Digital Service Innovation for Sustainable Development: A Systematic Literature Review

Research Paper

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Abstract. Creating and delivering products and services that promote sustainability is increasingly important in today's economy. Novel services based on digital technologies and infrastructure can significantly contribute to sustainable development, as demonstrated by digitally enabled car-sharing services where increased asset utilization reduces production-related greenhouse gas emissions. However, there is still limited knowledge on how digital service innovation can purposefully be applied to promote sustainability.

To address this gap, we conduct a systematic literature review and perform a qualitative inductive analysis of 50 articles on the impact of digital service innovation on social, environmental, and economic sustainability. We provide a comprehensive overview of real-world applications and identify five underlying mechanisms through which innovation with digital services can drive sustainable development. In doing so, we aim to pave the way to purposefully conceive, design, and implement digital services for sustainability.

Keywords: Sustainability, sustainable development, digital service innovation, information systems, systematic literature review

1 Introduction

As digital technologies and infrastructures offer powerful capabilities to promote economic, environmental, and social sustainability both in industrial activities and in citizens' daily life (de la Calle, Freije and Oyarbide, 2021), targeted innovation efforts in this area are critical for achieving sustainability goals. For instance, car sharing mediated by digital services can significantly reduce greenhouse gas (GHG) emissions by up to 0.58 tons per household per year (Duncan, 2011; Martin and Shaheen, 2011). Therefore, innovating digitally supported car-sharing services can help to develop sustainable transportation systems and support the Sustainable Development Goals (SDGs) proposed by the United Nations (2015). Similarly, telemedicine or remote diagnostics, which have gained importance during the COVID-19 pandemic, also bear significant potential to lower carbon emissions by reducing the need for travel, while

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promoting the well-being of citizens by improving healthcare quality and reducing patient waiting times (Ashford, 2017; Zimiles, 2020; Purohit, Smith and Hibble, 2021).

Achieving sustainability is a highly debated topic for policy makers due to pressing challenges such as climate change, global inequality, lack of financial inclusion, and discrepancies in access to healthcare (e.g., UN, 2015; Bundesregierung, 2021). As the examples above show, technology-driven innovation has been successful in promoting sustainable development and, thus, should form a key focus of information systems (IS) research (Malhotra, Melville and Watson, 2013; Pan et al., 2022). The IS discipline has a rich history of research on integrating economic, environmental, and social responsibility into organizations through information and communication technology (ICT) and methodological knowledge (e.g., vom Brocke et al., 2013; Gholami et al., 2016; Schoormann et al., 2023) and is well-suited to promote sustainable development due to its history of solving complex problems and driving advancements in software and hardware (Zeiss et al., 2021).

Designing and innovating digital services can significantly impact sustainable change (Saviano et al., 2017; Field et al., 2021), making it crucial for service research in the IS discipline to contribute to this discussion. However, there is neither a comprehensive understanding of the interplay between digital service innovation (DSI) and sustainable development nor a well-articulated research agenda to foster sustainable development with digital services. To address this issue, this article explores the following research question: *"How can digital service innovation promote sustainable development?"* To answer this question, we have conducted a systematic literature review to identify how digital services can help achieve sustainability based on the 17 SDGs (UN, 2015) and the Triple Bottom Line (Elkington, 1997). In particular, our study reveals five key mechanisms in which DSI may drive sustainable development: (a) promoting sustainable behaviors, (b) promoting social inclusion and integration, (c) improving citizens' daily life, (d) promoting sustainable economic growth, and (e) improving urban safety. These results should help to purposefully conceive, design, and implement novel services for sustainability benefits.

The article is structured as follows: The next section provides a brief overview of related work. Section 3 outlines our research method, before Section 4 presents the analytical results of the systematic literature review, including the key mechanisms of DSI's contribution to sustainable development. Finally, the study concludes by discussing potential negative aspects of DSI, pointing out the implications and limitations of our study, and suggesting directions for future research in form of a research agenda.

