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Towards Bridging IS and Sustainability Transitions Research Communities? – Bibliometric Mapping of IS Beyond GreenIT

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Completed Research

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Abstract

This paper explores how to bridge the field of IS on sustainability with Sustainability Transitions Research (STR). Using a bibliometric analysis of 5 IS conference proceedings, it maps possibilities for such bridging, moving beyond the current approaches of GreenIT. Semantic content analysis of IS abstracts and keywords indicates themes characterizing GreenIT, focusing mostly on sustainability practice on the organizational level. In contrast, sustainability research (systems-level) is still uncharted territory for the IS community. Social network analysis of the authors and journals shows that collaboration and co-citation "within" the IS community are as low as the connection "without". We propose that more diffusion of IS theory and methods through Design Science may enrich current STR to be truly data-driven and theory-guided. First, the mapping suggests that IS theorizing can augment STR to be more generalizable for the digital era. Second, the thematic patterns suggest that Design Science methods and artifacts can augment the design of large-size STR studies bringing a more robust and data-driven theory-guided analysis of system innovation and transitions actor networks.

Keywords

Information Systems, sustainability transitions, field bridging, design science, bibliometric analysis.

Introduction

There is increasing attention to IS's role in sustainability, although such efforts could progress with more intensity. However, research exploring the role of IS has mostly taken an exploratory qualitative approach in mapping opportunities for IS. This paper leverages a more integrative "quantitative" bibliometric mapping of IS research and explores how to bridge the field of IS on sustainability with Sustainability Transitions Research (STR). Using a bibliometric analysis of ***5 IS conference proceedings***, we map possibilities for such bridging, moving beyond the current approaches of GreenIT. Semantic content analysis of IS abstracts and keywords from SCOPUS indicates themes characterizing GreenIT have enjoyed focusing on ***sustainability practice*** on the ***organizational level***.

In contrast, ***sustainability (transitions) research*** and the ***systems level*** remain uncharted territory for the IS community. Social network analysis of the authors and journals shows that collaboration and co-citation "within" the IS community are as low as the connection "without". We propose that an engagement with the STR community will translate to a more fruitful diffusion of IS theory and methods and vice-versa(more diffusion of transitions theory into IS). More concrete is the possibility of mediating this diffusion and exchange through Design Science. IS approaches can move beyond sustainability practice in individual organizations to researching the systems level and may enrich current STR research designs to

be truly data-driven and theory-guided. Building on current literature that proposes the value of IS for achieving sustainability-oriented outcomes, the socio-semantic network maps are useful for exploring territory for IS and STR collaborations. First, current literature does not propose how IS theorizing can augment STR to be more generalizable and data-driven for the digital era. Second, current IS research on GreenIT has not explicitly proposed Design Science methods and artifacts that can be useful in designing large-size STR case studies bringing a more pluralistic and robust analysis of systemic innovation and transitions. Although more research on sustainability is evident in the IS conference community annually, there is still an opportunity for IS research on systems-level sustainability engagement, particularly with the STR community. For our corpus, the annual growth rate is 7.82%, and we can speculate that the growth in 2018 was due to research on blockchain and big data as IS technologies that can augment sustainability practice.

