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Digitalization, knowledge sharing and higher education for sustainable development

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Abstract:

This academic paper focuses on digitalization and higher education for sustainable development (HESD). A systemic review of 67 articles published in *Web of Science* (WOS) in the past decade was undertaken. The articles were chosen because of their relevance to this era of digitalization and the role of higher education in promoting knowledge sharing with respect to sustainable development. The analysis used six categories: journals, publication year, research design, industry sectors, topics, and opportunities and challenges. However, there is lack in exploring the recent trends, possible application industries and the essence of HESD in the context of digitalization and knowledge sharing in different regions of the world. The main aim of this article is to report on a meta-analysis consisting of a systematic review of the available literature related to digitalization and knowledge sharing. The study revealed that current research on sustainable development lack mathematical models and empirical tools.

Keywords: Digital age; Digital higher education; Higher education for sustainable development; Knowledge sharing; Sustainable practices,

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1. Introduction

Education for sustainable development is essential. It is one of the Sustainable Development Goals (SDGs) proposed by the United Nations Economic and Social Development Organisation (UNESCO), and adopted by institutions worldwide (Chankseliani & McCowan, 2021). The topic 'Higher Education for Sustainable Development' (HESD) has been widely discussed (García-Peñalvo, 2021).

Digitalization, on the other hand, has been quietly changing the way humans live. For example, almost all fields of knowledge are benefiting from digitalization (Arnold et al., 2021). It provides a more efficient way for knowledge sharing (Chen et al., 2022). It is in this 21st century that institutions of higher education worldwide have gradually become an important platform for promoting sustainable development (Elmassah et al., 2021). Digitalization has transformed the way instructors have developed courses and institutions have disseminated research findings (Bygstad et al., 2022).

Digital networks such as 5G are gradually rolling out around the world. The industrial sector has already changed production and marketing strategies, for example (Tsaramirsis et al., 2022). These developments have been made possible to a considerable degree through the work of universities and technical training colleges in advancing UNESCO's Sustainable Development Goals (Chankseliani & McCowan, 2021).

Higher education has been the main stage for the generation, development, and promotion of knowledge (Elmassah et al., 2021). In recent years, Asian countries, such as China, India, Thailand, Vietnam, as well as African countries, such as Nigeria and Kenya, have been successful in applying digitalization and in using higher education for sustainable development (Soltani et al., 2019; Hallinger & Chatpinyakoo, 2019).

The digitalization has been a powerful instrument for the sharing of knowledge (Gregson et al., 2015). In a world of higher technology, and the invention of the Internet, has made possible the sharing of knowledge generated by multitasking experts in institutions of higher education to new generations of learners (Frolova et al., 2020). 'Sharing knowledge is power' became a unique proposition according to Funk (2021).

Lindell (2018) believes that digital technology is changing how learners appreciate and interpret new knowledge and the motivation of academicians to share their findings (Kraus et al., 2021). Even the way people work as is evidenced in the construction industry (Blindheim & Karlsen, 2018), and in the information technology field (Lindell, 2018). This is possible because digitalization can increase information flow which, in turn, can improve coordination between independent units and individuals.

In higher education institutions, digitization has had a significant effect. Several initiatives have been launched worldwide to promote its further development (Lo, 2019). Digital platforms present new structures for better knowledge sharing and continuous innovation (Arfi et al., 2020).

Higher education for sustainable development (HESD) has become one of the crucial instruments for global sustainability (Xiong & Mok, 2020). Thus, raising sustainability awareness among higher education stakeholders is being advocated as a shortcut to achieving awareness of the

importance of working toward sustainable development globally, and also a way to increase employee awareness, too. (Lo, 2019).

However, research links between knowledge sharing and sustainable practices are still sparse. There remains, though, a strong belief that knowledge sharing in higher education can have a positive effect on achieving the SDGs (Lindell, 2018). Digitalization and knowledge sharing have been familiar concepts for nearly a decade. They provide a reference and tool for sustainable development in various fields.

In higher education, there has been very little research on sustainable practices, digitalization and knowledge sharing. This present academic research project, using a systematic meta-analysis approach, aimed to uncover research which focuses on trends in digitalization, knowledge sharing and the importance of promoting strategies for achieving greater levels of sustainable development. In summary, the research on Higher Education for Sustainability (HESD) in the context of digitalization and research on knowledge sharing appear to be relatively mature. However, one essential element remains obscure: how can institutions of higher education, in this era of digitalization, use its knowledge advantages to better engage their alumni in sustainable practice activities? There are only a few studies on this question. This present study attempts to identify gaps and trending in this and in other areas.

This present report will be guided by three questions: (1) What is the significance of studying digitization, knowledge sharing, and HESD? (2) What is the current research status of these topics? Which countries, authors, and sectors are the focus, and what research methods are being employed? And, what, exactly, have these studies contributed? Finally, (3) what, if any, are the gaps in the studies of digitalization, knowledge sharing?

2. Method

This present research used a meta-analysis analysis technique (Brüggemann et al., (2022)). The Web of Science (WOS), one of the world's most important data repository, was the primary data source.

