

Review

Understanding Innovation and Sustainability in Digital Organizations: A Mixed-Method Approach

Sabrina Schork , Dilan Özdemir-Kaluk  and Cudi Zerey 

Technische Hochschule Aschaffenburg—University of Applied Sciences, Economy and Law, Würzburger Straße 45, 63743 Aschaffenburg, Germany; dilan.oezdemir@exsolut.com (D.Ö.-K.); cudi.zerey@gmail.com (C.Z.)

* Correspondence: sabrina.schork@th-ab.de; Tel.: +49-(0-60-21)-4206-629

Abstract: In recent years, organizations have increasingly turned to digital transformation (D) to drive innovation (I) and sustainability (S). However, the rapid growth of studies on this topic, particularly since 2019, has made it challenging to clearly define these concepts, operationalize their constructs, and understand their positive organizational impacts. This article addresses these gaps through a systematic literature review (SLR) that combines quantitative and qualitative analysis. This study begins with a comprehensive bibliometric analysis of 3099 articles published between 2010 and 2023 in the Scopus database containing the terms “digital,” “innovation,” and “sustainability” (or “sustainable”). It then covers a detailed qualitative review of 20 high-quality articles from VHB-JOURQUAL-C-ranked journals or higher. By employing an inductive–deductive approach, the authors identify consistent and conflicting definitions, diverse constructs for each D-I-S concept, and numerous positive organizational effects. This article provides a structured overview of existing D-I-S definitions and introduces a model to distinguish environmental, organizational, and solution levels. Additionally, it presents a visual framework of the direct and mediated positive effects of D-I-S in organizations. Overall, these insights underscore the critical role of digital transformation in advancing innovation and sustainability, offering valuable guidance for researchers and practitioners alike.

Keywords: bibliometric analysis; digital transformation; innovation; mixed-method approach; sustainability; systematic literature review



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1. Introduction

The digital transformation of organizations has introduced major changes, reshaping how value chains and business models work. Over the past 30 years, the use of digital technologies has grown rapidly worldwide, with artificial intelligence (AI) becoming increasingly important since 2022 [1]. This shift gained even more momentum during the COVID-19 pandemic as digitalization accelerated across industries [2].

Digitalization is critical in driving innovation and supporting a more sustainable economy. This is highlighted by various studies, i.e., [3], political initiatives [4,5], and indices [6–8] that assess organizational performance. The growing number of publications on this topic worldwide reflects its importance, emphasizing the value of our research and the essential contribution of our audience in shaping the future of digital transformation.

The importance of sustainable innovation is growing as CO₂ emissions continue to rise. With emissions projected to increase in several regions, including China, India, and the rest of the world, there is an urgent need for solutions to mitigate environmental impact and promote long-term sustainability. Meeting these challenges requires innovative

approaches that promote both economic development and environmental responsibility [9]. Sustainable development means meeting today's needs without compromising the ability of future generations to meet theirs. For businesses, this requires integrating environmental, social, and economic principles into their operations, with innovation playing a key role. Innovation can involve new products, services, processes, or organizational methods [10]. In fact, achieving sustainable development often depends on innovation. Recently, the concepts of "sustainability" and "innovation" have merged to form the idea of "sustainable innovation" [10–12]. Sustainable innovation is developed by considering a balanced combination of three types of elements: economic, social, and environmental. Economic elements traditionally dominate decision making, yet with sustainability, the three elements are simultaneously and equally considered. Thus, the combination of the social, environmental, and economic elements in innovation processes differentiates sustainable innovations from traditional innovations. Not every innovation, as a result, is sustainable [12].

"'Green innovation', 'environmental innovation', 'eco-innovation', and 'sustainable innovation' are among the terms that have been increasingly used during the last 20 years. Understanding the differences between these terms is essential because of the need to recognize the different interests that are pertinent to different societies. The term 'green innovation' primarily focuses on innovations in products, processes, and management methods, with the aim of attaining competitive advantages in an environmentally friendly way. [...] Both 'environmental innovation' and 'eco-innovation' can be listed as innovations in which the focus is on ecological sustainability [...] that improve environmental performance'. In contrast to these three terms (green innovation, environmental innovation, and eco-innovation), in which the central focus is on environmental performance, sustainable innovation covers all three elements of sustainability and integrates the environmental, social, and financial factors for embedding in the entire life cycle of a company, including their products, services, and technologies" [12] (p. 704).

As the above definitions show, it is challenging for companies to navigate the DIS (digital, innovation, and sustainable OR sustainability) research field. A significant amount of time must be invested to gain a holistic overview of existing studies, which are often incomparable and rarely fully transferable. Nevertheless, operationalizing existing studies can give a company an innovative and sustainable orientation. Management and the executive level can apply digitalization strategies to accelerate sustainable development. This article aims to increase the speed of corporate transformation and promote the comparability of scientific studies by presenting the breadth of studies and analyzing selected approaches with the highest fit in depth.

The following article, therefore, pursues three objectives:

1. **Definitions:** to delineate the DIS concepts and underlying constructs;
2. **Operationalization:** to derive the operationalization of the constructs underlying the DIS concepts;
3. **Positive effects:** to show the positive DIS effects in organizations.

This is achieved through a systematic literature review (SLR). The output was analyzed both broadly and deeply. A broad analysis of 3099 articles using the keywords "digital, innovation, sustainability AND sustainable" from Scopus was conducted bibliometrically. The titles were then filtered, duplicates were removed, and their VHB-JOURQUAL ranking was analyzed. (The VHB Rating is a rating of business journals based on the opinions of members of the German Association of University Professors of Business Administration (VHB). It is divided into 18 subject-specific sub-ratings. The VHB is the leading academic association for business studies in German-speaking countries. As the authors are based in Germany, they decided to use this ranking). Articles that ranked at least C, with all three DIS keywords in the title and abstract and dealt with value contribution in organizations

were subjected to a thorough inductive–deductive in-depth analysis, further enhancing the robustness of our research.

The filtered material is presented in tables and figures. The findings from the bibliometric and inductive–deductive content analysis were then prepared for the three objectives and summarized in the Section 4.

2. Materials and Methods

To pursue the three objectives of the paper (definition, operationalization, and positive effects), an SLR is conducted. This review comprises eight steps, problem formulation, review protocol development, title analysis, abstract analysis, text analysis, data extraction, data analysis, and result aggregation [13], as visualized in Figure 1.

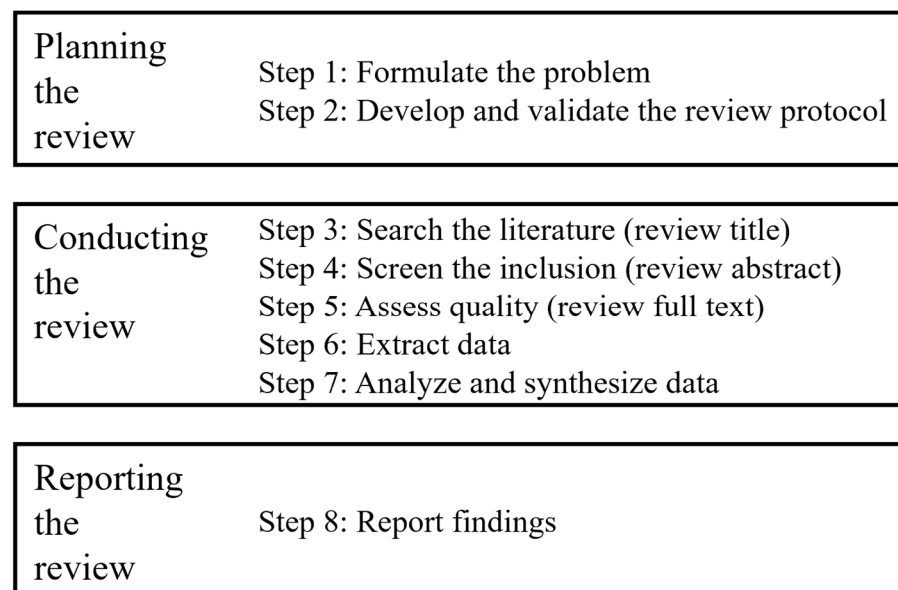


Figure 1. SLR overview.