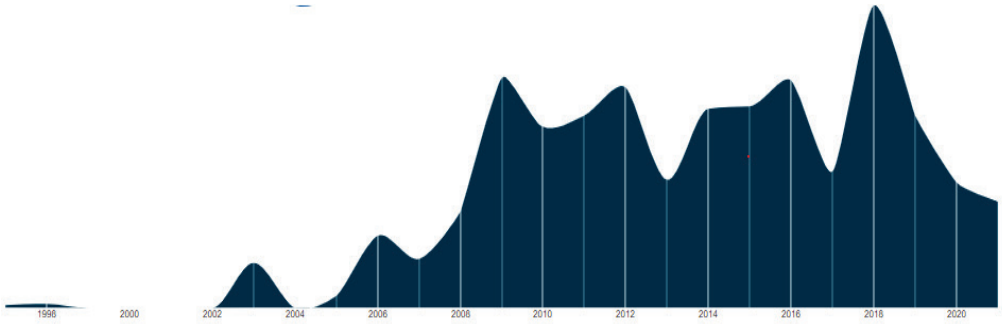

Figure 1 Growth Trend SUSGREENIS Conference Papers

This paper is a bibliometric meta-analysis of the body of Information Systems (IS) research on sustainability based on conference proceedings, although future work will look at journal articles. To operationalize such a task, we looked at 5 IS conferences, such as ***ICIS, ECIS, HICSS, AMCIS and PACIS,*** to delineate social and semantic patterns in their metadata. Our approach was to map the topic and collaboration landscape to provide bibliometric context and visually enhance our understanding of how IS may augment/interface the field of sustainability beyond current approaches on GreenIT. The mapping of co-reference and citations show that the IS community is not connected to the STR community. Although IS is active in the broad theme of sustainability and GreenIT, we see sustainability transitions (action) research (Loorbach et al. 2017, Wittmayer et al. 2014, Markard et al. 2012) as uncharted territory for the IS community. This mapping and educing are even more urgent in the era of *twin transformations* (sustainability and digital). In the spirit of proactive mediation between both fields, we suggest that a design science paradigm instantiated in the body of research called "design science research" may bridge both fields. By bridging research we mean research that mediates between data driven and theory driven research (Maass et al 2018)

Although Information systems have embraced the research and practice of sustainability on the organizational level, *the systems level* is still whitespace for both IS research and practice communities. IS engages in themes such as but maybe moving farther from (action) research on sustainability transitions. Sustainability transitions is an emerging field interested in (a) understanding complex patterns of over-production and consumption in socio-technical societal systems such as health, energy, and food and (2) facilitating transition dynamics in these systems to bring about more sustainable cultures, structures and practices. Transition dynamics are characterized by multi-actor-network strategies emerging in regimes and niches such as *optimization, experimentations, phase-out* etc., defined as "understanding of transition processes". Transition dynamics is also linked to Transition Governance (how actors influence the Transition process. Although positive to the overall approach of sustainability transitions, Information systems (in our opinion) has been involved so far in *experimentation* approaches and *optimization* notions of sustainability from a somewhat Green IT stance, i.e., at the somewhat organizational level. There is an opportunity for IS to contribute to researching transition constructs such as *destabilization*, *phasing out*, *acceleration*, and the *emergence* of Sustainability outcomes, particularly at the Systemic level indicated in current transition frameworks. Such systems framing is depicted in the Multi-Level Perspective and the Transition Governance literature on X-curve. (Loorbach et al. 2017)

In light of the opportunity to bridge both fields, our exploratory mapping questions are :

1. *What is the state of the art literature on Information Systems related to green IT and sustainability?*
2. *Which semantic patterns (topical) and social network patterns (relational) are observable in the bibliometric analysis of SUSGREENIS research using metadata on the main IS conferences as input data?*
3. *How could IS research theory and methods contribute to the field of sustainability transitions research moving beyond the greenIT paradigm?*

The paper proceeds as follows. First, we map the literature on IS and Green themes/sustainability using the five conferences as data sources for semantic and relational patterns. Then we show the trends and topics between the 5 IS knowledge arenas and collaborative patterns between IS conference authors. We conclude by making explicit the need to apply IS beyond GreenIT towards systemic transformations. Finally, we propose how IS theory and methods, e.g., Design Science artifacts, methods, and instantiations can augment transitions research and vice versa.

Method – Bibliometric Analysis of IS Conference Proceedings

This section details the SCOPUS query for curating the data used in answering the questions, particularly, "*what is the state of the literature on sustainability in Information systems on sustainability?*".

First, we obtained 2,421 document results with *(SRCTITLE ("amcis" OR "icis" OR "hicss" OR "ECIS" OR "pacis")) AND (sustainable OR green) AND (LIMIT-TO (DOCTYPE, "cp"))* .

Second, we iteratively searched the corpus for noisy data by employing options in Bibliometrix (Aria M and Cucurulo C 2017), an open-source tool for executing a comprehensive science mapping analysis of scientific literature. We use the acronym SUSGREENIS for referring to this curated corpus subsequently in this paper and the following sections.

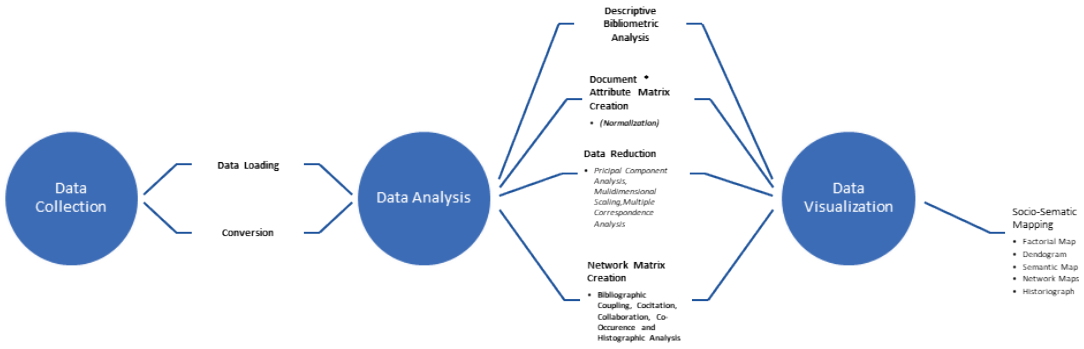

Figure 2 Bibliometric Analysis Workflow (Adapted from Aria, M. & Cuccurullo, C. (2017))

