The Research Architecture for Transdisciplinary Knowledge Synthesis for an Urban Sustainability Programme: A Meta-Study Methodology

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Abstract

In today's globalized world, cross-cultural settings, projects, and institutional setups are becoming increasingly common, presenting both opportunities and challenges. Knowledge creation and management plays a critical role in addressing these challenges by facilitating the sharing of information, ideas, and best practices across different cultures and contexts. However, effective knowledge creation and management in cross-cultural settings requires a nuanced understanding of different cultures, as well as a recognition of the potential barriers to communication and collaboration. One specific area where knowledge generation and management is of particular importance is sustainable development in the built environment. As the world's population continues to grow and urbanization accelerates, sustainable development is increasingly recognized as a critical challenge that requires urgent action. To address this challenge, knowledge creation and management approaches that can facilitate the exchange of ideas, best practices, and innovative solutions are essential. However, effective knowledge creation and management in this context requires an understanding of the unique cultural, social, and economic factors that shape different communities' perspectives on sustainability.

Against this backdrop, this paper presents the set-up of the SURE Facilitation and Synthesis Research Project, focusing on the conceptual architecture for its synthesis research. Part of the BMBF funding initiative SURE along with the ten collaborative projects, this project

facilitates the synthesis of knowledge about and the development of solutions for sustainable and resilient urban and rural development in Southeast Asia and China. The project focuses on the transdisciplinary synthesis of research outputs from the SURE collaborative projects, the identification of research gaps, and the development of knowledge generation and management approaches to support the implementation of sustainable solutions, while its primary goal is to contribute to transdisciplinary knowledge synthesis, sustainability research, and urban research. The project focuses on utilizing a multi-method approach that combines empirical research with artificial intelligence tools to analyse qualitative and quantitative data. The project team employs digital tools to structure data and turn it into accessible knowledge that can be used in transdisciplinary urban sustainability projects and beyond. The overarching goal of the project is to contribute to a new research approach that synthesizes knowledge in the topic area of urban sustainability.

Keywords – qualitative meta-analysis; synthesis research; sustainability science; knowledge creation and management, transdisciplinary knowledge synthesis

Paper type – Academic Research Paper

1 Introduction

This paper is a detailed introduction one of the two main pillars, or focus areas, of the large-scope meta-research SURE facilitation and Synthesis research project. Thematically, SURE Facilitation and Synthesis research Project (SURE FSR) explores the challenges of synthesis research in cross-cultural settings and institutional set-ups, with a particular focus on sustainable development in the built environment in South-East Asia and China. The activity of this complex project is divided in two main "wings": facilitation and synthesis research.

While this paper only sketches out what the facilitation tasks of the SURE FSR project ecosystem mean, it dives deeper into the project's view on the role of synthesizing knowledge in facilitating cross-cultural collaboration and information-sharing, as well as the potential barriers to effective knowledge generation and management in these contexts – in other words, into the project's synthesis research architecture.

Alongside that, the paper explains the project's knowledge creation and management approach that can support sustainable development in the built environment in a globalized setting, taking into account the unique challenges and opportunities presented by cross-cultural collaboration. By addressing these critical issues, the project and this paper aim to contribute to a more nuanced

understanding of the role of knowledge generation and management in promoting sustainable development and cross-cultural collaboration.

The approach used in the SURE Facilitation and Synthesis research project is transdisciplinary, problem-driven, and solution-oriented. The project employs a meta-study methodology that synthesizes and consolidates existing conceptual, methodological, and empirical knowledge from literature and the ten collaborative projects within the SURE funding priority.

The project also uses a flexible project architecture and adaptive management methods to address the partly asynchronous runtimes and heterogeneous contexts of the different collaborative projects. The research is guided by a set of guiding questions, which are designed to provide practice-relevant results and insights.

Overall, the approach used in the SURE Facilitation and Synthesis research project is designed to support individual research projects and to systematically leverage the cross-project synergy potentials at the funding priority level. The goal is to create conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address the issue of sustainable urban development.