Five filters were set as part of the SLR (the results of which can be downloaded in an Excel spreadsheet with one tab per filter, see Data Availability Statement):

Filter 1. Keyword search: First, a keyword search was performed in the Scopus database, which proved particularly good in previous work [14]. The defined criteria can be found in Tables A1 and A2 in the Appendix A. The output of 3099 articles was analyzed using R package bibliometrics 4.0.0.

Filter 2. Duplicate removal: Second, the file was cleaned of duplicates, resulting in an output of 2337 articles.

Filter 3. Title fit: Third, titles that did not contain all three DIS-terms were excluded (N = 112).

Filter 4. Ranking fit: Fourth, articles that had not yet appeared in a VHB-JOURQUAL-ranked journal that is at least C-ranked were excluded (N = 43).

Filter 5. Abstract fit: Fifth, papers with author or index keywords mentioning country, industry, or sector studies were **excluded**. All abstracts mentioning contributions to one of the three objectives (definition, operationalization, or positive effects) were included (N = 20). Table A3 aggregates the filter overview.

As shown in Table A4, the final publication list consists of 30% B- and 70% C-ranked publications (in terms of the VHB-JOURQUAL score).

The keyword search (filter 1) was analyzed with a bibliometric analysis using the R package bibliometrix 4.0.0 [15]. Papers resulting from the abstract fit (5 filters) were qualitatively analyzed inductively–deductively [16].

Figure 2 shows the described research design.

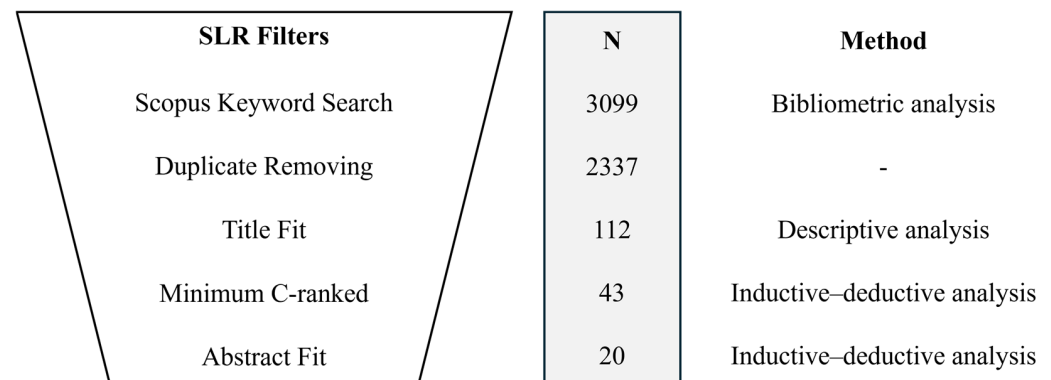


Figure 2. The research design.

Figure 3 shows the final extract of the 20 articles [10–12,17–33] published in journals such as Business Strategy and the Environment, IEEE Transactions on Engineering Management, Industrial Marketing Management, Journal of Business Research, Journal of Cleaner Production, Journal of Engineering and Technology Management-JET-M, Sustainability (Switzerland) and Technological Forecasting and Social Change. Sixty-nine articles [34–101] were excluded by applying filter 4 in the SLR. These articles were published in a scientific journal that does not meet the minimum requirement of a C-publication according to the VHB ranking. Filter 5 in the SLR led to the exclusion of a further 23 articles [102–124], whose abstracts did not contain a reference to all three DIS constructs. Publication 56* was retracted that is why this publication is not mentioned in the reference list but in Figure 3.

Filter 4: Ranking-based exclusion				Filter 5: Abstract Fit	Filter 5: Abstract-based exclusion	
1. 34	18.51	35.67	53.85	1. 10	1. 102	19.120
2. 35	19.52	36.68	54.86	2. 11	2. 103	20.121
3. 36	20.53	37.69	55.87	3. 12	3. 104	21.122
4. 37	21.54	38.70	56.88	4. 17	4. 105	22.123
5. 38	22.55	39.71	57.89	5. 18	5. 106	23.124
6. 39	23.56*	40.72	58.90	6. 19	6. 107	
7. 40	24.56	41.73	59.91	7. 20	7. 108	
8. 41	25.57	42.74	60.92	8. 21	8. 109	
9. 42	26.58	43.75	61.93	9. 22	9. 110	
10. 43	27.59	44.76	62.94	10. 23	10. 111	
11. 44	28.60	45.77	63.95	11. 24	11. 112	
12. 45	29.61	46.78	64.96	12. 25	12. 113	
13. 46	30.62	47.79	65.97	13. 26	13. 114	
14. 47	31.63	48.80	66.98	14. 27	14. 115	
15. 48	32.64	49.81	67.99	15. 28	15. 116	
16. 49	33.65	50.82	68.100	16. 29	16. 117	
17. 50	34.66	51.83	69.101	17. 30	17. 118	
		52.84		18. 31	18. 119	
				19. 32		
				20. 33		

56* had to be removed from the reference list because the paper was retracted: Gao M.; Ma X.; Zhao, X. Entrepreneurship, Digital Capabilities, and Sustainable Business Model Innovation: A Case Study. *Mobile Information Systems* 2022, 2022, 5622423.

Figure 3. An overview of excluded and included papers focusing on filters 3 to 5.

An important piece of preliminary work that led to this paper is mentioned in the Supplementary Materials and can be downloaded from there via a zenodo link.

3. Results

The following four subsections summarize the results of the three objectives of the paper (definition, operationalization, and positive effects) and consider further insights

from the quantitative and qualitative analysis that support an understanding of the DIS concepts. Before exploring the three main objectives—definitions, operationalization, and positive impacts—we present an overview of the selected studies (Figure 3). The center of the figure (the “sweet spot”) shows the 20 papers chosen for the detailed qualitative analysis. The box on the left lists the studies that were excluded due to their ranking, while the box on the right lists those excluded based on the content of their abstracts.

3.1. Goal 1: Definitions

In the following section, the DIS concepts are defined based on the qualitative inductive–deductive analysis of the 20 extracted papers.

The analysis shows that the term “digital”, abbreviated with “D”, is associated with (dynamic) digital (platform) capabilities, digital orientation, digital platform ecosystems, digital technology, digital transformation, and digitalization.

