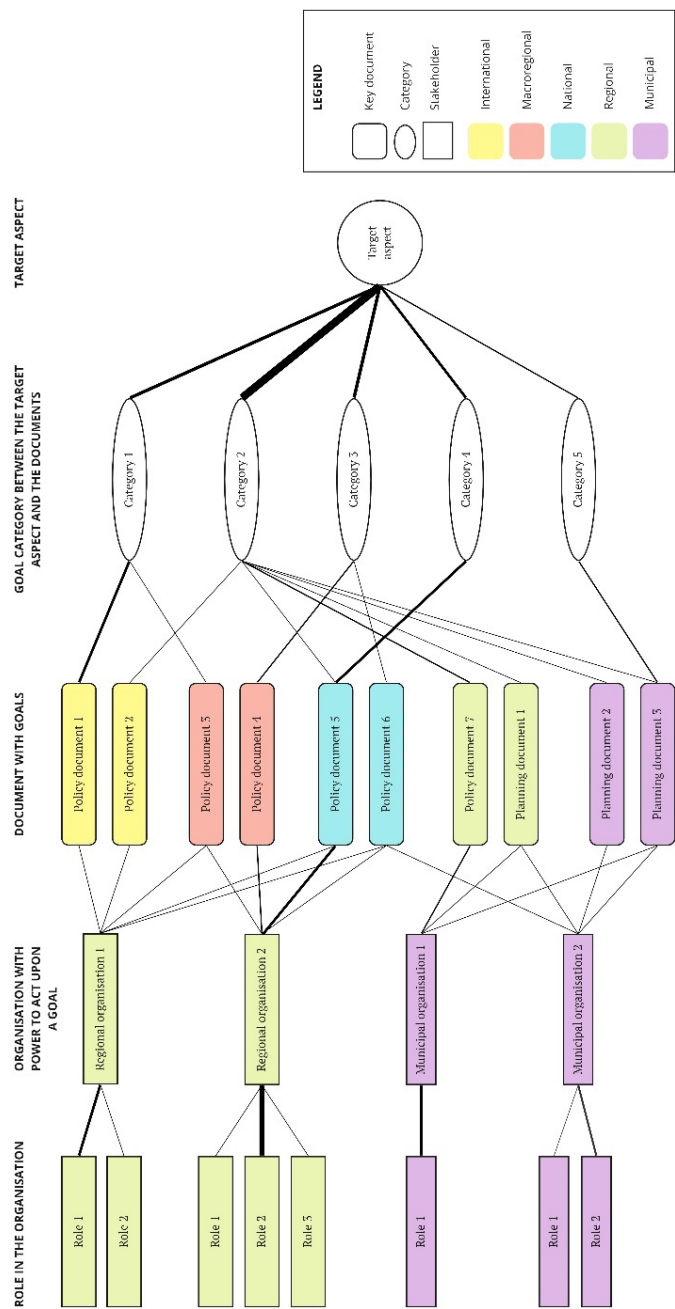
Figure 4. An organised overview of sustainability goals for relevant stakeholders in relation to one target aspect. This figure depicts a part of the outcome of the tool application.

The easiest way to read Figure 4 is to start from the middle – documents with goals (rectangle with rounded corners). They contain the goals relevant to practitioners. These documents could be coming from different levels of planning structure (depicted by colours in the figure), for example, international (yellow), national (blue) etc. To the right from the documents, one can see the goal categories between the target aspect and the documents (oval in the figure) identified in Step 6 and loop i of the procedure. To the very right one can see the selected target aspect (circle in the figure). To the left of the documents, the organisations that have utilitarian power to address the goals in the documents (rectangle in the figure) and the respective roles at each of these organisations (also rectangle in the figure) are shown, illustrating the actors who need to be part of the multi-level governance to address these goals at the local level. Finally, the lines between elements of the figure depict connections between these elements and the strength of these connections.

For example, one starts reading Figure 4 by going from the middle to the right: Policy document 5 has five goals relevant to the context. It is depicted by the thickness of the lines connected to Policy document 5. One of these goals is interpreted in relation to Category 2, while the other four concern Category 4. In turn, Category 4 is relevant to the Target aspect with strength four. Now, reading from the middle to the left, one goal of Policy document 5 can be addressed by Regional organisation 1 and the other four goals by Regional organisation 2. Finally, at each organisation, people with certain roles have utilitarian power to address each of the goals at the local level. The thickness of the lines between the roles and organisations shows how many goals these actors can address. Finally, the tool establishes the direct connection between the goals and stakeholders.