2 Background

Increased interest in service innovation by public and private organizations (Snyder et al., 2016), and the pervasive role of digital technologies in innovation processes and outcomes—as evident in emerging phenomena such as social media (Kaplan and Haenlein, 2010), the Internet of Things (Gubbi et al., 2013), and big data analytics (Hunke, Heinz and Satzger, 2022)—are driving research on digital services. While servitization and digitalization as global trends have been studied separately for some time

(Vendrell-Herrero et al., 2017), recent research highlights their close interrelationship and introduces the concept of "digital servitization" (Kohtamäki and Rajala, 2016; Sklyar et al., 2019; Paschou et al., 2020). Digital servitization can be studied from multiple perspectives, such as strategy and partner orchestration, organizational transformation, and technological capabilities. Thereby, all of these interdisciplinary perspectives contribute to understanding how organizations and their employees can innovate digital services.

From an IS perspective, DSI can be defined as the use of digital technologies to create new or improve existing services (Rizk, Bergvall-Kåreborn and Elragal, 2017; Heinz et al., 2022), drawing on the literature on service innovation (e.g., Lusch and Nambisan, 2015) and digital innovation (e.g., Yoo, Henfridsson and Lyytinen, 2010). Rizk et al. (2017) identified three streams of DSI research that take different elements as their primary unit of analysis: the *digital service* as the artifact of innovation, the *innovation process* as the stages of how the innovation of a digital service unfolds, and *digital infrastructures* as enabling resources and networks for DSI. In our research we adopt this conceptualization for the search and selection of research articles.

In line with current publications by the United Nations (e.g., UN, 2018), we adopt Brundtland's (1987) notion of sustainability as meeting the needs of the present without compromising the ability of future generations to meet their own needs, which balances nature, production, and business (US Environmental Protection Agency, 1969). While sustainability rather represents a long-term goal, we refer to sustainable development as "the many processes and pathways to achieve it" (Jeronen, 2013, p. 2371). We ground our conceptual understanding of these two intertwined concepts in the Triple Bottom Line approach, which proposes three dimensions of sustainability: social, environmental, and economic (Elkington, 1997) as well as the UN's 17 Sustainable Development Goals (UN, 2015). Table 1 summarizes the 17 SDGs and maps them into the three dimensions of sustainability, building on previous studies (Vinuesa et al., 2020; Schoormann et al., 2023) and our own analysis.

Table 1. SDGs classified into sustainability dimensions.

SDGs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	No poverty	Zero hunger	Good health & well-being	Quality education	Gender equality	Clean water & sanitation	Affordable & clean energy	Decent work & economic growth	Industry, innovation & infrastructure	Reduces inequalities	Sustainable cities & communities	Responsible consumption & production	Climate action	Life below water	Life on land	Peace, justice & strong institutions	Partnerships for the goals
Social	●	●	●	●	●	●	●			○	●	●				●	
Environmental						○	●				●	●	●	●	●		
Economic								●	●	●							●

○ *added based on our analysis* ● *adopted from Vinuesa et al. (2020) / Schoormann et al. (2023)*

3 Research Method

To answer our research question, we conduct a systematic literature review according to established methods in IS research (Webster and Watson, 2002; Vom Brocke et al., 2009). Our research process follows the five-step procedure suggested by vom Brocke et al. (2009), as described below.

First, we *define the review scope* using Cooper's (1988) taxonomy of literature reviews. Our focus is on systematizing theories as well as practices and applications explaining how DSI can promote sustainable development. The primary goal of our review is to integrate and synthesize existing literature on this topic. We conduct our review from a neutral perspective and aim for a representative rather than exhaustive coverage of the literature, given the far-reaching linkages of our topic. We employ techniques for conceptual synthesis and grouping of studies, and we reach out to general scholars as the audience of our review.

Second, we *conceptualize the topic* of our review to generate a search phrase by combining two main areas of focus: sustainability and digital service innovation. To conceptualize sustainability, we follow the approach of Schoormann et al. (2023) and draw on the Triple Bottom Line (Elkington, 1997) and the 17 SDGs (UN, 2015). Regarding DSI, we engage in an iterative process of constructing a search phrase that ultimately combined the term "digital" and synonyms such as "smart," "data-based," "analytics," and "data-driven" with the terms "service," "innovation," and "infrastructure," which we derive from the conceptualization of DSI by Rizk et al. (2017). The full search phrase is shown in Figure 1.