Overview of SUSGREENIS

This section details the metadata and description of the corpus used in the bibliometric analysis of sustainability-related IS conference papers. Using Gephi, we observe in figure 3 below that there are 39 communities in the SUSGREENIS conference SCOPUS dataset, considering each of the five conferences and authors as network nodes. The number of weakly connected components in the authors' analysis and conference/source title is 11, while the number of strongly connected components is 3840. Figure 3 below is a visualization of the network layout plot based on IS conference authors and keywords.

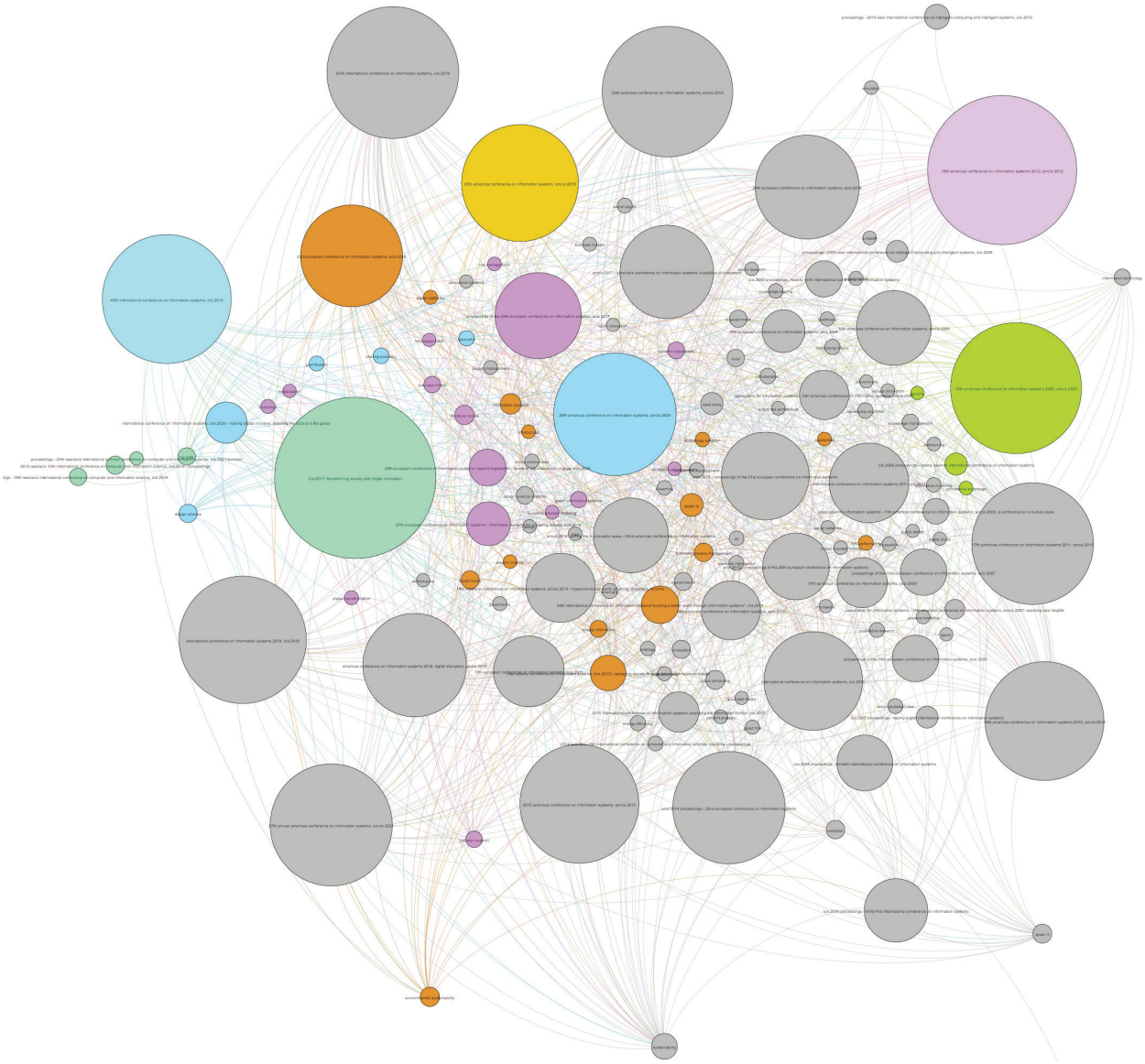

Figure 3 Authors and Conference papers on SUSGREENIS

SUSGREENIS Semantic Patterns

This section presents maps based on a bibliometric analysis of text, i.e., keywords associated with IS conferences on the sustainability theme. It explores sustainability IS papers' by looking at their conceptual structure, trend topics, and topical clusters.