An illustrative case

The MUSTS tool was applied in a case of transport planning in Sweden. This study managed to sort and organise 179 goals in 30 documents at five levels into 109 goal categories and help stakeholders identify the goals relevant to their work. All eight sustainability principles (described in background section) were used to assess the goals, however, in this paper, just parts of the results are presented to provide one illustrative example of the application of the tool (related to health). Below this study describes how the

procedure of the tool played out and what outcomes the research found as a result.

Application of the tool

The procedure of the tool was used in the following way step-by-step in this application of the tool.

Step 1: Define the context. The tool was applied in a setting of a collaborative project for transport planning on regional and municipal levels in Sweden. There, an organisation of sustainability goals was identified.

Step 2: Decide upon the target aspect(s). Health was selected as a target aspect for this illustrative case.

Step 3: Identify goals relevant to the context in the documents at all levels. The research team identified relevant policy and planning documents. These documents were from five different levels – international, macro-regional, national, regional, and municipal. A consolidated list of all stated goals related to health in the documents was produced. It had 23 goals from 12 documents produced by nine institutions. Excel as used for this and the following steps.

Step 4: Identify relevant stakeholders who have utilitarian power. Organisations and respective roles were identified through expert knowledge within the research team and the conducted interviews with stakeholders.

Step 5: Analyse whether the goals support or violate target aspects. The matching of each goal in the documents using a top-down approach (here, only for 'health') was done by one of the research team members, who all have a similar understanding of the sustainability principles of the FSSD. The grouping effort was later reviewed by at least one more team member to ensure robustness. Furthermore, it was specified, whether each goal supports or violates the target aspect.

Step 6: Develop intermediate goal categories between the target aspect and the documents. This study grouped each goal bottom-up, defining categories of the goals, based on the interpretation of these goals by the co-authors of the paper. After that, these goal categories were revised, combined, and adjusted where necessary. These goal categories will later be used as input for

developing indicators for sustainable transport planning in a region in Sweden.

Step 7: Complement with categories identified by stakeholders and sourced from literature. This study organised two workshops to get input from diverse stakeholders. Moreover, this study used the results from the previous work (Nikulina, Simon, et al. 2019). From this literature, this study identified more goal categories that could be relevant for sustainable transport planning in a region in Sweden.

Loop i: Re-evaluate. This study adjusted existing goal categories and integrated additional categories from Step 7 into the consolidated list of goal categories. In some cases, this study re-grouped the goals using a top-down approach, where the new consolidated set of goal categories was utilised as a pre-defined list for top-down grouping.

Step 8: Illustrate the organised overview of sustainability goals for relevant stakeholders at different levels. This study used a miro board[1] to visualise the results.

Due to previous collaboration with stakeholders, three stakeholder engagements into one (to fulfil their purposes and collect the data) were combined, thus reducing them to a total of two engagements. The two stakeholder engagement moments were conducted in the following way in this application of the tool:

- *Stakeholder engagements (α, β, γ).* This study conducted six interviews with representatives of the municipal and regional authorities to better understand the context (Steps 1-3 of the procedure). Researchers among co-authors of this paper have previously conducted several visionary workshops with the local stakeholders (e.g. Borén et al. 2017; Ny et al. 2017; Thomson et al. 2020); therefore, this study discussed and agreed upon what target aspects would be of interest for further investigation during these interviews (Step 2). This study has additionally clarified the current practice of working with goals at different levels: updated the list of the documents, organisations, and their respective representatives (Steps 3 and 4).

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[1] miro.com

-   *Stakeholder engagement (δ).* As mentioned in Step 7, this study organised two workshops for identified stakeholders to collect input on goal categories.

Matching of goals and stakeholders: outcome

Here, the outcome of the tool for the target aspect of 'health' is presented. Among the eight target aspects (following sustainability principles within the FSSD), the target aspect 'health' had relatively fewer goal statements than the other target aspects, making it easier to present clearly and coherently.