Digital capabilities refer to a firm’s ability to mobilize and deploy digital resources in conjunction with other resources and capabilities [11]. Digital capability ensures the transformation and integration of technological resources and makes full use of these technological resources, including analytical capability, connective capability, and intelligent capability. Digital capability highlights the management efficiency of digital technology and the use of functions. Digital dynamic capability is defined as enterprises’ responsiveness to changes in the market environment through restructuring digital technologies and creating new digital products and production flows, including three capabilities: digital perception, capture, and conversion [17]. The authors emphasize the organizational adaptability achieved using digital technologies in developing new solutions.

Digital technology encompasses artificial intelligence (AI), blockchain, cloud computing, and big data and merges information, computation, communication, and connectivity technologies [17].

Digitalization entails firms using advanced DTs to alter the value proposition, value creation, and value capture components of their business models. DTs include, among others, AI, cloud computing, robotics, smart sensor devices (e.g., Internet of Things (IoT)), big data analytics (BDA), high-speed infrastructure (HSI), and blockchain [10]. Digitalization represents the use of digital technologies to innovate a business model and provide new revenue streams and value-producing opportunities in industrial ecosystems [19].

Digital orientation refers to the premeditated strategic placement of an enterprise to attain the benefits of the promising opportunities provided by digital technologies [20].

Digital platform capabilities consist of the organization’s ability to leverage the latest advanced digital tools and technologies to collect customer information and access user-generated content from digital channels [21].

A digital platform ecosystem is a value network comprising platform owners and consumers who implement governance mechanisms to promote value creation [22].

A digital transformation involves an organizational shift toward big data, business analytics, cloud computing, mobility, and social media platforms [17]. Furthermore, it is the process of upgrading business processes by using digital technologies, e.g., AI, blockchain, the IoT, and cloud computing, to improve customer experiences, simplify operations, and build new business models. A case study on a digital platform for redistributing surplus food highlights key insights for sustainable business model innovation. It shows that the process must consider how business model innovation, the platform’s internal sustainability dimensions, and the opportunities created by digital technologies all influence one another [33].

The analysis shows that “innovation”, abbreviated with “I”, is associated with business model innovation, innovation realization capability, open innovation, and organizational innovation.

Business model innovation is defined as “designed, novel, non-trivial changes to the key elements of a company’s business model and/or the architecture linking these elements” [19,23].

The innovation realization capability refers to an enterprise’s ability to develop existing business opportunities [24].

Open innovation was first introduced by Chesbrough to describe an organization’s distributed innovation process based on purposefully managed knowledge flows across organizational boundaries to accelerate internal innovation on the base of external knowledge or external innovation on the base of internal knowledge [21].

Organizational innovation is the “integration and utilization of new products and services in technology or management, changes in existing production methods, implementation of new technological processes, or implementation of new management systems”. A multi-case study examined four capital goods companies from a business-to-business perspective. The results suggest that digitalization boosts both basic and advanced services, positively affecting the economic and environmental aspects of sustainability. However, its impact on social sustainability remains limited [25].

The analysis shows that “sustainable/sustainability”, abbreviated with “S”, is associated with environmental sustainability, ESG (Environmental, Social, and Governance) management, sustainability, sustainable business models, and sustainable development.

Environmental sustainability implies that human welfare must concurrently preserve the resources necessary for human needs and ensure that the waste generated from human activities does not exceed capacity [18].

ESG management can be understood as a key management strategy in which companies pursue sustainability in the context of the environment, society, and governance [25].

Since the 1980s, from the corporate responsibility perspective, the market focus has been on the triple bottom line concept in the social, environmental, and economic spheres of sustainability [26].

A sustainable business model should not only consider “economic benefits” but also “social and environmental benefits” to achieve organizational sustainability [25]. This corresponds to the demands of the 1980s sustainability movement, whose ideas are reflected in the definition of sustainable development.

Sustainable development refers to meeting various current needs as much as possible without compromising the ability of future generations to meet their own needs. In order to achieve sustainable human development, more and more companies are required to implement sustainable practices and processes [18].

The combination of “D” and “I” leads to the term “digital technology innovation”. Digital technology innovation refers to enterprises, research institutes, and other institutions breaking the boundaries of existing digital technology theories and applications through self-research, collaborative research and development, and creating new production factors and tools [18].

The combination of “D” and “S” leads to the term “digital sustainable entrepreneurship”. The term is defined as the organizational activities that seek the sustainable objective of boosting social and environmental value creation by creatively deploying and utilizing digital technology [17].

The combination of “I” and “S” leads to the terms eco-innovation, green innovation, sustainability-oriented innovation, sustainable business model innovation, sustainable innovation capability, and sustainable innovation.

The combination of “D”, “I”, and “S” leads to the terms “sustainable digital innovation” (SDI) and “digital innovation sustainability”, whereby digital innovation sustainability is not clearly defined [27]. SDI is “a long-term organizational change process to achieve the firm’s

longevity needs and the livelihood of its ecosystem” [28]. SDI helps to implement the newest digital technology for achieving creative solutions that will address the social, economic, and environmental business issues in the long run. It is a dominant combination of digitalized technologies and digitalized management systems for innovating business processes sustainably, and it is also based on the frugal innovation concept [20]. SDI is not just about developing new digital products or new products digitally; it is a self-referential and scalable process of continuous iteration and improvement. Therefore, SDI is not only the result of the convergence of digital technologies or digital platforms with traditional technologies but is also influenced by the digital orientation of companies that have long been committed to digital innovation. SDI reflects the sustainability of firms’ digital innovation. Furthermore, digital innovation incorporates the use of digital technologies, such as 3D printing and cloud computing, to develop new business models or invent new products [29].

The definitions of the constructs underlying the three DIS concepts are very diverse. Most definitions exist for D and I in combination with S. The definitions of digital capabilities [11,17,25], digitalization [10,19], and sustainable digital innovation [20,28,29] differ in terms of content.

The terms used per construct are aggregated in Figure 4.

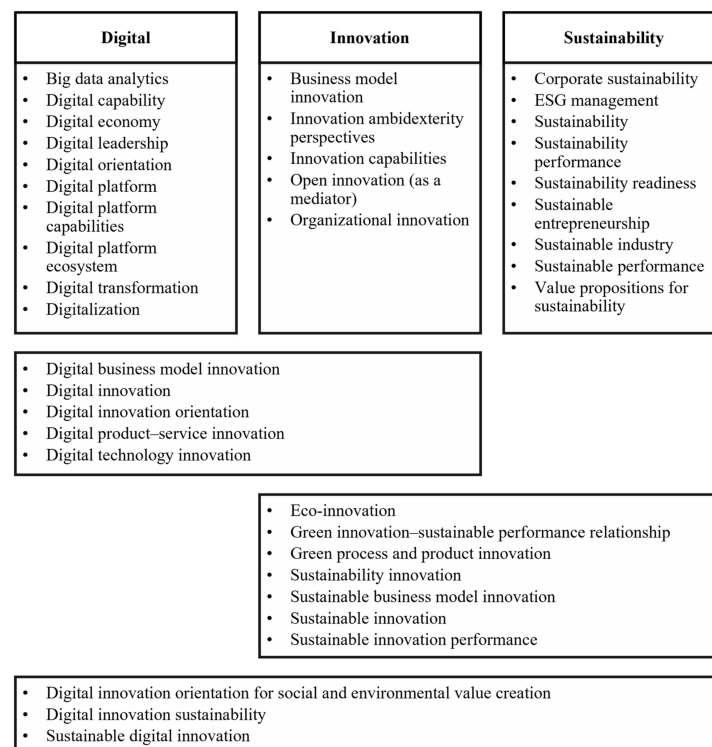


Figure 4. The terms used per construct (an inductive analysis of the titles—final list).