Using an advanced search function and the topic (TP) 'higher education for sustainable development' yielded 5089 items. The earliest literature appears to date back to 1990, in which the significance of higher education for sustainable agricultural development was explored (Harmsen, 1990). The present research focused on literature over a five-year period (*TP=higher education for sustainable development & Year=recent five years*). After an analysis using 'data type', there remained 2749 relevant articles. Some 2673 were labelled 'literature'. 'English language' was used as a filter.

The next search added 'digitalization' and 'knowledge sharing', using the search formula *(((ALL=(sustainable development)) AND TS=(higher education)) AND TS=(Digitalization)) AND LA=(English)) AND DT=(Article OR Review)*. This yielded only 9 results meaning that there were 9 Articles in English related to digitalization and HESD in the last five years.

Next, using *((((ALL=(sustainable development)) AND TS=(higher education)) AND TS=(Knowledge Sharing)) AND LA=(English)) AND DT=(Article OR Review))* yielded 52 English articles

However, the next search using "digitalization" and "Knowledge Sharing" and "sustainable practices" and "higher education" yielded zero (0) results. The search criteria was then lowered by

deleting "higher education": (((TS=(sustainable practices)) AND TS=(Knowledge Sharing)) and LA=(English). This yielded 6 articles which were related to digitalization, knowledge sharing, and sustainable practices, but not related specifically to higher education.

Finally, after removing duplicates, there remained 67 articles for meta-analysis, including publication year, name of the journal, study design, and sector. Figure 1 explains the article selection process resulting in the identification of 67 articles over the recent five-year period.

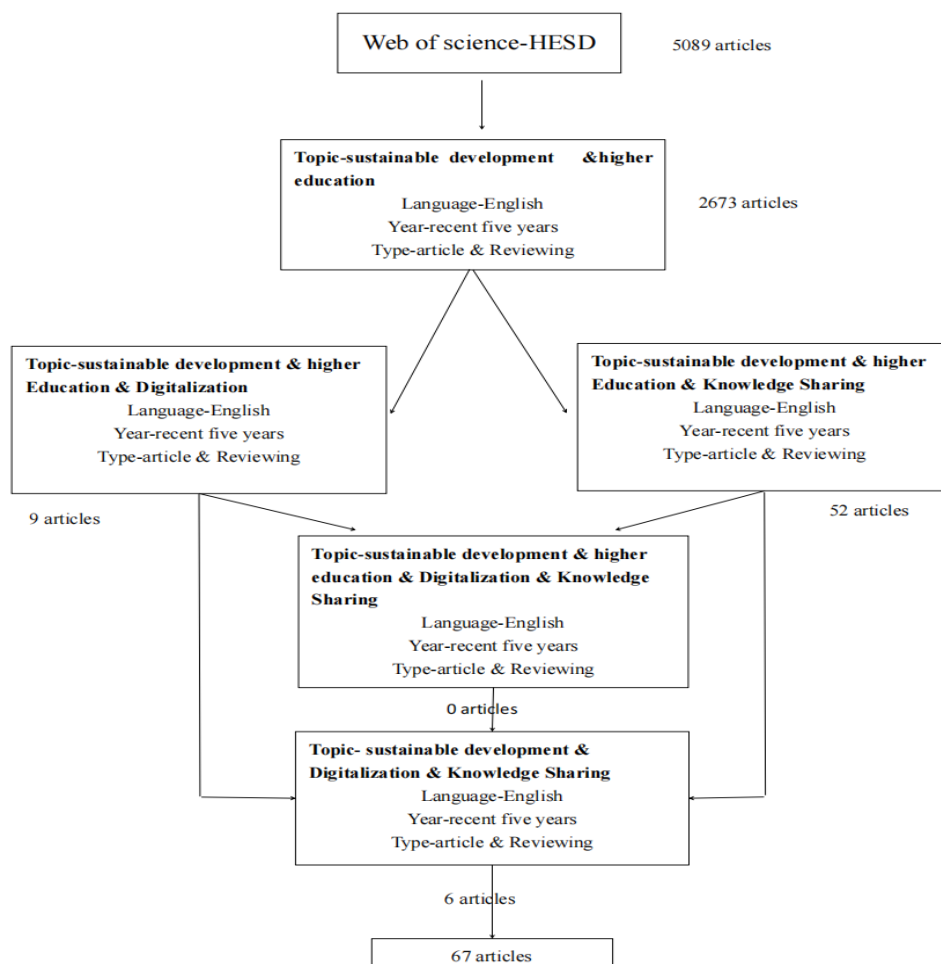


Figure 1. Research Methodology

3. Findings and Discussion

3.1 Article classification based on publication year

In the early 2016s, the awareness of “knowledge sharing & sustainable development & higher education” was found to be rare. It was around 2016, when many researchers began to focus on higher education with respect to sustainable futures and expanded the use of digitalization in research.