Figure 5 shows that there were 13 documents with one or more health-related goals. This study groups these goals into five goal categories that clarify how this study interprets what health means within these documents: emissions and toxins into the air that affect human health, water and soil that affect human health; accessibility to services that transport network might enable or disable; injury/death rate that happens due to transport accidents; accessibility appropriateness – barrier free – how people can move around freely and easily; and land use – in what way multimodality needs could be met by the land use practices and plans. Additionally, this study can see that ten different organisations with their respective 15 representatives have the power and legitimacy to act upon the goals within the documents related to health. Some of the organisational representatives have the power to act upon one or two goals, whereas others have multiple goals they can address. How these results can be further used is described in discussion section.
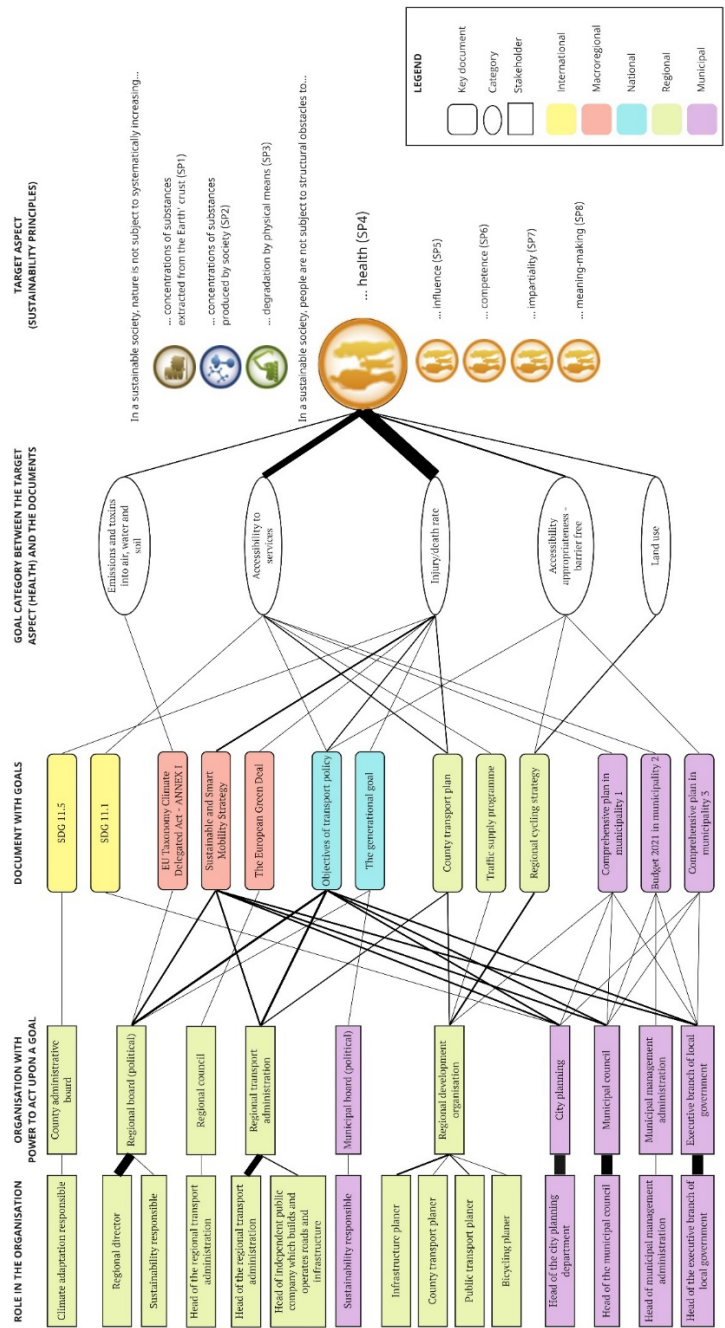
Figure 5. An organised overview of sustainability goals for relevant stakeholders in relation to health in transport planning in Sweden. The thickest lines, e.g. between the

Head of the city planning department and the City planning organisation mean that this person has responsibility for several sustainability goals. Multiple stakeholders have a responsibility to act upon the same goals, for example, in the Objectives for transport policy, which is depicted by several thick lines between the document and the local organisations. Injury/death rate-related goals are the most common goals, which are illustrated by multiple lines between the goal category and the policy and planning documents. Similar figures could be built for other target values and their combinations.