Three levels of definition can be distinguished: the environment, the organization, and the solutions created within the organization. Figure 5 shows a three-level model depicting the DIS terms and their combination pairs categorized by ecosystem, organization, and solution.

Digital	Innovation	Sustainability	
- Digital economy - Infrastructure		Sustainable industry	Ecosystem
- Data (digitization) - Digital technologies (digitalization) - Digital transformation (capabilities, leadership) - System	- Innovation capabilities - Organizational innovation	- Corporate sustainability - ESG management - Sustainability performance - Sustainability readiness - Sustainable entrepreneurship - Sustainable performance	Organisation
Digital innovation orientation			
	- Green innovation–sustainable performance relationship - Sustainable innovation performance		
- Digital innovation orientation for social and environmental value creation - Digital innovation sustainability			
Digital platform	- Business model innovation - Open innovation - Process innovation - Product innovation - Service innovation	Value propositions for sustainability	Solution
- Digital business model innovation - Digital innovation - Digital product–service innovation - Digital technology innovation			
	- Eco-innovation - Green process and product innovations - Sustainability innovation - Sustainable business model innovation - Sustainable innovation		
Sustainable digital innovation			

Figure 5. DIS three-level model (deductive–inductive analysis).

3.2. Goal 2: Operationalization

The qualitative in-depth analysis of the 20 papers shows that not all definitions were operationalized, and not all operationalized constructs were defined. All existing operationalizations that refer to one or more DIS terms are listed below.

In relation to the concept of D, the following operationalization can be aggregated:

1. **BDA:** enhanced decision making, the integration of different data sources, data visualization for user assistance, decomposed information for cause analysis, decreased waste, faster adaptation, longer life cycles due to analysis, optimized resource usage, utilized assets, increased recycling options, better resources usage, faster response, change in energy supply, adherence to timelines, and regular goal adjustments [30].
2. **Digital capabilities:** external stakeholder management, market responsiveness, portfolio management, technical skills, and cost efficiency [11].
3. **Digital capability:** digital technology acquisition, digital interactions, management of digital technologies, digital opportunity identification, tech trend search, scouting and scenario building, digital thinking, quick resource reallocation, change, new ecosystem generation, and leverage of digital knowledge [17].
4. **Digital dynamic capability:** digital sense, digital capture, and digital transformation [17].
5. **Digital leadership:** technical capabilities, digital governance abilities, digitalization as a competitive factor, and accurate evaluation of digital capabilities and technologies [25].
6. **Digital platform capability:** integration capability (easy data access and seamless partner connection), real-time information exchange, and information aggregation [21].

7. **Digital technology capability:** analytics, visualization, acquisition, connection, governance, and adoption [17].
8. **Digital transformation:** product digital transformation, service digital transformation, process digital transformation, model digital transformation, organizational digital transformation [24] or digital capability, and digital strategy [17].
9. **Digitalization:** AI, cloud, Robots, SmartDev (Smart devices), BDA, HSI, and blockchain [10].
10. **Firm degree of digitalization:** adoption of a given DT among those mentioned in the data description (AI, cloud, Robots, SmartDev, BDA, HSI, and blockchain) [10].

In relation to the concept of I, the following operationalization can be aggregated:

11. **Business model innovation:** from the perspective of its sub-components: value creation (new customer-oriented offers, optimized portfolio, agile service innovation process, digital application combination, and customer data leverage), value delivery (new capabilities, revised processes and roles and responsibilities, cultural change, and new infrastructure), and value capture (cost efficiency, revenue, and risk management) [34].
12. **Business model innovation:** evolution of the customer segments, customer relationships, and economic model; extension of platform scope [23].
13. **Open innovation:** inbound open innovation: knowledge or tech acquisition; external idea scouting; reaching out to external knowledge or tech; innovation ties with external parties; and outbound open innovation—info and knowledge flow to the outside, knowledge and tech sales, intellectual asset commercialization, IP purchases, and rare co-working with externals [21].
14. **Organizational innovation:** new ways of working; implementation of new organizational structures; innovative operations; new technology, products, and services; and entering new markets [25].

In relation to the concept of S, the following operationalizations can be aggregated:

15. **Corporate sustainability practices:** sum of eight unknown binary variables [10].
16. **Economic performance:** decrease in material cost, energy consumption, and waste and increase in ROI and earnings per share [33].
17. **Economic performance:** better fulfillment of customer needs, stronger customer relationships, differentiation and lockout of competitors, increased revenue, identification of new markets and better response, agility, access to service data, reduced customer risk, improved technology, and reduced life cycle costs [26].
18. **Environmental performance:** reduced air emissions, waste, and gasoline/fuel; green organization partnerships; better environmental compliance; and use of environmentally friendly material [30].
19. **Environmental performance:** reduced air emissions, waste, consumption, environmental accidents, and energy [33].
20. **Environmental performance:** resource efficiency, longer product life, increased product usage, reuse and recycling, dematerialization, and liberty for sustainable design [26].
21. **ESG management:** eco-friendly ecosystems are valued, win–win supply chain, pursuance of sound governance, ethical management, and importance placed on workers' welfare [25].
22. **Managers' cognition of sustainable opportunities:** seeing the natural and social environment as controllable positive opportunities that should be promoted [17].
23. **Organizational performance:** market position improvement; enhanced sale volume, profit rate, and reputation [30].

24. **Organizational sustainability:** sales growth rate, welfare and safety improvement for employees, strong community and stakeholder relationships, reduced carbon footprint and waste emissions, and increased renewable energy and recycled materials compared to the industrial average [25].
25. **Social performance:** improved community and employee health and safety and reduced environmental impacts and general risks [33].
26. **Social performance:** increased employment; local supplier development; increased demand, health and security, and open innovation [26].
27. **Sustainability benefits:** economic and social benefits, process efficiency, safety, regional development, radical innovations, and adaptations to policies [19].
28. **Sustainability dimensions:** translating sustainability dimensions into credits and finding a business model that is sustainable and financially robust [23].
29. **Sustainability performance:** cost optimization, net returns, waste minimization, environmental compliance, carbon footprint, boosted income, work safety, job environment, organizational commitment, and communal contributions [11].
30. **Sustainability performance:** economic performance, environmental performance, and social aspects [12].
31. **Sustainable business model:** value proposition, value creation, value network, finance model, and customer interface [22].
32. **Sustainable performance:** organizational and environmental performance [30].
33. **Sustainable performance:** the measurement of sustainable performance is derived from work by Paulraj (2011). It consists of five items of both environmental and economic performance and three items of social performance, reflecting the development level of companies in terms of sustainability [33].
34. **Sustainable technology capabilities:** a logarithm of the number of green patents in the International Green List owned by the enterprise [18].