Conceptual Structure and Thematic Evolution in IS Conference Papers

Figure 4 below shows the topical clusters of the IS conferences related to sustainability based on multiple correspondence analyses of the author's keywords. None of the topic clusters trace back to sustainability transitions research explicitly. Instead, the papers surveyed by clustering relate to sustainability on the organizational level. From this clustering, we can conclude that IS has not been explicitly bridged with systemic innovation and transitions research. The eight main themes, at first glance, inspire questions on how these IS-centered topics can be translated to STR research designs.

Figure 4 Conceptual Structure Map SUSGREENIS

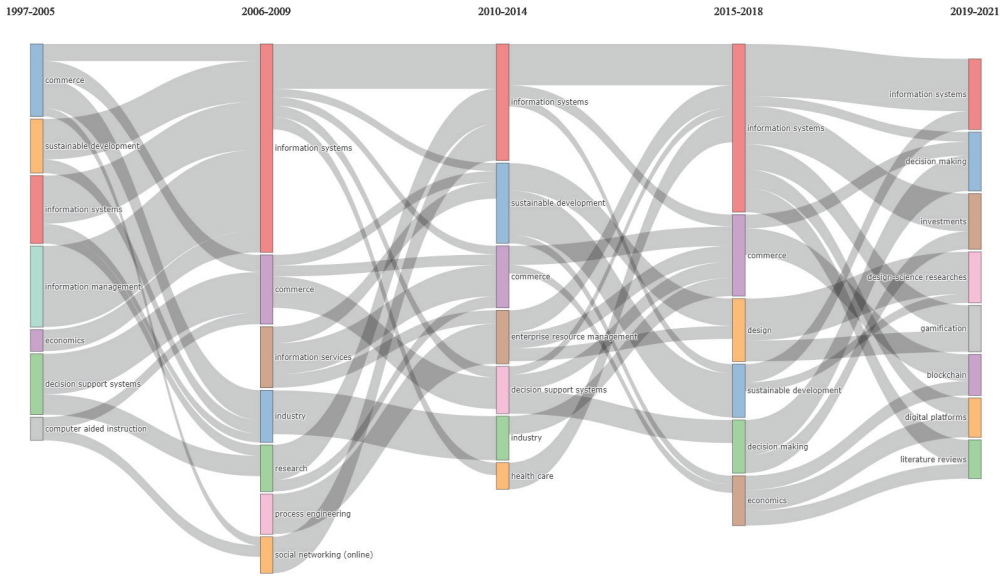

Figure 5 Thematic Evolution by Author Keywords

Figure 6 below shows the trending topics in the five conferences from 2005. Again, smart-city emerges as a topic indicating IS interest in sustainability at the systems level.