Discussion

Many aspects can be discussed in relation to a new tool; however, the discussion will be focused on the feasibility of the tool, its usefulness for practitioners, application to different contexts, critical assessment through the lens of transdisciplinary co-production of knowledge, and further developments of the tool.

Feasibility of the tool

It was possible to apply the MUSTS tool in a real situation and it produced useful results for its application context within transport planning in Sweden. It was possible to follow a step-by-step procedure and involve relevant stakeholders to produce an organised overview of sustainability goals for stakeholders with the power and legitimacy to act upon them. It was also possible to illustrate some of the outcomes of the tool using a miro board. When attempting to illustrate connections between all the goals and stakeholders, the miro board was proven to be insufficient, therefore there is a need for a different interactive visualisation tool. However, this study did not find a suitable one, and future research would, therefore, be needed to develop one.

To apply the tool, the process leader requires knowledge about both the transdisciplinary approach and the sustainability principles of the FSSD. According to key characteristics of transdisciplinarity, stakeholder engagement moments should lead to a better outcome, therefore this study suggests a collaborative approach independent of who initiates the process, a practitioner, or a researcher.

Usefulness of the MUSTS tool for practitioners

The application of MUSTS adds a structure to a dialogue-based process and produces an organised overview of sustainability goals that are relevant to stakeholders in a transition process (see Figure 3). It is expected that the tool could be useful for both practitioners and researchers who seek a way to get an overview of sustainability goals for stakeholders who can address them. The selection of goals to work on is often done based on the personal interests of stakeholders doing the job (Parnell 2016b). Therefore, illustrating who has the power and legitimacy for each goal might make the work towards the goals more integrated.

The MUSTS tool adds two additional benefits and functions. It could monitor the progress of actions towards fulfilling individual goals and it adds a possibility to make sustainability assessment of the goals. These two benefits and functions are presented below.

Very often, there is no one system for monitoring the progress of actions towards fulfilling various goals at multiple levels (Valencia et al. 2019). This work is done independently from policy to policy, from plan to plan, although the same actions might lead to the fulfilment of several sustainability goals within different documents at the same time. Figure 4 visualises connections between various policy and planning documents by intermediary means of the goal categories, thus could lead to a reduction of the amount of work needed for reporting.

Additionally, sustainability principles of the FSSD could be used as target aspects in the tool. The principles make a useful definition of sustainability as they are generally applicable and sufficiently concrete to analyse goals in the documents at multiple levels (Broman and Robèrt 2017). Therefore, using them can aid sustainability assessment of the goals in the documents and identify potential sustainability gaps within those goals, assisting strategic planning. Below, this study presents three examples of how the outcomes from the proposed tool (specifically diagrams like Figure 5) could be used for sustainability assessment by a transport planner at a municipality or a region in Sweden (exemplified in relation to the target aspect 'health').

Firstly, a user of the proposed tool could analyse and assess past commitments to reducing health risks in transport planning. One could use the goal categories to assess which goal categories past activities, plans and projects fell under to get an overview of what kind of work has been done in

relation to health. Moreover, one could see the relations between the goals in the documents and organisations (as well as actors within) who have the power to act upon the goals.

Secondly, similarly, one could assess the current state of work towards minimising health risks. The information in the figure could also be used to reflect upon what other goal categories related to health issues could be missing and whether any local strategic documents need modifications: for example, to consider some other goal categories that are relevant for the municipality but are currently missing. Additionally, one could reflect if there are dialogue-based processes in place and if dominant and/or definitive stakeholders are invited to the table.

Thirdly, the information on the figure could be used for future planning. Similarly to the current state assessment, one could see whether practitioners work towards all the necessary policy documents and which ones should be included if missing; and what kind of goal categories are being addressed now and which ones should be added. Moreover, this makes the introduction and integration of new policy documents easier into the planning processes.

Moreover, the tool helps identify the stakeholders with utilitarian power who need to be part of participatory planning processes. If stakeholders with the power and legitimacy to act upon the goals lack a sense of urgency, inviting them to a dialogue-based process where diagrams like Figure 5 are presented might help increase their sense of urgency and transform them into definitive stakeholders. Finally, this tool could generally support dialogue-based processes focused on working towards diverse goals in multi-level governance.

To conclude, the tool could be used to create an organised overview of sustainability goals for stakeholders who can act upon them. Additionally, it is possible to use the tool for monitoring actions towards sustainability goals and for strategic planning.