Highly relevant operationalizations of DIS combinations include the following:

35. **Digital business model innovation:** digital value creation innovation, digital value proposition innovation, and digital value capture innovation [31].
36. **Digital innovation orientation:** digital technology usage for corporate efficiency, cost reduction, information misalignment reduction, new offerings, new working, better structures, better business models, and new stakeholder connections [22].
37. **Digital innovation technology:** a logarithm of the number of core digital technology patents owned by the enterprise in the Industry 4.0 field [18].
38. **Digital sustainable entrepreneurship:** efforts to improve social and environmental value creation, such as businesses, a competition approach, digital transformation programs, digital technology usage for better profitability, improved customer loyalty, and resource protection [17].
39. **Eco-management innovation:** novel systems, parts of policies, engagement and investment in eco-innovation, and adaptation to outward environmental pressure [33].
40. **Eco-process innovation:** manufacturing process updates, new technology, or new processes to protect the environment or save energy [33].
41. **Eco-product innovation:** simplifying packaging, construction, waste, or damage reduction [33].
42. **Green process innovation:** emission and waste reduction; waste recycling; emission reusage; a reduction in water, electricity, coal, and oil consumption; and a reduction in raw materials [30].
43. **Green product innovation:** emission and waste reduction; waste recycling; emission reusage; a reduction in water, electricity, coal, and oil consumption; and a reduction in raw materials [30].

44. **Sustainability exploitation innovation:** reactivity to stakeholders, external analysis, stakeholder participation, process variability, and goal-driven [11].
45. **Sustainability exploration innovation:** product design refinement, re-engineering, technology and process adoption, knowledge and skill enhancement, learning culture, and external search [11].
46. **Sustainability-oriented innovation:** the use of low-impact materials, improved end-of-life phase of products (e.g., improved recyclability), efficient resource/material deployment, reduced resource consumption, reduced environmental pollution and waste, decreased transportation and logistics, improved health and safety of employees, and an improved social and ethical situation [21].
47. **Sustainable business model innovation:** business model innovation, leverage of opportunities offered by digital technologies, and the evolution of endogenous sustainability dimensions [23].
48. **Sustainable digital innovation:** quality–price ratio of digital solutions is improved compared to competitors, features of digital solutions are improved compared to competitors, applications of digital solutions are improved compared to competitors, digital solutions are different from competitors, new digital solutions are minor improvements, digital solutions are new to the market (when launching), digital innovations/solutions are based on cutting costs and reducing waste (when launching), and digital solutions rely on frugal innovation (when launching) [20].
49. **Sustainable digital innovation:** features and applications of digital solutions are different from competitors; compared with competitors, digital solutions and the iteration have a lower cost; compared with competitors, digital solutions create new value for incumbent businesses; and compared with competitors, digital solutions can generate a larger portfolio [29].
50. **Sustainable innovation capability:** opportunity identification capability, innovation realization capability, and commercialization capability [24].
51. **Sustainable innovation:** social environmental innovation + social innovation + environmental innovation [12].

The operationalizations of digitalization, innovation, and sustainability reveal overlaps and contradictions in their definitions. Overlaps occur where concepts share common principles:

1. **Digitalization:** Many definitions emphasize integrating and managing digital technologies, focusing on resource optimization, digital interaction, and governance. Digital transformation stands out by encompassing broader organizational changes across processes, products, and models.
2. **Innovation:** Business models and open innovation emphasize value creation through new processes and stakeholder interactions, prioritizing agility, customer focus, and external knowledge. Sustainability-oriented innovation aligns with eco-innovation in reducing environmental impact and improving resource efficiency.
3. **Sustainability:** Environmental and economic performance definitions converge on efficiency, waste reduction, and profitability. The dimensions of sustainability (economic, environmental, and social) connect concepts like ESG management and organizational performance.

Contradictions arise from differences in scope or focus:

1. **Digitalization:** Digital dynamic capability's narrow focus on sensing, capturing, and transforming contrasts with broader definitions like digital leadership, which includes governance and strategy.

2. **Innovation:** Business model innovation prioritizes customer-focused value creation, while organizational innovation emphasizes structural and operational changes, sometimes misaligned with customer benefits.
3. **Sustainability:** Stakeholder-driven sustainability exploitation contrasts with the long-term, exploratory approach of sustainability exploration. Social performance definitions vary, ranging from local supplier development to employee safety.

It is noticeable that the operationalization of the constructs in all three DIS concepts takes place at the organizational and solution level. In addition, the operationalization of the same terms differ significantly in various publications, e.g., economic, environmental, and social performance [26,33] or business model innovation [19,23] or sustainable digital innovation [20,29].

3.3. Goal 3: Positive Effects

The direct positive effects between the DIS constructs are aggregated in Figure 6 on the following page.

Notably, most positive relationships emanate from the construct ‘digital’. Digitalization has a positive impact on organizational innovation and sustainability as well as on solutions such as sustainable innovation, SDI, and digital business model innovation. Digital constructs are influential because they serve as foundational enablers of organizational innovation and sustainability:

1. **Building Digital Capabilities:** Organizations develop skills and tools like data analysis and automation that make them more efficient and effective. These capabilities improve decision making and help organizations adapt to challenges quickly,
2. **Driving Sustainable (Digital) Innovation:** Digital tools enable organizations to create new products, services, and business models that are not only profitable but also environmentally friendly. This includes innovations like renewable energy, recycling, and eco-friendly processes.
3. **Enhancing Sustainability Performance:** Through digitalization, organizations can track and improve their environmental, social, and governance (ESG) metrics, making them more transparent and accountable.

Digitalization significantly impacts how organizations innovate, operate, and achieve sustainability. An organization’s ability to innovate and the associated creation of digital and sustainable innovation or sustainable digital innovation positively impacts sustainable performance and competitive advantage. The mediated positive DIS effects within organizations are visualized in Figure 7.

If an organization successfully combines digitalization with sustainability practices, sustainable innovations can emerge. Advancing digitalization and developing business model innovations can also lead to greater sustainability. Overall, it is noticeable that combining all three DIS concepts into one solution is rarely considered. Moreover, at an organizational level, all three dynamics—digitalization, organizational sustainability, and organizational innovation capability—are needed, as they are mutually dependent. Management practices and leadership models have a positive effect here, as does a holistic focus on capability development. Sustainable innovations are most frequently discussed as solutions for achieving sustainable performance. In this context, big data analytics [30], data [10], digital capabilities and digital flexibility [11], digital leadership [25], digital orientation [12,20,27], digital platforms [27], digital transformation [17,24,31], innovation (i.e., [10–12]), and ESG management [25] act as drivers.