The SURE funding priority, which stands for Sustainable and Resilient Urban-Rural Development, is an initiative created by the German Federal Ministry of Research and Education (BMBF) focused on the challenges of sustainable development in the face of urbanization, natural resource depletion, and climate change. The SURE funding priority supports collaborative projects that develop locally implementable solution strategies for the sustainable use of resources and an improved quality of life in urban regions in Southeast Asia and China. The focus is on the development and testing of concepts for a sustainable transformation of fast-growing urban regions, which lead to the strengthening of ecological factors and greater resilience in the face of natural disasters and other consequences of climate change.

Facilitation activities within the SURE Facilitation and Synthesis research project

Apart from the synthesis research – the topic of this paper – SURE's other pillar of activity is facilitation. To briefly outline the project's tasks in that regard, three main areas of work can be named. The first one is offering support to projects at individual project level. This entails, for example, regular one-on-one meetings, project visits (both in Germany and in Asia), or the establishment of an

collaboration and exchange platform called SURExChange. The second one is putting in effort to create or expand impact that the ten projects will have in their target locations, but also beyond the programme, understood geographically, formally, practically and scientifically. The third one is working to identify synergies between the projects, creating awareness of such synergies in the project teams, and helping the sides to capitalise on the synergies. Importantly, the facilitation side of SFSRP's activity and the synthesis research side feed into each other in a dynamic feedback loop.

2 Transdisciplinary research and synthesis research: background and theory

Henrik von Wehrden et al. (2019) define transdisciplinary research as "a collaborative approach that engages researchers from different disciplines, as well as non-academic stakeholders such as practitioners, decision-makers, and civil society representatives, in the co-creation of knowledge, solutions, and policies that address complex real-world problems." They emphasize the importance of integrating different types of knowledge, including academic, lay, and practical knowledge, in order to develop more holistic and effective solutions to societal challenges. They also note that transdisciplinary research requires a process of continuous dialogue and learning between all participants, and that it is often characterized by a focus on real-world impact and the co-production of knowledge with stakeholders.

Complementary to that, Walsh and Downe's 2005 publication "Meta-synthesis method for qualitative research: a literature review" discusses the use of meta-synthesis as a method for synthesizing qualitative research. The authors note that meta-synthesis involves a systematic and rigorous process of analyzing and synthesizing qualitative research findings from multiple studies. They highlight the importance of developing clear research questions, establishing inclusion and exclusion criteria, and using a transparent and reproducible process for data analysis. Walsh and Downe also discuss the challenges of conducting meta-synthesis, including the need for careful consideration of the quality and relevance of the included studies, the potential for bias in the synthesis process, and the difficulty of combining findings from studies with diverse methodologies and epistemologies. Overall, the authors argue that meta-synthesis can be a valuable approach for synthesizing qualitative research findings and generating

new insights, but emphasize the need for methodological rigor and transparency in order to ensure the validity and reliability of the results.

Furthermore, Wyborn et al.'s paper (2018) on "Understanding the impacts of research synthesis" aimed to explore the impacts of research synthesis, particularly in the context of environmental management and sustainability. The paper identified four main types of impacts of research synthesis: instrumental, conceptual, capacity-building, and empowerment. Instrumental impacts refer to the tangible, material changes that result from the application of research synthesis, such as changes in policy or management decisions. Conceptual impacts refer to changes in understanding or perception, such as changes in how researchers view an issue or how stakeholders understand the implications of research. Capacity-building impacts refer to the development of skills or knowledge that can be applied beyond the specific context of the research synthesis. Empowerment impacts refer to changes in power dynamics or relationships, such as increased participation of marginalized groups in decision-making processes. The paper also highlighted some challenges and limitations of research synthesis, such as the potential for oversimplification or the exclusion of important perspectives or sources of knowledge. The authors emphasized the importance of transparency and stakeholder engagement throughout the research synthesis process to mitigate these challenges. Overall, Wyborn concluded that research synthesis can have significant impacts in environmental management and sustainability, but that these impacts are context-dependent and require careful consideration of the specific goals and methods.

Cooper, Hedges, and Valentine discussed (2019) the potentials and limitations of research synthesis. Their findings can be distilled into the following list:

Potentials:

- Research synthesis provides a way to integrate the results of multiple studies and identify patterns and trends that may not be apparent in individual studies.
- It can increase the generalizability of findings by combining data from multiple sources and contexts.
- It can help identify areas where further research is needed or where conflicting findings need to be resolved.
- It can provide a way to summarize and communicate the findings of research to practitioners, policymakers, and the general public.