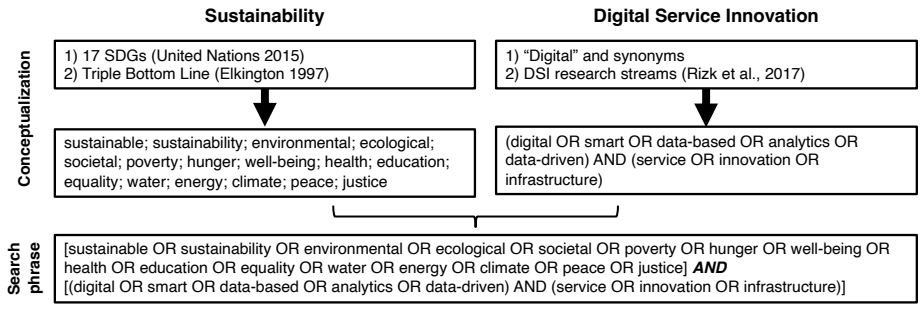

Figure 1. Search phrase based on the conceptualization of the topic.

Third, we conduct a *literature search* for articles in the IS discipline drawing on the VHB-JOURQUAL3 as a recognized rating of academic outlets. We searched the journals of the AIS Senior Scholars' Basket of Eight and the proceedings of major IS conferences (ICIS, ECIS, PACIS, AMCIS, HICSS, WI), which we consider to be a representative sample of high-quality research as well as the most recent research in the IS discipline. We consider only articles published after January 1, 2010, as DSI is an emerging phenomenon resulting from recent advances in digital technologies. Using the Web of Science, Scopus, and AISeL databases, we identified 386 articles, which we narrowed down to 369 after removing duplicates and incomplete articles.

We then perform an initial screening of the remaining articles based on their titles, abstracts, and keywords. We select articles that meet specific criteria, including those that (a) promote sustainable development and help achieve the 17 SDGs, (b) contribute to DSI through one of the three DSI research streams, (c) discuss digital technologies' implications on sustainability, and (d) are located at the intersection of DSI and sustainability. After the initial screening, we included 21 articles in the final sample, with 85 articles undergoing a second relevance assessment based on their full-text (Templier and Pare, 2018). Ultimately, 29 more articles were included in the final sample in this step, resulting in a total of 50 articles that are considered relevant to our study.

Fourth, we *analyze the literature*, beginning with a preliminary thematic analysis to familiarize ourselves with the dataset (Braun and Clarke, 2006) by extracting each article's research questions, methods, findings, and limitations and paraphrasing its contribution to sustainable development. Then, we apply qualitative inductive coding techniques to analyze how DSI promotes sustainable development. We follow the cascading approach of the Gioia methodology (Gioia, Corley and Hamilton, 2013; Gioia, 2021), which we apply to academic articles instead of empirical sources (similar to, e.g., Hund et al., 2021). In the first-order analysis, we search for similarities and differences across articles, using initial and in vivo coding. In the second-order analysis, we summarize the information and aggregate similar first-order concepts into second-order themes. Finally, we group second-order themes into aggregated dimensions that represent the key mechanisms of how DSI promotes sustainable development. We derived five key mechanisms, which we present in the next section. After the qualitative analysis, we interpret the mechanisms' impact on the 17 SDGs and the Triple Bottom Line. Two authors independently labelled the direct or indirect impacts of each mechanism on the SDGs. Both authors reached broad agreement, and the few discrepancies were resolved in a subsequent discussion.

Finally, we *develop future research directions* for service research in the IS discipline. Our goal in this phase is to promote a more comprehensive contribution of DSI research to sustainable development and to facilitate synergies between the IS discipline and long-term sustainability.

4 Mechanisms of How DSI Promotes Sustainable Development

In this section, we present the findings of our systematic literature review. As the results of our qualitative inductive analysis of the literature sample, we present five key mechanisms of how innovating digital services can promote sustainable development. After introducing the five mechanisms in detail, we map them to the 17 SDGs to explore the general potential of DSI to achieve sustainability.