Direct positive DIS effects within an organization

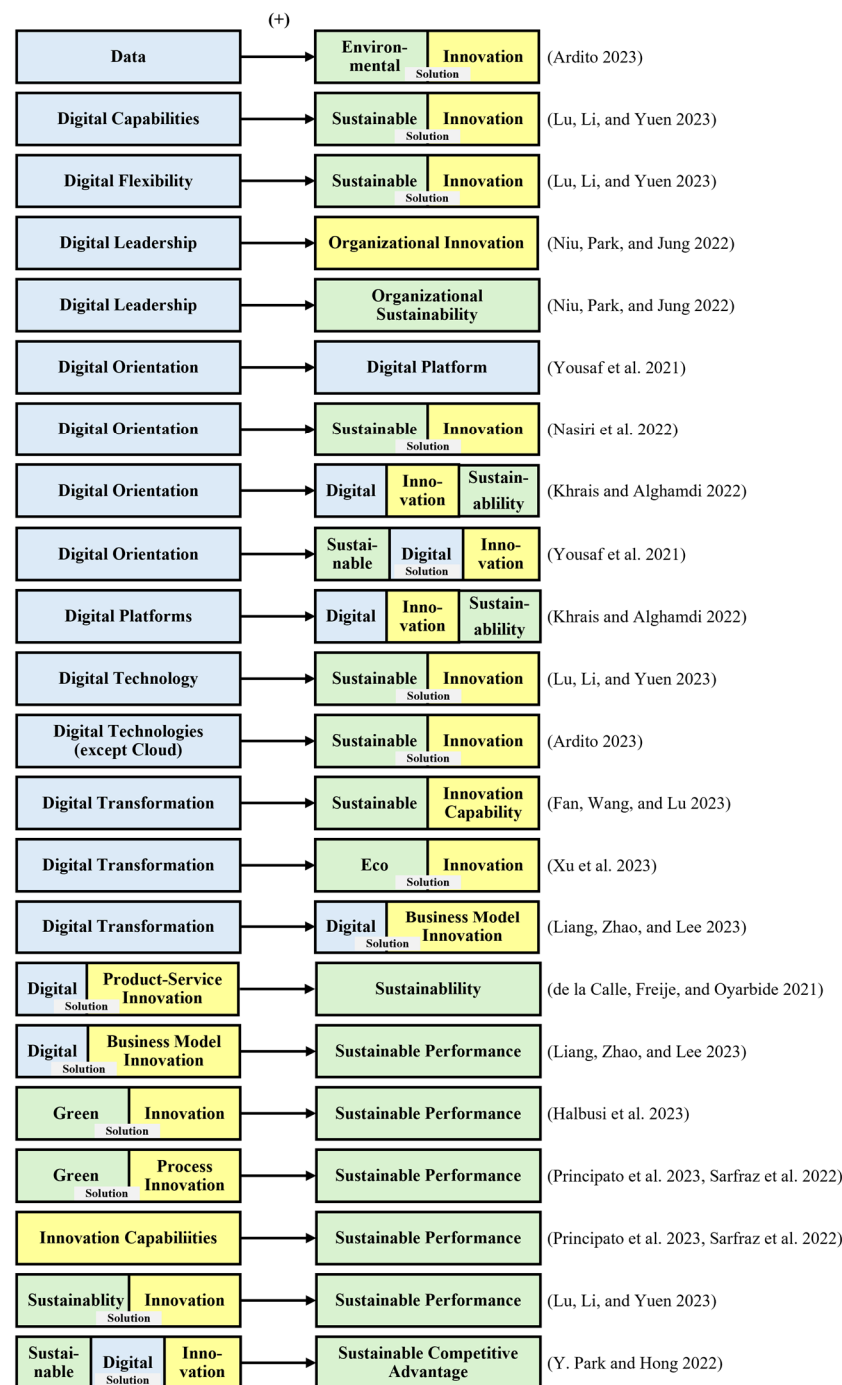


Figure 6. Direct positive DIS effects within an organization [10–12,20,23–28,30,31,33].

Data collection in different countries, such as South Korea and China, may lead to other results [25]. Innovation Capabilities of an organization driving green product and process innovation increase sustainable performance [32].

Mediated positive DIS effects within an organization

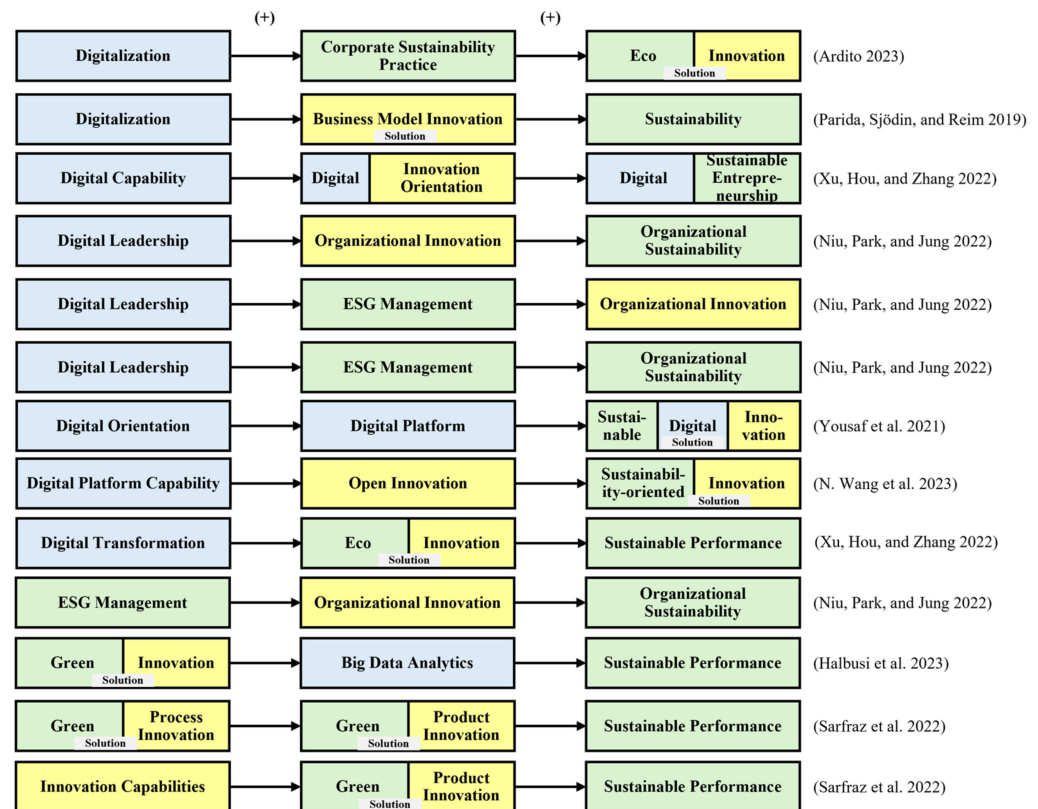


Figure 7. Mediated positive DIS effects within an organization [10,17,19–21,25,30,32,33].

3.4. Other Broader Insights

A quantitative bibliometric analysis of the CSV files containing 3099 publications with the R package bibliometrix [15] led to the following insights:

After 2022, “sustainable development” was the most frequently mentioned term, appearing 400 times, followed by “innovation” and “sustainability,” each with 300 mentions. Figure 8 illustrates these insights.

Term frequency	2014	2016	2018	2020	2022	...
China					200	
Economic development					100	
Carbon					100	
Sustainable development					400	
Innovation					300	
Sustainability					300	
Industry 4.0					100	
Industrial revolutions					<100	
Cloud computing					<100	

Figure 8. Bibliometrix: trend topics’ term frequency.

Figure 9 illustrates the growing prominence of the terms “innovation,” “sustainability,” and “digitalization”. Additionally, “artificial intelligence” and “ecological sustainability” are highlighted as key driving topics.

Figure 10 shows the most relevant sources regarding the three DIS concepts of “Sustainable OR Sustainability AND Digital AND Innovation”. The journal *Sustainability* hosts the highest number of relevant publications regarding DIS.