Limitations:

- Research synthesis is limited by the quality and quantity of the studies included. Poorly designed or executed studies may bias the overall findings.
- Synthesizing results across different contexts or populations can be challenging due to differences in study design, measurement, and other factors.
- Publication bias can occur, where studies with null or negative findings are less likely to be published, leading to an overestimation of effect sizes.
- The process of synthesizing studies involves making decisions about which studies to include or exclude, and these decisions can be subjective and may introduce bias.

In all, we hold that the challenges of knowledge creation and management in cross-cultural settings, projects, and institutional set-ups are being tackled through various approaches. Some ways to achieve that are:

1. Building cross-cultural understanding is an important first step. This can be achieved by creating opportunities for individuals from different cultures to interact and exchange knowledge. Cross-cultural training can also be provided to employees to improve their cultural sensitivity and communication skills.
2. Technology can be a powerful tool for knowledge creation and management in cross-cultural settings. Collaboration tools, such as video conferencing, project management software, and online collaboration platforms, such as SURExChange, can help overcome language and distance barriers. Additionally, machine translation software can be used to facilitate communication between individuals who speak different languages.
3. Encouraging knowledge sharing is critical to effective knowledge generation and management in cross-cultural settings. This can be achieved by creating a culture of knowledge sharing within the organization and providing incentives for individuals to share their knowledge. Knowledge sharing can also be facilitated through the use of social media platforms and other online tools.
4. Building trust is key to effective knowledge creation and management in cross-cultural settings. Trust can be built by demonstrating a

commitment to cultural sensitivity, establishing open lines of communication, and being transparent in decision-making.

5. Partnering with local organizations can help overcome cultural and linguistic barriers. Local organizations can provide valuable insights into the cultural norms and expectations of the local community, and can help facilitate communication and knowledge sharing.
6. Adopting a participatory approach can help overcome cultural barriers and promote collaboration. This requires involving stakeholders from different cultures in the knowledge creation and management process, and actively seeking their input and feedback.
7. Finally, creating a strategy is essential to effective knowledge creation and management in cross-cultural settings. This involves identifying the organization's knowledge needs, developing a plan for meeting those needs, and regularly evaluating the effectiveness of the strategy.

Knowledge creation and management approaches for sustainable development in the built environment in a globalized setting have been developed to address the challenges of promoting sustainability in the face of rapid urbanization and globalization. While these approaches are crucial, they also face several critical challenges and limitations.

One of the significant challenges is the difficulty in effectively sharing knowledge across different organizations, communities, and stakeholders. Sustainable development in the built environment requires the collaboration and cooperation of multiple actors, each with their unique knowledge and perspectives. Knowledge creation and management approaches must be designed to promote collaboration and communication across these actors, but it can be challenging to do so effectively.

Another limitation is the lack of empirical evidence on the effectiveness of knowledge creation and management approaches for sustainable development in the built environment. Many knowledge creation and management strategies are theoretical or conceptual, and there is a lack of empirical research evaluating their effectiveness in real-world settings. Without evidence to support these approaches, it is challenging to determine their impact on promoting sustainability in the built environment.

Finally, knowledge creation and management approaches must be designed to address the social, economic, and environmental dimensions of sustainability. However, many knowledge creation and management strategies focus primarily

on environmental sustainability and fail to address the social and economic aspects of sustainability adequately. Without addressing all three dimensions of sustainability, knowledge creation and management approaches may not be effective in promoting sustainable development in the built environment.

In conclusion, knowledge creation and management approaches are crucial for promoting sustainable development in the built environment in a globalized setting. However, these approaches face several critical challenges and limitations that must be addressed to maximize their effectiveness. To overcome these challenges, knowledge creation and management approaches must be designed to promote collaboration and communication across actors, address different institutional structures and policies, and address all three dimensions of sustainability. Furthermore, empirical research is necessary to evaluate the effectiveness of knowledge creation and management approaches in promoting sustainability in the built environment. Additionally, we need a thorough understanding how (differently) scientific knowledge is created in the different cultural settings and within different contexts, which includes following the questions of how researchers work in different contexts and what are their different rationalities as well as asking ourselves and others: what is supposed to be scientific?