4.1 Promote Sustainable Behaviors

As the first mechanism, DSI can "promote sustainable behaviors" ultimately leading to sustainable development (Radziszewski, Weichbroth and Anacka, 2021). Figure 2 depicts related concepts and themes, which we explain in more detail below.

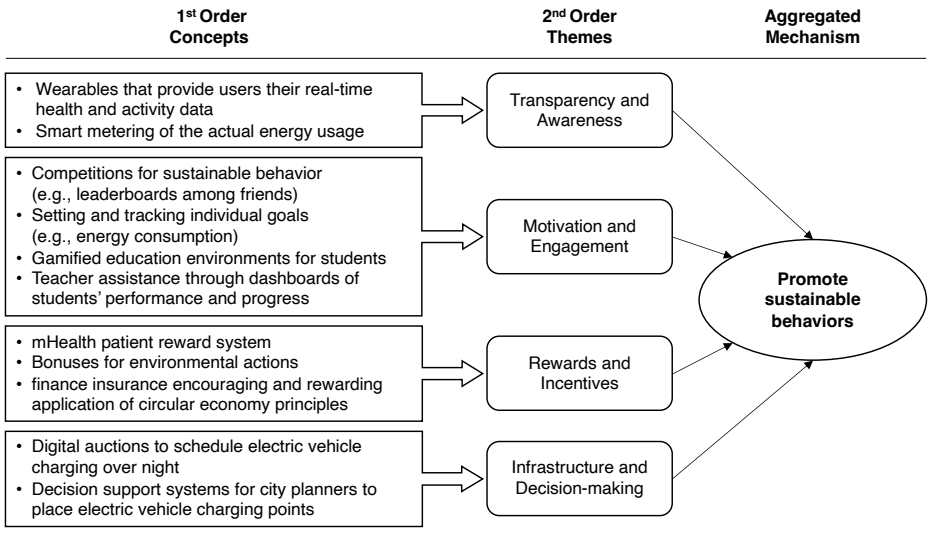

Figure 2. Data structure for "promote sustainable behaviors" mechanism.

Digital services can increase transparency and citizens' awareness of the consequences of their behavior. Two main applications in our literature sample are mobile health (mHealth) apps that use wearables and smartphones to provide real-time data on physical activity and physiological functions, such as daily steps or blood glucose (e.g., Hakkila et al., 2016; Ghose et al., 2022), and smart metering technologies that make energy consumption more transparent and allow users to identify ways to save energy (Lawson, Watson and Ramaswamy, 2015; Wunderlich, Veit and Sarker, 2019). This theme can also be applied to other domains, such as making the GHG emissions of different transportation modes transparent.

Another way how digital services can promote sustainability is by motivating and engaging users through certain features. Many of these features "gamify" sustainable behavior, such as creating leaderboards for sports activities to compete among friends (Emerson, Heavin and Power, 2020), setting and tracking household goals for energy savings (Loock, Staake and Thiesse, 2013), or introducing gaming elements into workplace training to create a more engaging experience (Helms, Barneveld and Dalpiaz, 2015). Digital service features can also provide information for teachers or other in-person service providers to adjust their interactions with clients based on individual progress (Hakkila et al., 2016).

Third, digital services can serve as means to provide rewards and incentives for sustainable behaviors: For example, Bonazzi et al. (2017) designed an mHealth app that provides monetary rewards to diabetic patients who adhere to health goals set as part of their treatment, such as diet or exercise goals. Other articles propose other monetary reward systems for pro-environmental actions, such as bonus points that can be traded for sustainable products (Radziszewski, Weichbroth and Anacka, 2021) or benefits in insurance programs (Wood and Godsill, 2021).

Finally, DSI can provide an infrastructure for incorporating sustainability goals into decision-making. Two examples are digital services that provide a decision support system for city planners to optimize the placement of electric vehicle charging points (Wagner, Brandt and Neumann, 2014) or conduct digital auctions to schedule overnight vehicle charging based on renewable energy availability (Valogianni et al., 2019).

4.2 Promote Social Inclusion and Integration

The second mechanism describes how DSI promotes social inclusion and integration and, therefore, sustainable development. The respective concepts and themes are depicted in Figure 3.