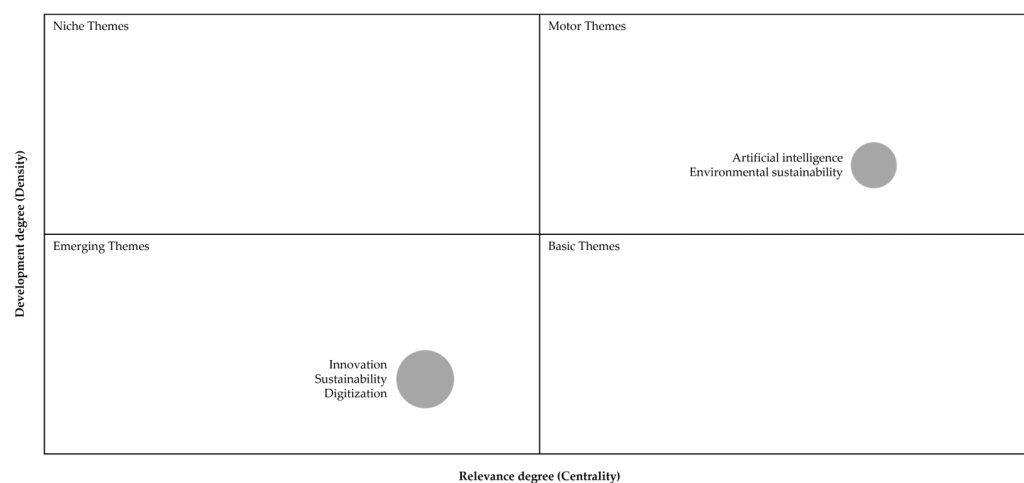


Figure 9. Bibliometrix thematic map: degree of relevance and development.

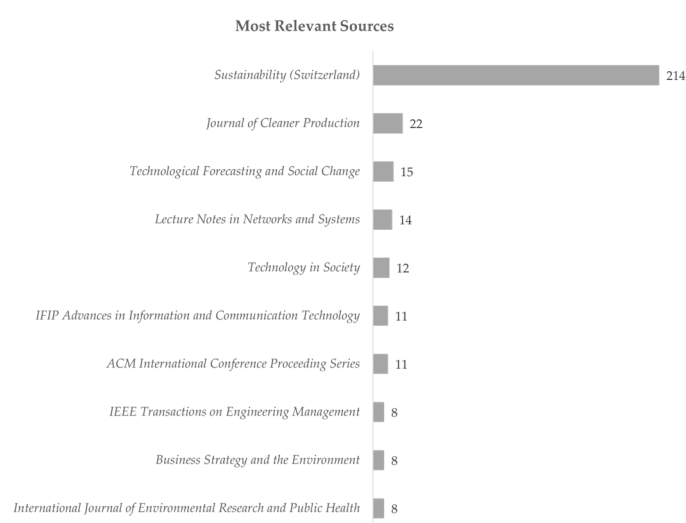


Figure 10. Bibliometrix output: the most relevant sources.

An increase in annual scientific production has been recorded since 2019. This is shown in Figure 11.

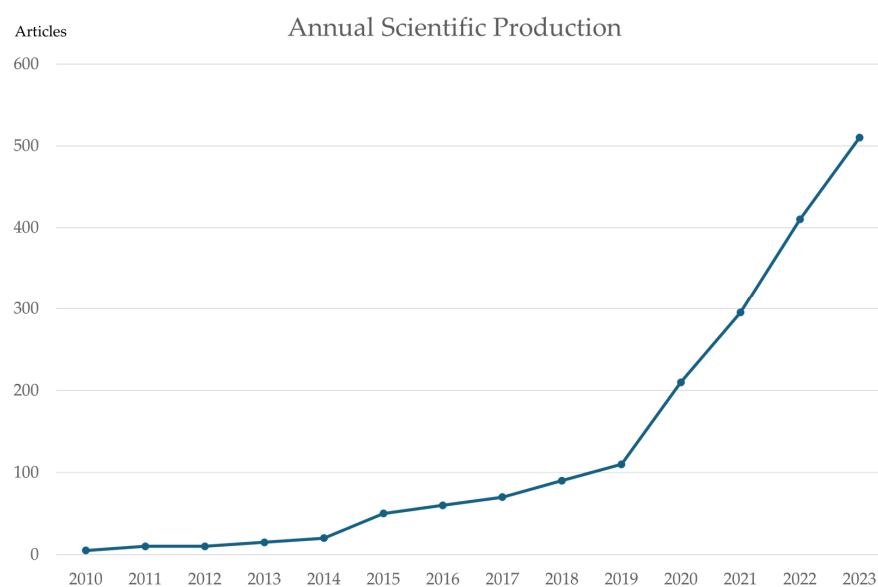


Figure 11. Bibliometrix: source production over time.

4. Discussion

This article adds threefold value to science and practice. It shows the variety of definitions of DIS concepts used in scientific studies in organizations. It also highlights differences in operationalization and presents findings on the positive effects of the active management of the three DIS concepts.

4.1. Implications for Theory

It is important for the research community to understand just how closely digitalization, innovation, and sustainability (DIS) are linked and how strongly they can influence how organizations perform [11,23,30,32]. To truly appreciate their impact, we need to consider these concepts (see Figure 5), since their combined effects are both wide-ranging and undeniable (see Figures 6 and 7). Comparing scientific studies in this field can be challenging because researchers may define and measure these ideas differently or examine different kinds of organizations. As noted by [25], studying the same concepts in different countries can produce varied results. This indicates the need for a careful, well-rounded approach when comparing research findings.

Additionally, some studies [27,28,31,32] do not clearly define or measure the concepts they investigate, causing confusion and inconsistent results. To avoid these issues, researchers need to establish clear, standardized definitions and methods for studying DIS concepts. This would improve the quality of their findings and make it easier to compare results across different studies.

Additionally, not clearly separating the study of DIS concepts at the organizational level from those at the solution level can slow progress in understanding these ideas. Researchers should examine these concepts more precisely at each level to gain a fuller picture of their effects. By doing so, the scientific community can move toward a more solid and consistent approach to studying DIS concepts, guiding future research in this field.

So far, only a small number of studies have examined how sustainable digital innovation (SDI) develops [20,29]. This is unfortunate and needs to change, since developing SDI can give companies a lasting competitive edge [28] and can be encouraged through digitalization [20].

4.2. Implications for Management

Before moving on to practical studies, it is important to understand why exploring the three-stage DIS model is so valuable. As shown in Figure 5, this model offers valuable insights that can greatly improve how managers and leaders think about and guide their organizations.

While it is valuable to consider potential positive effects, it is also wise to proceed with caution. Testing these effects one by one and keeping in mind that the results may vary from one country to another helps avoid quickly jumping to conclusions. Still, there are useful recommendations to guide sustainable organizational growth. These include using big data analytics [30], leveraging data [10], building digital capabilities and flexibility [11], strengthening digital leadership [25], fostering digital orientation [12,20,27], using digital platforms [27], pursuing digital transformation [24,31,33], encouraging innovation (i.e., [10–12]), and practicing ESG management [25].

Taking a broad, integrated view of digitalization, innovation, and sustainability (DIS) and actively managing the organization, its future solutions, and its entire ecosystem is a forward-looking strategy. In this context, digitalization is a powerful force that drives innovation, helping organizations become both sustainable and innovative [24,25,27].

Further study is needed to better understand how sustainable digital innovation (SDI) can be developed and how digitalization, innovation, and sustainability (DIS) concepts

work together. At the same time, organizations should look for practical ways to apply these insights, turning theory into real-world action.