3 SURE facilitation and synthesis research architecture

3.1. Architecture logic

The project looks to synthesize and consolidate existing conceptual, methodological, and empirical knowledge from literature and the ten SURE collaborative projects. This qualitative meta-study aims to contribute to the transdisciplinary sustainable research discourse by providing a scientific contribution to the third epistemic way (Lang, Wiek et al. 2012). The third epistemic way refers to a mode of knowledge production that goes beyond traditional disciplinary and interdisciplinary approaches. This epistemic way is called "transdisciplinary" and is characterized by the integration of diverse knowledge systems, including scientific, local, and experiential knowledge, as well as the involvement of multiple stakeholders in the research process. The research project is designed to support individual research projects on the one hand and to systematically leverage the cross-project synergy potentials at the funding

priority level based on the collected and structured knowledge from the projects and beyond. Conducting meta-research across disciplines and across cultural borders requires a management of knowledge that is sensitive towards these challenges (Ioannidis, Fanelli et al. 2015). Within the SURE facilitation and synthesis research approach, we developed a research and knowledge architecture that allows for constant reflection to improve the applied concepts.

The project goals described above necessitate the several research questions that SURE Facilitation and Synthesis research posits for itself. The six most important ones are:

- Which user group requires/uses what results of the funding priority?
- Which of the results are transferrable or scalable to other regions?
- Is it possible to draw general conclusions?
- How can the gained knowledge be consolidated?
- How are the results fed into the ongoing expert discussions?
- How are the results transferred to experts?

Guided by these, and some more detailed and minor, research questions, the SURE FSR project collects, generates, and structures data before it is turned into knowledge (see Rowley 2007 in contrast to Nonaka 1990). The data is composed of three types of sources: scientific, non-scientific, and directly from the ten projects ("project data"). However, these three sources types can, on another dimension, be split into coming from two "directions": the former two kinds from internal efforts of the project team, while the latter kind thanks to the facilitation activities carried out with the ten projects.

Scientific data can easily be categorized to come from two origins: scientific literature and policy documents (regional, national, international). Non-scientific data includes social media, professional network websites, news outlets, websites, and geo-spatial data. Finally, project data consists of:

- project proposal and report texts
- scholarly publications of the researchers working for the ten projects
- the so-called Synergy Workshops (regular workshops of the ten projects along with the SURE facilitation and synthesis research team)
- project profiles
- peer-to-peer observations
- reference picture questionnaires; network structure
- conference participation output

The data is then organised, structured and stored in a database (Directus).

The collected, generated, and structured data then (1) becomes the object of preliminary data analysis and (2) is used to form research hypotheses. In a double-step approach, the preliminary data analysis then also feeds into the research hypotheses formulation effort, with the goal of solidifying the reasoning and legitimizing the creating hypotheses. Moreover, the research hypotheses are revisited in one of the later steps of the research construction logic. The current set of SURE FSR project's research hypotheses is the following:

- There is a need for thorough knowledge synthesis and consolidation, as well as for methods and practices to do so;
- There is an urgency in recalibrating evaluation schemes and funding criteria;
- There is a necessity for deeper understanding of and sensitivity to cultural intricacies, as well as a guideline on how such skills can be evaluated;
- There is a necessity for a better identification of emerging and existing urgencies and topics;
- There is a need to identify and consolidate cross-cutting issues across the SURE funding priority;
- Project architectures influence the local impact of implementation and how sustainable the projects results will continue to be.

In the next, fundamentally important step of the architecture logic, the data is analysed through the lens of the research hypotheses. This, in turn, activates two further tasks: (1) validation of hypotheses and (2) answering of research questions. Naturally, the exercise of validating the hypotheses is the afore-mentioned revisiting of that item; moreover, the research questions also receive a rededication in this advanced research stage (see Peirce's writings on the three-stage cognitive logic of abduction, deduction and induction, Peirce (1974 [1934]), or Hanson (1958) and Hoffmann (2005)).