Applicability to different contexts

The tool could have similar value in transport planning in other geographical contexts, such as Nordic countries due to their similarities in central-local

relations (Baldersheim and Ståhlberg 2002). There is a trend that policymaking is done at the central-regional level, whereas implementation is a responsibility of the local and regional levels. The proposed tool could be useful in identifying stakeholders who have the power and legitimacy to develop and implement actions that address sustainability goals. Furthermore, this tool could be useful in a context, such as Kenya, where there is a single national transport policy (Ministry of transport, infrastructure, housing and urban development 2020), one policy for each county – county integrated development plan (e.g. County government of Kisumu 2018) and one policy for each municipality – sustainable mobility plan (e.g. ITDP 2020). The MUSTS tool could be used to assess whether the goals between different policy and planning levels are aligned and who the stakeholders with the power and legitimacy to act upon the goals are.

Moreover, the tool could be useful in other contexts than transport planning, for example, for energy transitions or other contexts, where multi-level governance is adopted or recommended. The energy transition is widely discussed in this decade (e.g. Solomon and Krishna 2011; Markard 2018; Markard, Raven, and Truffer 2012; Tian et al. 2022; Zhang and Chen 2022; De La Peña et al. 2022; Khan et al. 2022). There are many suggestions of what should be done coming from various experts (e.g. Bogdanov et al. 2021; Kalair et al. 2021; Kovač, Paranos, and Marciuš 2021; Gürsan and de Gooyert 2021). However, there is a lack of tools that provide an overview of sustainability goals that need to be met for the energy system to be sustainable and related stakeholders, who need to be part of dialogue-based processes for the development and implementation of roadmaps towards such systems.

Finally, the tool could be useful for organisations that aim to have a systemic and strategic approach to sustainability and report on their contribution to the implementation of international and other agreements.

Critical assessment through the lens of transdisciplinary co-production of knowledge

For a tool to work well in a transdisciplinary setting, it needs to allow for active intermediation, reflexivity, and knowledge integration (described in background section). This section assesses whether the proposed tool includes opportunities to address these quality criteria.

The users of the proposed tool become active intermediaries between the three types of knowledge in transdisciplinary research. The users of the tool create all three types of knowledge by using a procedure of the tool: new knowledge is obtained about the context; the goals in the policy and planning documents at all levels are evaluated in relation to target aspects, such as sustainability principles of the FSSD; and stakeholders who have the power and legitimacy to act upon goals are identified. Furthermore, the users of the tool need to create a safe space for a dialogue with stakeholders: for example, co-create the rules of conduct, and ensure that all the needs of stakeholders are met (e.g., an interpreter if there is no common language), and set up the space for a dialogue in a way that would not create perceived hierarchy.

The users of the tool need to reflect upon their own epistemic standpoint and what assumptions they bring into the project, for example, by using guidelines suggested by Tim May and Beth Perry (2017; 2021). Such reflexive practices are recommended throughout the process of tool application. We live in conditions where our lives are fragmented, having fast lifestyles and experiencing both a constant lack of time and high pressure from society (Hemström and Polk 2021; Hemström et al. 2021). This means that the creation of a safe space for a dialogue, where people can slow down and reflect, is more important than ever. The proposed tool encourages reflexivity through the loop as users are encouraged to go back and re-assess their choices and, if necessary, adjust and redo the grouping of the goals (see Figure 3). Engagement with stakeholders becomes another expert-review process that could allow for further reflexivity.

Finally, the proposed tool integrates knowledge from different levels, domains, and stakeholders. In the context of the empirical study, the sources of knowledge were policy documents, strategies and plans specific to the transport sector, closely related documents, and engagement with stakeholders.

Further developments of the tool

Even if the tool worked well, there is room for development. One suggestion this study has is digitalising the proposed tool and creating an online open-access tool that could visualise various relationships between the goals and stakeholders. For example, one could be able to see all the policy and planning documents related to one target aspect (as in Figure 5), or all the

target aspects related to one policy or planning document. Additionally, one could be able to see the exact formulations of the goals in the documents. Another illustration could be all the goals that a certain stakeholder has the power to act upon. One could potentially build many visualisations with such an online tool. Therefore, such an online tool could be useful for sustainable transport planning, monitoring and reporting as well as identifying relevant stakeholders for multi-level governance.