Trend Topics and Topic Dendrogram

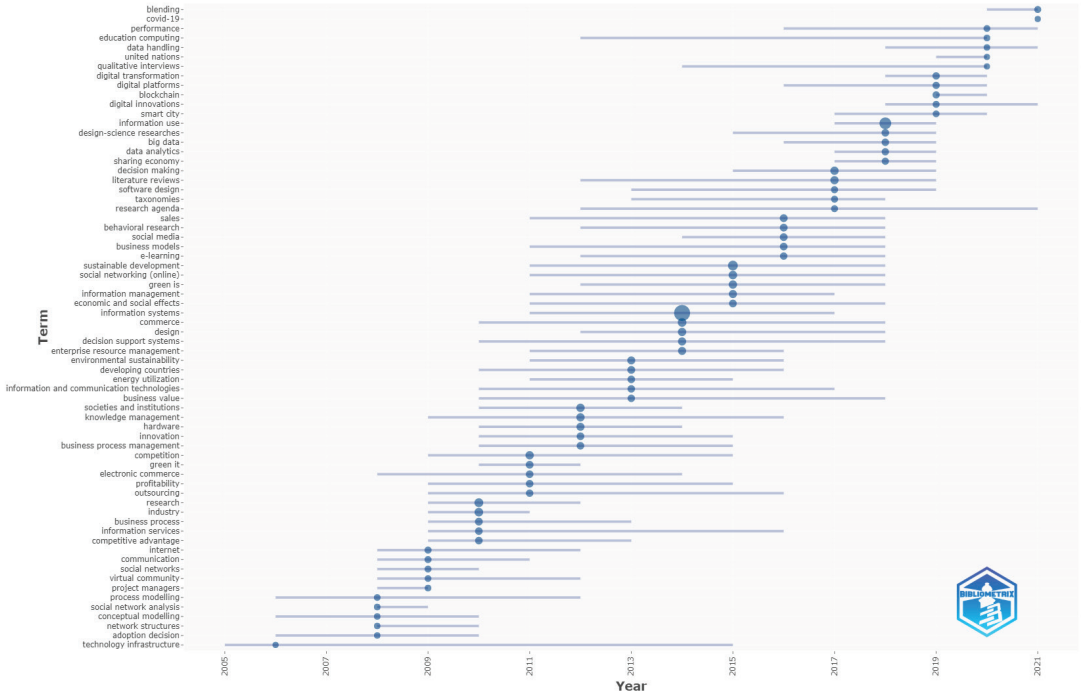

Figure 6 Trend Topic Keyword on SUSGREENIS

What is clear from the thematic map in figure 6 above is the shift in the thematic focus of authors in the IS conferences. In current times, IS research on sustainability has become more interested in gamification, digital platforms, computational literature reviews, and the role of blockchain. In addition, investments and decision-making that support sustainability governance goals are also a recent focus of IS conference papers. Figure 7 below further shows these papers' patterns of hierarchy and interconnectedness of topics.

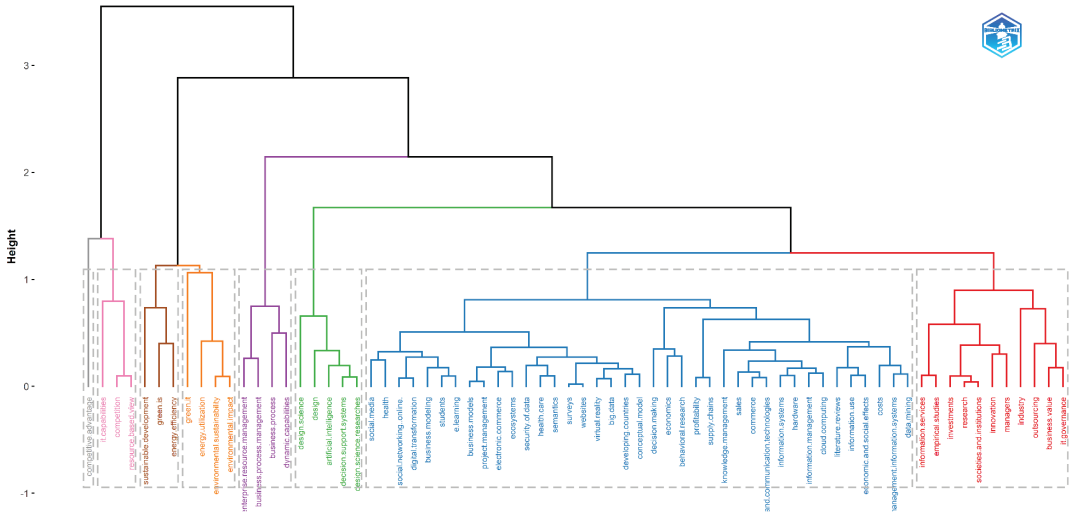

Figure 7 Topic Dendrogram Map SUSGREENIS (By Documents)

To conclude, the exploration of *semantic patterns* discovered in the IS conference corpus at the author and keywords is beyond the scope of this current paper. However, what is clear is the three-part clustering depicting how IS conferences are presenting work that shows the value of, e.g., artificial intelligence,

decision support systems, big data, and ICT. A closer look at the source papers shows that adequate attention is directed to the organizational aspects of sustainability, but there is a need to move beyond organizational sustainability. The trends in Corporate Social Responsibility and Environmental Social Governance are a testament to this focus on the community.

SUSGREENIS Social Patterns

In this section, we elaborate on the *social patterns*, i.e., patterns of relations between IS sustainability-related papers and their concepts (concepts in abstracts) see Figures 8 and 9 below. The network graph shown above is somewhat connected (Number of Weakly Connected Components: 805, Number of Strongly Connected Components: 3768). Furthermore, by using Gephi (gephi.org), we applied a modularity clustering algorithm by Vincent D Blondel and colleagues (Blondel 2008), shown here as a simple, directed graph of 3,768 nodes with 5,567 edges. With a density of ~0.0004, the SUSGREENIS sustainability-focused collaboration network is clustered into ***822 communities*** with modularity of 0.970. In figure 13 below, topics such as trust, big data, and digital platforms are linked to current solutions anticipated for sustainability, e.g., car sharing. Furthermore, the most relevant authors and collaborations correspond to nodes with the highest network degrees and links between the larger nodes in figure 8 below.