3.2. Methodology: a multi-method approach

In awareness that a complex challenge requires a fitting methodology. According to Ashby's Law of Requisite Complexity states that a system must be at least as complex as the problem it is trying to solve. This means that in order to effectively address complex problems, a system must have a certain level of complexity and variety in order to match the complexity and variety of the

problem. The law suggests that if a system is not complex enough to handle the demands of the problem, it will be unable to effectively address the problem and will likely fail. Therefore, the Law of Requisite Complexity emphasizes the importance of ensuring that a system is appropriately designed and structured to address the complexity of the problem it is intended to solve (Ashby 2004 [1962]). The SURE Facilitation and Synthesis research project consortium has created a multi-method approach that this section briefly presents. Departing from the vantage point of understanding transdisciplinary knowledge synthesis as integrating knowledge from different disciplines and stakeholders to address complex problems, the SURE FSR team has analysed the state of the art in approaches towards it and has distilled the following five overall, theoretical approaches:

- Participatory research: this approach involves engaging stakeholders, including community members, policymakers, and practitioners, in the research process. That helps to ensure that the research is relevant and useful to those who will ultimately use the findings;
- Systematic reviews: This approach involves identifying, evaluating, and synthesizing existing research to answer a specific research question. Systematic reviews use rigorous methods to minimize bias and ensure that all relevant evidence is included;
- Meta-analysis: This approach involves using statistical methods to combine the results of multiple studies to produce a summary estimate of an effect. Meta-analysis can be used to identify patterns and trends across different studies;
- Mixed-methods research: This approach involves using both qualitative and quantitative research methods to answer a research question. Mixed-methods research can provide a more comprehensive understanding of complex problems by combining the strengths of different research methods;
- Co-creation of knowledge: This approach involves bringing together stakeholders from different disciplines and backgrounds to jointly develop new knowledge. Co-creation of knowledge emphasizes the importance of collaboration and the active involvement of stakeholders in the research process.

Having weighed the strengths and weaknesses of the analysed approaches, the SURE partnership has arrived at the following list of methods applied in daily project work:

- pattern analysis,
- cross-sectional analysis,
- AI-supported data analysis,
    - NLP, MaxQDA,
    - machine learning,
- topic modelling,
- literature review,
- multi-layer analysis,
- knowledge integration,
- knowledge synthesis.

It is necessary to note that one of the items from this list, the AI-supported data analysis within the SURE FSR project framework, is the topic of another paper and presentation during the 2023 IFKAD conference (ID 203), authored by Chintan Patel et al. from the HafenCity University Hamburg with the title *'Unlocking the potential of AI in qualitative data analysis for sustainable urban development'*. It talks about the application of AI to support data and knowledge creation and management in sustainable urban development research by presenting the first results of the ongoing AI-based analysis and discussing how it could contribute to a systemic qualitative analysis of large text-based data sets in urban sustainable knowledge creation and management.

3.3. Outputs

Finally, SURE Facilitation and Synthesis Research Projects's research outputs – another fundamentally important element of a project – can be categorised in two main ones: the so-called Knowledge Synthesizer and the Reference Picture. The former aims to support the generation, integration, and access to sustainability knowledge overall and to include an interactive digital tool for multiple stakeholders. The latter involves the ten projects' own reference picture and a global reference picture.

Importantly, the current conference will see both of these project outputs items embodied in the form of contributions. The SURE Knowledge Synthesizer is the object of a paper by Agota Barabas et al., titled *'sustainable knowledge*

synthesizer: a modular tool for urban research', from the HafenCity University Hamburg (ID 245) and shows how databases, as well as data services for knowledge creation and management and communication and collaboration, are provided, adapting solutions from business intelligence (e.g. project dashboard, monitors, cockpits), and then aggregated in the functional tool "Synthesizer". The paper discusses the concept of such a synthesizing system and its application in a meta-research environment of transdisciplinary sustainable urban development approaches, sheds light on the opportunities and challenges of the development of such a synthesizing tool, and draws a first picture of the complexity accompanying the development of a "synthesizer". The Reference Picture, in turn, is tackled by the paper authored by Dietrich et al. from the Technische Hochschule Lübeck (ID 209), with the title *'Sustainable development of urban regions. Transformative Research Project as (self-) learning Systems?'* in which, among other angles, the architecture of the SURE Framework and the related Reference Pictures developed by the SURE Facilitation and Synthesis Research project to support the process of observation and reflection are described as a self-learning process of complex systems, and the question how to make the gained knowledge explicit is discussed.