One potential improvement could be exploring the possibility of machine-based selection of the goal statements from the documents through text mining. This would make the time for tool application significantly shorter and reduce human error. Moreover, this study believes that adding a feature of 'monitoring progress' could make the tool even more useful. For that, it would be necessary to add indicators for each goal category. That way, the progress towards the goals could be measured and recorded. Additionally, it could be useful to add a year when the goals need to be met according to policy or planning documents. These additional elements could further improve dialogue-based processes of multi-level governance that involve dominant and/or definitive stakeholders within transport planning.

Conclusion

This paper presents a tool that produces an organised overview of sustainability goals and matches them with the relevant stakeholders. The tool was conceptualised within a project and illustrated here in a generalised form as well as within a project. The need for the tool was triggered by a need within a project. The tool was developed through design research principles, applying and combining sustainability principles of the FSSD and three types of knowledge of transdisciplinary co-production of knowledge.

It is foreseen that the tool can be used within the context of dialogue-based processes of multi-level governance by providing an overview of sustainability goals in relation to target aspects and identifying dominant and definitive stakeholders who have the power and legitimacy to act upon these goals. Therefore, it can likely improve the design and outcome of such dialogue-based processes.

This study recommends the MUSTS tool be used by researchers and practitioners (e.g., city and transport planners, and local authorities) who

want to get an organised overview of the goals for relevant stakeholders at multiple levels. This study expects that this tool could help these actors to improve their strategic work.

Further testing of the tool could be done in various contexts, improving its generalisation. Additionally, it is foreseen that a future potential version of an open-access online tool could be used by researchers and practitioners for their dialogue-based processes of multi-level governance and even for monitoring and reporting sustainability goals.

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ABSTRACT

There are numerous sustainability challenges related to mobility. One of the main challenges is the necessary reduction of greenhouse gas emissions. The transport sector is one of the main emitters. There are also challenges regarding accessibility, health, equity, and justice that need to be considered. The recent COVID-19 pandemic led to a temporary decrease in emissions (mainly from reduced aviation), at the same time as there were worsening aspects such as social exclusion. These and other complex challenges require urgent, comprehensive change and creative solutions. The urgency for a change adds to the challenge of mobility planning since conventional planning processes are usually slow. Moreover, local planners who plan for transitioning to sustainable mobility need to facilitate participatory processes since mobility planning affects many stakeholders. When engaging with planning practitioners, it was found that there is a lack of tools that can support practitioners when conducting reflective and generative multistakeholder dialogues.

The aim of this research was to develop process-oriented methodological support for multistakeholder dialogues in strategic planning for transitioning to sustainable mobility. A transdisciplinary research approach was used to explore this topic, including the problem space of participatory research modes. Furthermore, a design research approach was used for tool development.

A comprehensive literature review to identify prominent research themes in regional and urban planning for transitioning to sustainable mobility was made. The developments in the field over the past 15 years show a paradigm shift from 'predict-and-provide' to participatory visionary approaches, such as backcasting and SymbioCity. However, this has led to new challenges concerning processes that support reflective and generative stakeholder dialogue in a rapidly changing and highly diversified world. These challenges relate to, among other things, an insufficient diversity in multistakeholder processes, a limited availability of stakeholders to participate in such processes and a lack of tools that can aid with an overview of various sustainability goals from policy and planning documents. Among participatory research approaches, transdisciplinary research and action research were explored. As these research modes have become prominent, it is important to know more about them. It was found that transdisciplinary research could be particularly useful for advisory reflective contexts, whereas action research could be particularly useful for contexts where action is a priority.

The dissertation presents further forms of methodological support that can help structure participatory multistakeholder dialogue-based processes:

– a framework for analysing the complexity of co-production settings in relation to epistemic communities, linguistic diversities, and culture;

– a rapid scenario planning method to support regional visioning for sustainability transformation; and

– the MUSTS tool that connects sustainability goals at multiple levels with stakeholders who have the power and legitimacy to act upon them.

To conclude, the methodological process-supporting tools that were investigated and those developed in this research offer a form of "scaffolding" that aids facilitators to organise more efficient and effective participatory processes. These scaffolding tools are rooted in transdisciplinary co-production of knowledge research and offer promising elements for a toolbox for strategic planning for transitioning to sustainable mobility.