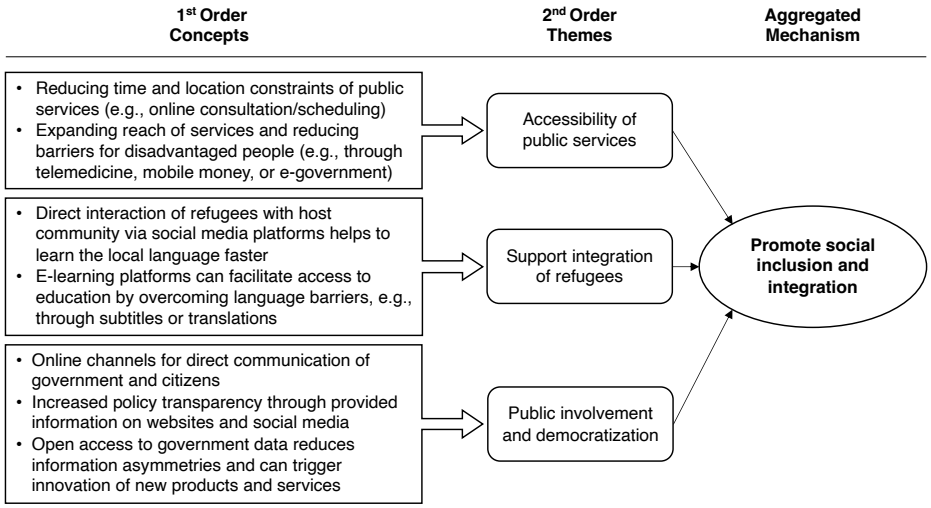

Figure 3. Data structure for "promote social inclusion and integration" mechanism.

Digitalization of services can improve accessibility for citizens, especially for disadvantaged groups. For example, online banking can meet most financial service needs of citizens in poor areas without access to offline banking (Lagna and Ravishankar, 2022), and peer-to-peer lending platforms can virtually connect low-income individuals with lenders, enabling access to loans at low interest rates (Ravishankar, 2021). Telemedicine (Srivastava and Shainesh, 2015) and mHealth services (Lichtenberg et al., 2019; Ahuja, Chan and Krishnamurthy, 2023) address health issues in developing countries, e.g., by remotely consulting community health workers to properly treat patients.

Equal access to quality education is crucial for an inclusive society and free education services can support the integration of refugees into the host society. Digital services promoting this can be media platforms that connect refugees with the local community—which is especially beneficial when learning the new language— or e-learning platforms that make knowledge accessible for domain-specific trainings (e.g., programming) (Abujarour, 2020).

In addition, digital services can promote public involvement in democratic processes. E-government service innovation can create new channels of communication between governments and citizens (Alawadhi and Scholl, 2016; Bernhard et al., 2019) and make policies more transparent by allowing citizens to obtain real-time information from local governments (e.g., vaccination policies, nuclear energy policies), ultimately increasing citizens' trust in the government (Chatfield, Reddick and Anggoro, 2016). Furthermore, DSI enables governments to provide open access to government data, which can reduce information asymmetries and inform decision-making (e.g., in the real estate market). This data can also be used as a resource for innovating new products and services, such as mobile applications that provide real-time transportation information to navigate public transit systems (Jetzek, Avital and Bjorn-Andersen, 2019).

4.3 Improve Citizens' Daily Life

DSI can improve citizens' daily life by providing convenience, quality care services, and a comfortable and safe environment, ultimately contributing to sustainable development in a society (Kjell, 2011). Examples of how DSI improves citizens' daily life and well-being are depicted in Figure 4 and discussed in more detail below.