Finally, it is crucial to highlight that both types of outputs in the SURE FSR are systemically tied to the facilitation activity, wherein the Reference Picture is being created directly thanks to the individual project support task, and wherein the Knowledge Synthesizer directly informs all three facilitation tasks.

Figure 1 below *'Overview of SURE Facilitation and Synthesis Research Architecture and linked IFKAD'23 paper presentations'* is a visualisation of the delivered description and the Reader is encouraged to confront the graph with the respective text sections.

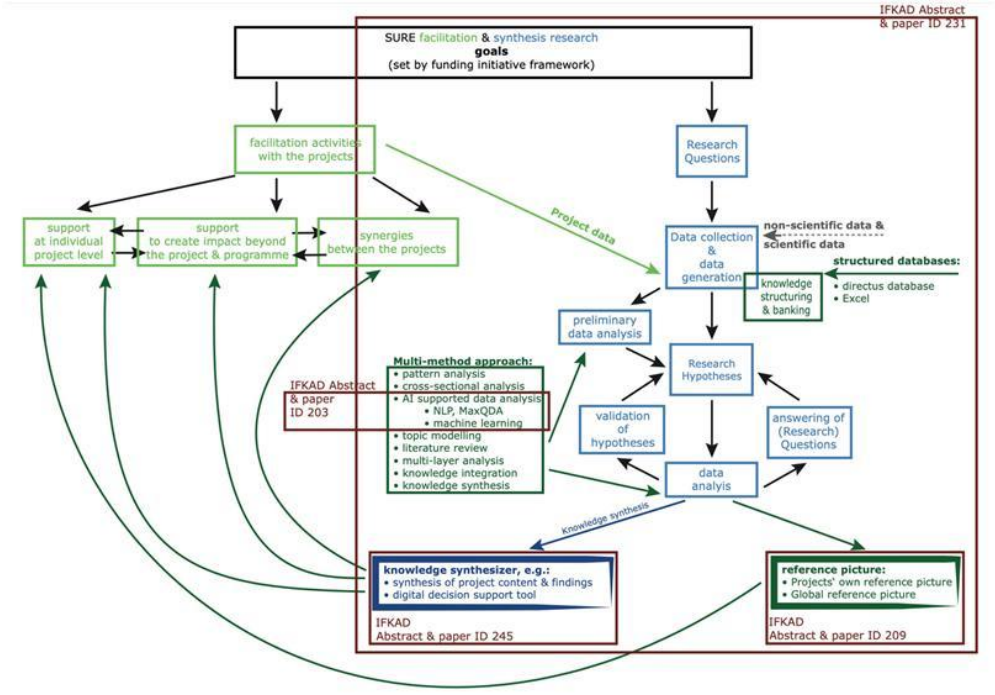

Figure 19: Overview of SURE Facilitation and Synthesis Research Architecture and linked IFKAD'23 paper presentations

4 Summary

The goal of synthesis research is to provide a comprehensive overview of the current state of knowledge on a particular topic, and to identify gaps or limitations in existing research. This information can then be used to guide future research and policy decisions. In the context of the SURE Facilitation and Synthesis research project, the synthesis research involves bringing together the conceptual, methodological, and empirical knowledge from literature and the ten SURE collaborative projects within the SURE funding priority. The aim is to identify patterns, themes, and relationships in the data, and to generate new insights that go beyond what is available in individual studies or disciplines.

The SURE Facilitation and Synthesis research architecture presented in this paper aims to provide a comprehensive overview of the current state of knowledge on sustainable urban development. By identifying gaps or limitations in existing research, information can be used to guide future research and policy decisions. The project aims to create conceptual, theoretical, methodological, and

translational innovations that integrate and push beyond discipline-specific approaches to address the issue of sustainable urban development. Overall, the SURE Facilitation and Synthesis research project aims to contribute to the field of sustainability science and is expected to impact on policy decisions in the future.

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