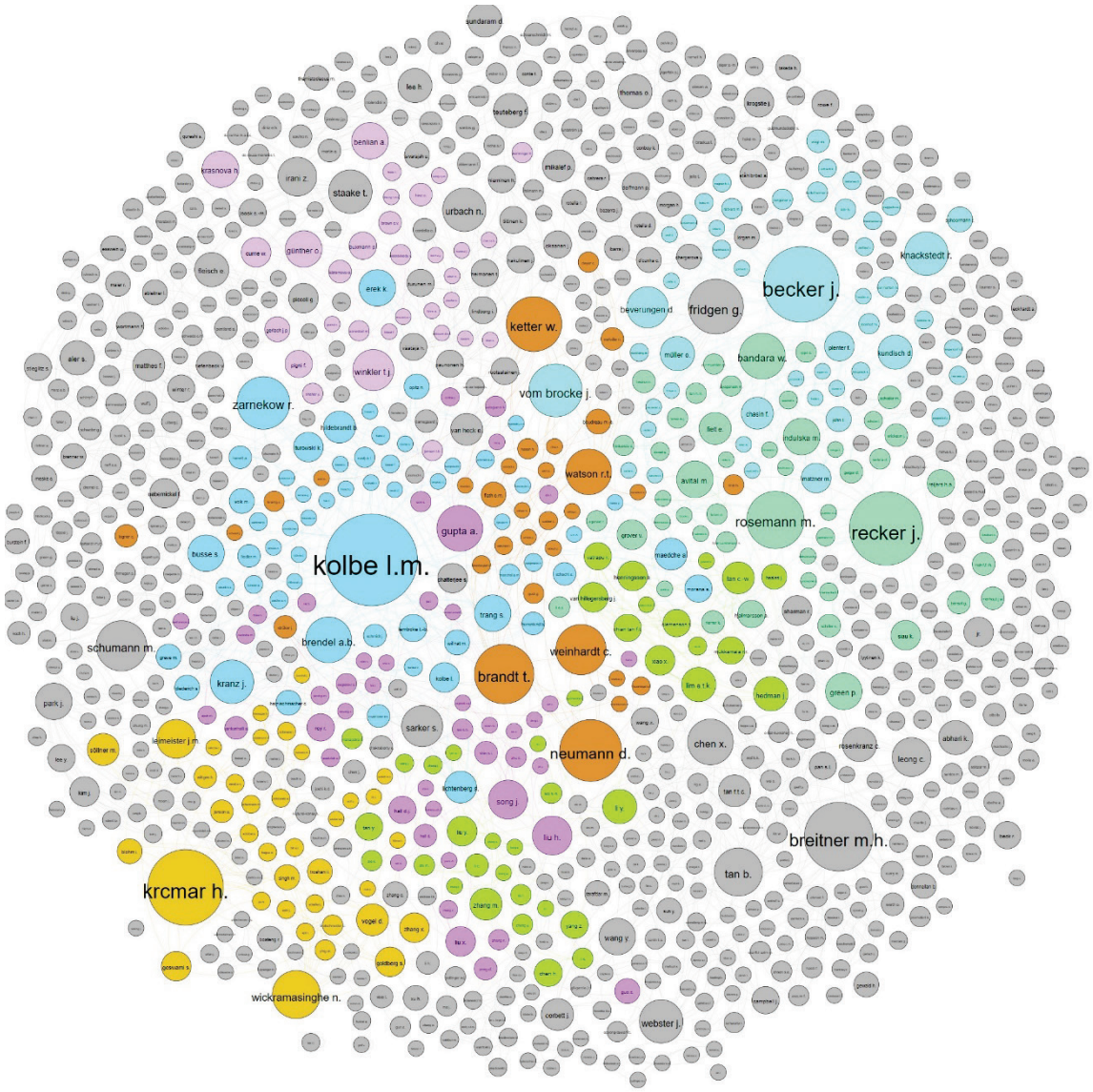

Figure 8 Collaboration Network SUSGREENIS (Authors)

Figure 9 below shows the keyword network of the IS conferences. It forms the basis of future reflection on how these clustered concepts, mostly related to the organizational level, may be contributing to/addressing sustainability outcomes on a system level. The paradox is that these topics are connected to IS themes such as machine learning and blockchain. The sustainability transition community anticipates that IS artifacts will increase dependence on energy regimes and consumption patterns. The rave for Non-fungible tokens and machine learning algorithm training justifies this critical view. There is a need for both fields to interact here with more transparency.