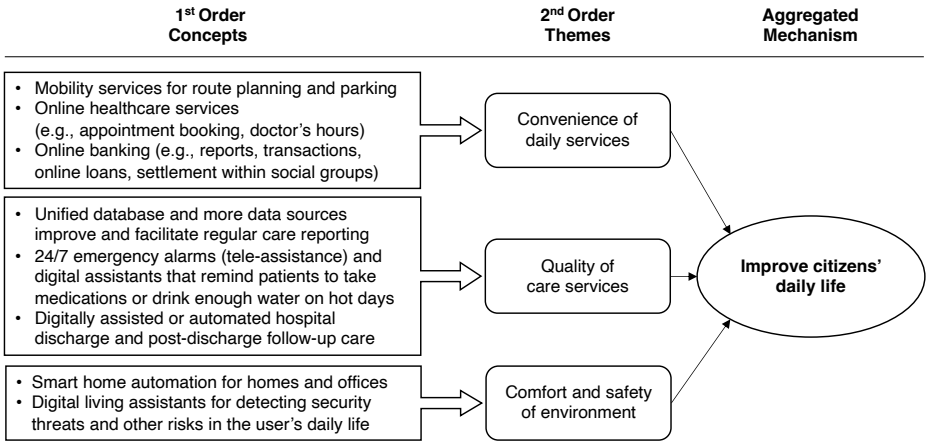

Figure 4. Data structure for "improve citizens' daily life" mechanism.

First, DSI can enhance citizen's daily lives with convenient services such as trip planning and parking assistance (Schreieck, Wiesche and Krcmar, 2016; Di Leo et al., 2019), online appointment scheduling (Thorseng and Blegind Jensen, 2015), remote professional services such as virtual medical consultations (Warren et al., 2020; Ghose et al., 2022), or financial services such as digital community currencies (Chasin, Schmolke and Becker, 2020; Nan, 2021). Some digital services also combine different forms of assistance into a comprehensive "life coach" (Cazier and Green, 2016).

Second, DSI has great potential to improve the quality of services in health care and elderly care. DSI provides the means to scale digital components across local care facilities, improving accuracy while reducing the workload for standard processes like

care reporting (Sahay et al., 2018), hospital discharge, and post-discharge communication (Tanniru, Khuntia and Weiner, 2016; Lichtner, Cornford and Klecun, 2017), allowing caregivers to spend more time with patients. In addition, electronic devices coupled with digital services can protect elderly people with disabilities who live independently. Examples are teleassistance services that can send emergency alerts around the clock (Di Leo et al., 2019), or digital assistants that remind users to take their medication and provide dietary advice (e.g., water intake on a hot day) (Fernando et al., 2016).

Third, DSI can contribute to a comfortable and safe environment. This can be enabled, for example, by smart home technologies that enhance thermal or visual comfort and indoor air quality (Yassaee and Winter, 2017; Laing and Kühl, 2018). Furthermore, digital assistants can identify potential safety risks, such as external threats or unusual resident behavior that indicates a critical health risk (Fernando et al., 2016).

4.4 Promote Sustainable Economic Growth

Besides social and environmental sustainability, DSI also provides means to promote sustainable economic growth, as depicted in Figure 5.

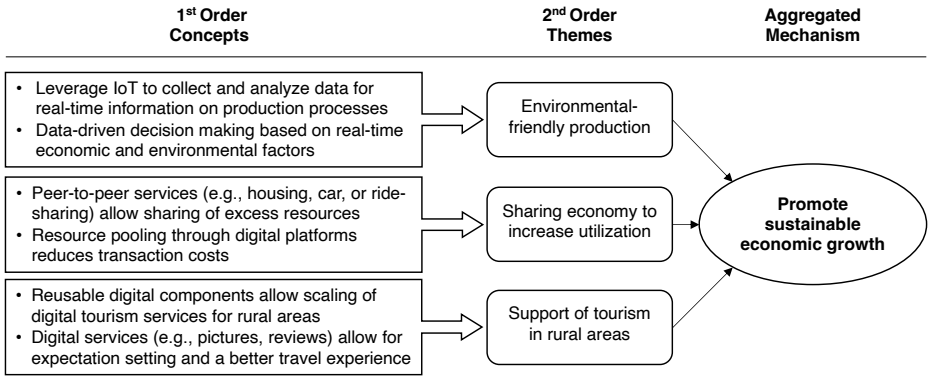

Figure 5. Data structure for "promote sustainable economic growth" mechanism.