This study shows that bringing together digitalization, innovation, and sustainability (DIS) positively affects organizations. By reviewing existing definitions and using a model that looks at environmental, organizational, and solution levels, it becomes clear that digital transformation plays a key role in driving innovation and sustainability in today's organizations.

4.3. Implications for Organizations

It is recommended that organizations use the three-stage DIS model (see Figure 5) as a strategic tool to analyze and improve their management and leadership practices.

While the potential benefits of combining digitalization, innovation, and sustainability are promising, organizations should carefully assess these advantages individually. Different national markets may produce varying results, so a cautious, case-by-case approach can help avoid broad generalizations and ensure that strategies suit each unique setting well.

Key steps include the following:

1. Applying advanced analytics to gain insights and improve decision making;
2. Encouraging leadership that values adaptability and innovation;
3. Integrating environmental, social, and governance (ESG) principles to achieve sustainability and a competitive edge;
4. Developing a clear roadmap that applies DIS concepts to ensure continuous improvement;
5. Strengthening an organization's capacity for sustainable innovation by tailoring approaches at the environmental, organizational, and solution levels.

By following these recommendations, organizations can more effectively harness the power of digitalization, innovation, and sustainability to thrive in a constantly changing world.

5. Conclusions

This study offers a unique contribution to organizational sustainability research by not only examining multiple definitions of sustainability, innovation, and digitalization (DIS) but also integrating them into a cohesive framework that reveals their combined positive effects on organizational performance. Previous research has often treated these concepts separately, resulting in fragmented insights that make it difficult to fully understand their interconnections. In contrast, this study's holistic perspective closes a crucial gap, demonstrating that the relationship among DIS elements is both significant and multifaceted.

By emphasizing the need for standardized terminology and clear distinctions between organizational- and solution-level analysis, this study addresses longstanding challenges in comparing findings across diverse contexts. Moreover, it identifies sustainable digital innovation (SDI) as a fertile area for further exploration, highlighting its potential to deliver lasting competitive advantages through digitalization—an angle that has not been sufficiently explored.

For practitioners, introducing the three-stage DIS model is a distinct advancement. This strategic tool can guide management and leadership toward more nuanced decision making; better alignment with environmental, social, and governance (ESG) criteria; and a more informed adaptation of digital capabilities and data analytics. In doing so, it moves beyond general recommendations, providing a clear, actionable roadmap for continuous improvement. Ultimately, this study's comprehensive, integrative approach not only enriches the theoretical landscape but also empowers organizations to more effectively leverage DIS concepts for long-term, sustainable success.

6. Limitations

This SLR has uncovered critical findings within the specified topic area. However, it is important to reiterate that due to the selective nature of the review process, not all relevant publications may have been included. The constructs and their positive organizational effects identified in this review are preliminary and should be cautiously approached. They serve as a foundation for further debate and must be rigorously tested in future studies. Despite strict criteria, the selection of papers and the review of titles and abstracts may introduce bias.

Bibliometric analyses often concentrate on quantitative data, such as the number of publications and citation frequency, without considering the qualitative aspects of research. This approach can lead to a skewed assessment, as the number of publications does not necessarily indicate the quality of the study [125]. It is crucial to recognize that the importance of publications varies significantly between disciplines. For instance, in computer science, conference papers often carry more weight than journal articles, a distinction that sets it apart from other fields. These variations can pose challenges to the comparability and power of bibliometric analyses [15,16].

This study shows that combining digitalization, innovation, and sustainability can have a positive effect on organizations, and the large number of articles analyzed supports this idea. However, future research should also investigate other factors that may hinder organizational growth and are not just due to the poor integration of these three elements.

Another important point is that the impact of combining these elements can differ widely depending on the country or industry. This means that our findings may not apply everywhere. Further studies are needed to understand how these effects vary across different regions and sectors.

7. Future Directions

In the long term, it is prudent to determine organizations' DIS maturity using a holistic, multidimensional approach. This approach can then be used to develop strategies to support their country-specific orientation. Evaluating several organizations in one country could provide vital information for further action. Given the increasing need for organizations to adopt a more sustainable orientation, it is crucial to train managers and executives. Furthermore, promoting organizational sustainability and innovation capability through digitalization, a key enabler in the current business landscape, is essential. Overall, further research on SDI and a holistic organizational approach that combines all DIS concepts, strategically reflects them, and manages them through active leadership is recommended.

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Appendix A

Table A1. The Scopus database search of “Sustainability AND Digital AND Innovation”.

Field	Selection
Date	6 November 2023
Search within	Article Title, Abstract, Keywords
Search documents	Sustainability AND Digital AND Innovation
Year	2010–2023
Language	English, German
Document Type	Journal, Review
Source Type	Journal
Keywords	Business Development, Business Model Innovation, Business Model, Business, Business Models, Case-studies, Digital Devices, Digital Innovation, Digital Innovations, Digital Platforms, Digital Technologies, Digital Technology, Digital Transformation, Digital, Digitalisation, Digitalization, Digitization, ICT, Information and Communication Technologies, Information and Communication Technology, Information Management, Information Systems, Information Technology, Literature Reviews, Management, Open Innovation, Review, Social Innovation, Strategic Approach, Sustainability, Innovation, Sustainable Development Goal, Sustainable Development Goals, Sustainable Innovation, Systematic Literature Review, Systematic Review, Technological Innovation, Technology
N	1190

Table A2. The Scopus database search of “Sustainable AND Digital AND Innovation”.

Field	Selection
Date	6 November 2023
Search within	Article Title, Abstract, Keywords
Search documents	Sustainable AND Digital AND Innovation
Year	2010–2023
Language	English, German
Document Type	Journal, Review
Source Type	Journal
Keywords	Article, Business Development, Business Model Innovation, Business Model, Business Models, Business, Digital Devices, Digital Innovation, Digital Innovations, Digital Platforms, Digital Technologies, Digital Technology, Digital Transformation, Digitalisation, Digitalization, Digitization, Green Innovation, Green Innovations, ICT, Information and Communication Technologies, Information and Communication Technology, Information Management, Information Systems, Information Technology, Innovation, Leadership, Literature Review, Management, Open Innovation, Research And Development, Review, Sustainability, Sustainable Business, Sustainable Development Goal, Sustainable Development Goals, Sustainable Innovation, Technological Innovation, Technology Innovation, Technology
N	1909

Table A3. SLR filter overview.

No.	Filter	Description	Number of Publications	Number of Exclusions
1	Keyword search	Sustainability OR Sustainable AND Digital AND Innovation	3099	
2	Duplicate removal	elimination of duplicates	2337	−762
3	Title fit	elimination of titles without all three DIS constructs	112	−2225
4	Ranking fit	elimination of journals ranked below VHB-JOURQUAL-C	43	−69
5	Abstract fit	elimination of papers not focusing on one of the three paper goals, with a macro or an industry focus	20	−23

Table A4. The VHB-JOURQUAL ranking coverage—final list.

VHB-JOURQUAL Ranking ¹	Number of Publications	Percentage of Coverage
B	6	30%
C	14	70%

¹ B = important and respected scientific journal in the field of business administration or its sub-disciplines;
C = recognized academic journal in the field of business administration or its sub-disciplines.

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