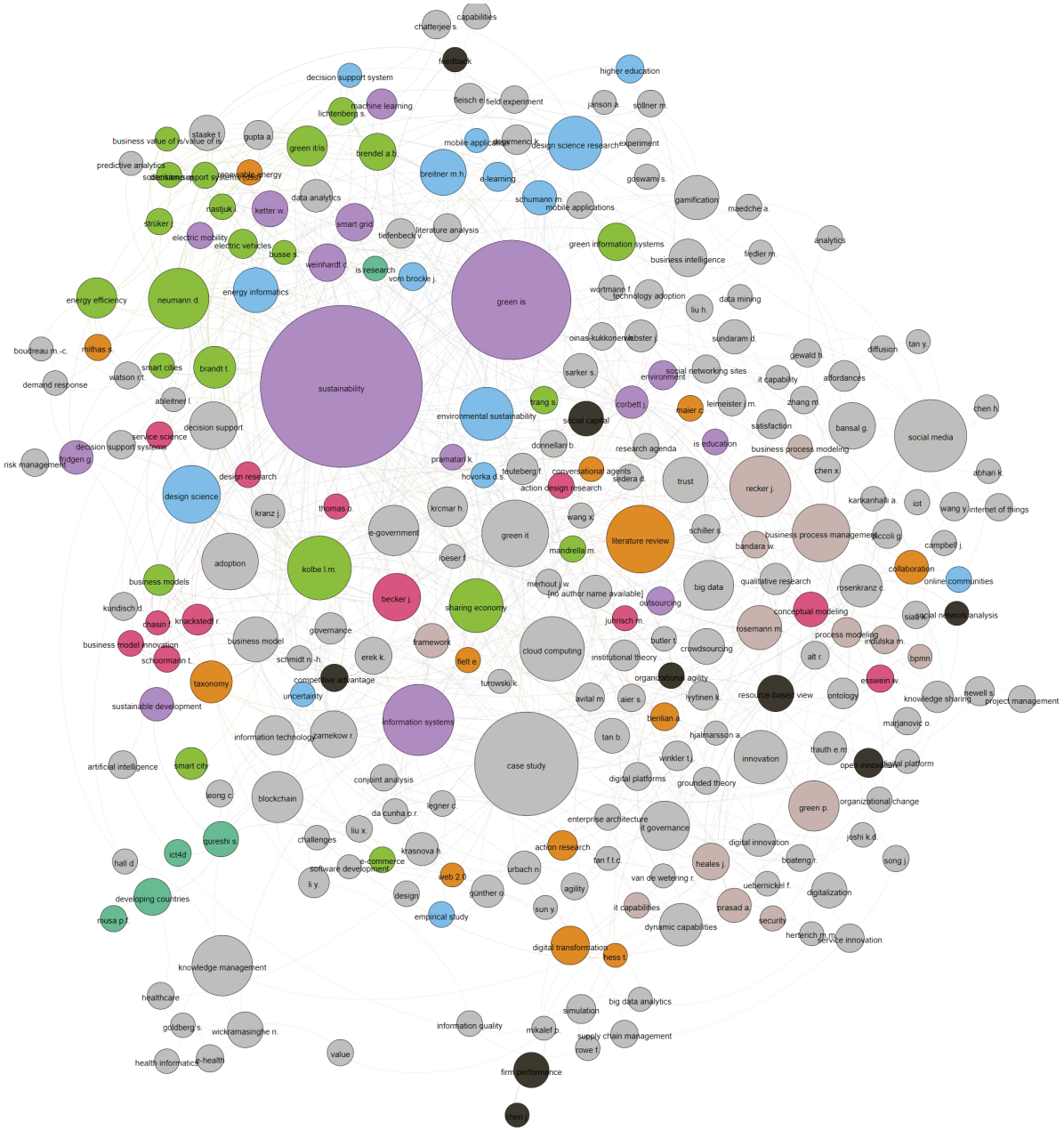

Figure 9 SUSGREENIS Conference Co-Occurrence of Authors and Keywords

IS artifacts allow us to track behavior while services like Uber (which runs on fossil fuels) are more accessible. Digital platforms indeed have positive and negative implications for sustainability. On the other hand, gamification approaches in IS can augment our understanding of the sustainability-oriented behavior of citizens/users. This attention to users and socio-material phenomena is the hallmark of some existing IS research and is a significant weak spot for current sustainability transitions research. More machine

learning analytics approaches are of timely relevance for the sustainability transitions community to augment the current overreliance of the transitions research community on small-size case studies.