DSI can help improve production processes while reducing the environmental footprint. The manufacturing industry has been using digital technology and automation for years to increase efficiency, reduce costs, and minimize material usage. Two articles in our sample focus on the benefits of smart agricultural services (Cu, Lamacchia and Nguyen, 2017; Jacobs et al., 2017). These services allow farmers to use Internet-of-Things (IoT)-enabled technologies to adapt agricultural processes to actual environmental conditions, leading to increased productivity and environmental benefits (e.g., more targeted and thus less use of pesticides). Other industries, such as oil and gas, can also benefit from DSI by using IoT-based services to simplify the collection and analysis of data from connected, inaccessible equipment in the ground (Khan et al., 2017).

DSI has also given rise to the "sharing economy," in which digital platforms increase the utilization of assets. In particular, peer-to-peer service platforms (e.g., housing, car

or ride sharing) can promote sustainability by enabling users to share excess resources at low transaction costs (Avital et al., 2014). However, the sharing economy can also have a negative impact on traditional economic networks. For example, an increase in Airbnb listings has been associated with a decrease in overall hotel revenues (Mody, Suess and Dogru, 2017).

Finally, DSI promotes local industry development and economic growth in rural areas. For instance, "Digital Wuyi" was a Chinese e-government initiative that developed an online channel to integrate tourism services, such as 3D images and online travel guides, to promote economic growth through tourism (Dong et al., 2012). Digital services in this context offer scalability by reusing components from other local areas. Digital services for less popular tourist destinations can also enable tourists to set their expectations in advance, leading to a better travel experience and sustainable growth of the local tourism industry (Dong et al., 2012).

4.5 Improve Urban Safety

The last mechanism DSI-promoted sustainable development focusses on improving urban safety, as depicted in Figure 6.

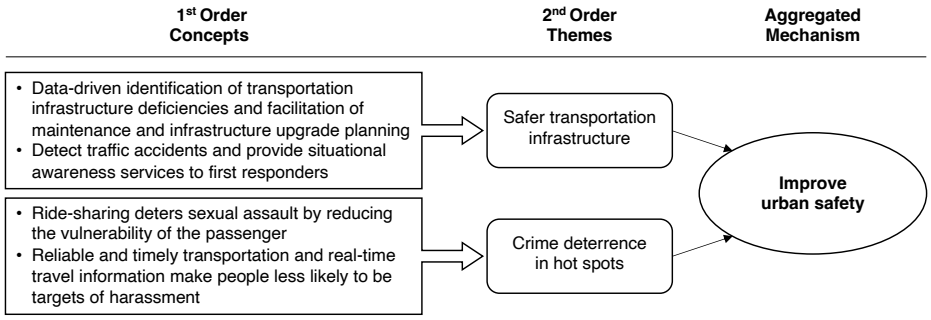

Figure 6. Data structure for "improve urban safety" mechanism.

DSI can enable governments to provide a safer traffic infrastructure: smart transportation systems can monitor road conditions and automatically identify deficiencies in transportation infrastructure based on road imagery (Chatterjee, Brendel and Lichtenberg, 2018). This information can be integrated into decision support systems to facilitate necessary maintenance processes and plan infrastructure upgrades. In addition, mobile applications based on vehicular social networks can quickly detect traffic accidents and provide situational awareness services to first responders (Hu et al., 2015). DSI can also improve urban safety by deterring crime in hot spots. Ride-sharing, for example, has been shown to reduce the likelihood of sexual assault (Park et al., 2021). Moreover, DSI allows for more reliable and timely transportation and real-time travel information, reducing the likelihood of harassment at public transportation stations (Park et al., 2021).

5 Discussion and Conclusion

5.1 Impact of the Mechanisms on Sustainable Development

After deriving the five domain-spanning mechanisms of how DSI can promote sustainable development, we used the first-order concepts and second-order themes to interpret the mechanisms' respective impact on the 17 SDGs and the Triple Bottom Line. The complete mapping is depicted in Figure 7. While discussing each relation would be beyond the scope of this article, we highlight key observations below.