How can IS Theory and Methods contribute to STR (research and practice) moving beyond the GreenIT paradigm?

IS research and practice can contribute to Sustainability Transition Research (STR) through topics identified in the semantic patterns section. Conceptual modeling of transitions, machine learning and predictive analytics are useful for understanding transition network dynamics. Big data approaches can map and catalog transition-related phenomena and events across several locations. IS approaches to games and gamification and Design science artifacts augment transitions action research. At the same time, data-driven computational databases and techniques can help the Sustainability transitions community move beyond small-size case studies (Moallemi and de Haan 2019). IS paradigms, concepts and constructs are crucial in helping STR operationalize the researcher roles highlighted by Maas and colleagues (Maass et al 2018). The authors suggest proactive, responsive and active roles for IS researchers to solve sustainability questions that may not be solved from just theory or big data. A bridging approach informs publication strategies to pluralize the IS sustainability landscape; in calls for papers, workshops, and transdisciplinary research avenues beyond current themes and topics. Potential research questions relate to the role of central nodes in the maps created and how they can be applied to STR research. Sample questions are *:*

- *How can big data approaches in IS be applied to STR to improve our understanding of individual and organizational transition actors?*
- *How can we leverage design science approaches and methods to mine diverse transition actors' activities, values, logics, events, resources, and roles?*
- *What can we learn from IS research on designing ethically sound large-size cases? How to leverage computational modeling techniques from IS to augment current approaches to sustainability transitions research beyond case studies?*
- *How can STR take inspiration from social media and visual analytics research on innovation networks and ecosystems to radically improve our understanding of mechanisms in transition themes such as food, energy, healthcare and digital transformation?*
- *Finally, what can IS learn from the current theorizing of sustainability and transformations in STR to help organizations navigate institutional complexity?*

Conclusion

The mapping executed here provides a quantitative overview of social and sematic patterns that characterize sustainability research in the IS field by looking at five conference abstracts for theories, themes, trends and topics. The mapping also identifies how IS authors could be encouraged to bridge the two fields (a potential for hyper-transdisciplinarity) using Design Science more in Transition Studies and data-driven approaches. Our meta-analysis aims to help contextualize IS research conference output/findings and inform future opportunities to fine-tune sustainability-oriented IS research questions. Furthermore, our mapping will help provide more meaningful guidance to practitioners in IS who want to understand the academic landscape. This paper, therefore, maps the conferences convened on IS, offering a quantitative analysis-based meta-analysis of IS research, particularly on work related to sustainability. The bibliometric mapping explores (a)*how IS conferences (authors and topics/themes) are connected,* but much more (b) *which research communities are (implicated),* i.e., *what fields IS is not yet connected to.*

We mapped the topic and collaboration patterns in ECIS, ICIS, HICSS, PACIS and AMCIS to date to show social and semantic patterns in the field of IS. In addition, our work zoomed in on the conferences as knowledge arenas typifying sustainability research in IS to date.

Limitations and Future Work

In the future, we want to compare the topics and collaboration patterns between the IS journals and Sustainability Oriented Journals to outline a more detailed data-driven theory-guided research agenda for

bridging both fields. A joint conference call for papers, workshops or special issues between any of the 5 IS conferences, and sustainability transition conference conveners, e.g., ***International Sustainability Transitions Conference (IST),*** is also a fruitful avenue for advancing the bridging agenda. The bibliometric review heavily adopts a visual sensemaking approach in positing its observations, and the author is making the dataset available on a data portal for accessibility and reproducibility. A limitation of our work is that we have excluded Journal publications and have used just metadata provided by SCOPUS for our bibliometric review. The references in the metadata have been carefully extracted and analyzed using open source tools such as Bibliometrix to facilitate reproducibility. Owing to the standard conference format limit for AMCIS submissions, we have also prioritized visualizing the patterns in the corpus rather than lengthy explanations. The raw files and graph network files are available on request and will be uploaded on a GitHub page. Our meta-mapping approach showed that IS could contribute to the field of Sustainability transitions beyond GreenIT-oriented research and practice. Towards bridging both fields, our visual mapping of the conference papers concludes that research on sustainability transitions can be augmented with IS theory (e.g., ***socio-materiality, generativity, affordances, openness)*** and methods ***(design science methods, instantiations, and infrastructures, as well as conceptual modeling***). These IS "packages" (theories and methods) can augment research on systems innovation but are still a blind spot for current transitions research and practice, particularly in combination with the transformations worthy of consideration in the digital era. IT can provide solutions for solving climate change and grand challenges and diverse communities

Acknowledgments

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