	Mechanisms / SDGs	Promote sustainable behaviors	Promote social inclusion & integration	Improve citizens' daily life	Promote sustainable econ. growth	Improve urban safety	Social	Environm.	Economic
1	No poverty		●		●				
2	Zero hunger								
3	Good health & well-being	●	●	●		●			
4	Quality education	●	●						
5	Gender equality		●		●				
6	Clean water								
7	Affordable & clean energy	●							
8	Decent work & economic growth			●	●				
9	Industry/Innovation/Infrastructure				●				
10	Reduced inequalities		●		●				
11	Sustainable cities	●	●	●	●	●			
12	Responsible Consumption	●							
13	Climate change	●			●				
14	Life below water								
15	Life on land				●				
16	Peace and justice					●			
17	Global partnership								

● *direct impact on SDG* ● *indirect impact on SDG*

Figure 7. Mapping of the five mechanisms to the SDGs and Triple Bottom Line.

Recent conference themes such as "Digital responsibility: social, ethical, ecological implications of IS" (WI 2023) or "Co-creating sustainable digital futures" (ECIS 2023) show that achieving sustainability is a high priority in the current academic IS discourse and should therefore also guide DSI research. The IS literature on DSI in our sample currently addresses 13 out of 17 SDGs, demonstrating the potential of DSI research to contribute to sustainable development. However, future studies should pay particular attention to the four omitted goals: SDG2 (zero hunger), SDG6 (clean water), SDG14 (life below water), and SDG17 (global partnership). Second, health services (SDG3) and digital services for smart sustainable cities (SDG11) are predominant themes in this area. In general, DSI research contributing to the social dimension of sustainability is the most common in our literature sample. In contrast, DSI research so far lacks a detailed discussion of how DSI can contribute to the environmental dimension helping to combat climate change and how achieving the SDGs correlates with sustainable economic growth.

5.2 Implications for Research, Policy, and Practice

Our research contributes to service research in the IS discipline and provides implications for research. First, our findings provide a broad picture of DSI application areas that relate to sustainable development. This comprehensive overview emphasizes the importance of service research in the scientific discussion on using digital technologies for sustainable development. Our aim is to mobilize future service research by enabling scholars to identify significant phenomena in terms of societal impact and relate their contributions to the SDGs and the Triple Bottom Line. Second, the derived mechanisms provide an analytical structure to conceptually explain the general role of DSI in promoting sustainable development in society. While we view our analytical results as a theory that "says what is" (Gregor, 2006), future research can build on our findings to explain why DSI promotes sustainable development as described. Finally, our findings have implications beyond service research within the IS discipline. They inform IS scholars about how service research complements other streams within IS research regarding their impact on sustainable development and sharpen the role of an IS perspective on service-related phenomena in an interdisciplinary context.

Our research has also implications for policy and practitioners. Highlighting the role of DSI for sustainable development, our research can benefit policymakers to allocate funding to DSI-related research projects that promote sustainable development. These projects can help to enact existing knowledge in local initiatives, improve scientific understanding by extending the scope of preliminary research findings, and generate new knowledge through long-term interaction and empirical insights. Moreover, managers can use the set of application areas as inspiration to identify ways to lead their organization towards contributing to sustainable development in its environment.

5.3 Limitations and Outlook

Given the nature of our study, there are limitations to our findings that should guide future research. First, our analysis deliberately analyzes the positive impact of DSI on sustainable development. However, it is important to consider that there are also many potentially negative impacts and unintended consequences of DSI. Some articles in our sample take a more critical stance on this issue, highlighting "dark sides" such as an increase in the digital divide within a society and between countries, a significant increase in privacy risks (e.g., for mHealth services) and other potentially threatening data security risks (e.g., for critical information infrastructures), or potential benefits of DSI for sustainable development not being realized (e.g., digital care services not leading to more time available for the patient but to less staffing). Second, we cannot claim that our sample is complete or representative as we limited it to a fixed set of journals and conference proceedings. Future research should validate and eventually extend our findings by discussing them in a broader context (e.g., beyond IS research). Finally, we again emphasize that we consider the proposed mechanisms to be analytical rather than explanatory, as we do not provide causal explanations for why DSI promotes sustainable development. Future research should therefore extend our findings in this regard.

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All articles included in the final sample of the literature review are marked with an asterisk (*).

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