The number of articles gradually increased – topics such as the curriculum for teaching about sustainable development goals, and cooperation among educators throughout the world (Caniglia et al., 2018), educational technology (Lebid, Krasulia, Sushkova, & Shevchenko, 2021), student services and well-being (Iordache-Platis, 2020), courses and research projects (Hilty & Huber, 2017),

sustainable talent management practices (Saleh & Atan, 2021), faculty team building (Koeslag-Kreunen et al., 2018), open educational practices (Funk, 2021), and communication technology (Nuninger & Châtelet, 2018).

Other domains included soil protection (Lobry et al., 2017), clinical care (King, et al., 2021), plant genetics (Achigan-Dako et al., 2014), energy issues (Popescu & Avram, 2020), animal feeding (Islam et al., 2021), foodstuff (Spiker et al., 2021), agroecology (Wezel et al., 2018), law (Wahid et al., 2018), health (Brandão et al., 2022), climate issues (Noy et al., 2021), and aging (Lacey et al., 2018).

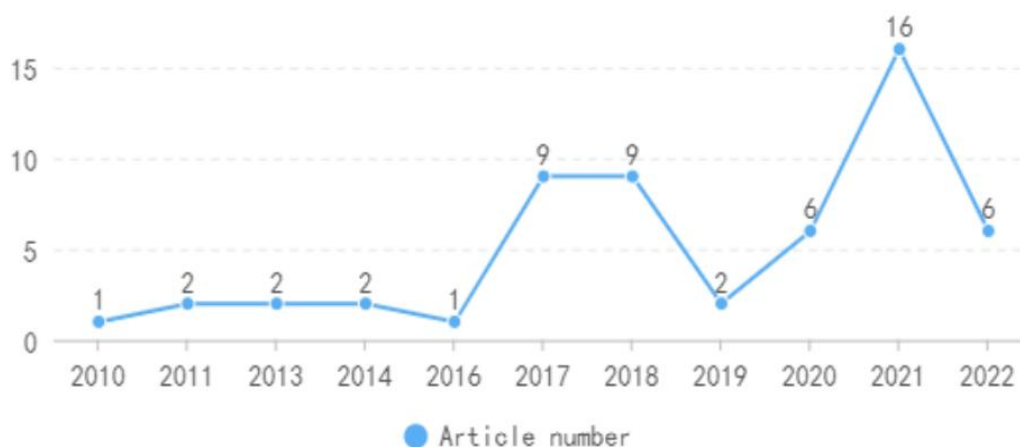


Figure 2. Article Classification Based on Year of Publication

3.2 Number of articles based on journal sources

Among the “digitalization & sustainable development & higher education” and “digitalization & knowledge sharing & sustainable development & higher education” (DKH) domains, various journals in fields such as m pedagogy, natural environment, energy, medicine, and tourism. In the journal, Sustainability, published the largest number of research articles (6). And, since 2016, this journal has published a wide variety of articles related to sustainable development.

The International Journal of the Sustainability in Higher Education has made a significant contribution and is number two in terms of the number of relevant articles. Other journals include: Handbook of Theory and Practice of Sustainable Development in Higher Education and Journal of Cleaner Production. The detailed description of article distribution based on journals and publishers is shown in Table 2.

Table 2. Number of Articles Based on Journal Sources

Journal Source	No. of publication	h-index
Advances in Health Sciences Education	1	76
Agriculture-Basel	1	133
Alsic-Apprentissage Des Langues et System de Information et de Communication	1	22
		1472

Amfiteateu Economic	1	89
Arctic	1	92
BMC Veterinary Research	1	32
Bottom Line	1	76
Environmental Engineering and Management Journal	1	97
European Journal of Contemporary education	1	179
Frontiers in Nutrition	1	117
Global Health Promotion	1	136
Handbook of Theory and Practices of Sustainable Development in Higher Education	2	164
Health Information and Libraries Journal	1	187
Healthcare	1	46
Higher Education	1	82
Hospitality and Tourism Management	1	75
Information	1	173
International Journal of Academic Medicine	1	162
International Journal of Disaster Resilience in the Built Environment	1	134
International Journal of Distance Education Technology	1	127
International Journal of Educational Development	1	25
International Journal of Environment Research and Public Healthy	2	197
International Journal of sustainability in Higher Education	4	326
International Review of Research in Open and Distance Learning		53
Journal of Cleaner Production	3	238
Journal of Education For Teaching	1	106
Journal of Environmental Management	1	128
Journal of General Internal Medicine	1	96
Journal of Interactive Media In Education	1	37
Journal of International Studies-Jis	1	48
Journal of Management Education	1	57
Journal of Management Information Systems	1	112
Journal of Transcultural Nursing	1	33
Kybernetes	1	9
Land	1	13
Natural Hazards	1	11
Plos Neglected Tropical Diseases	1	6
Saiee Africa Research Journal	1	3
Service Learning as Pedagogy in Early Childhood Education: Theory, Research, and Practice	1	12
Soil Science Society of American Journal	1	15
Springer plus	1	8
Sustainability	6	386
Teaching in Higher Education	1	64
		1473

Turismo-Estudios E Praticas	1	4
UAE: Policy Perspectives	1	6
University Partnerships for S. Development	1	14

3.3 Classification of articles by Country, author and number of publications

Table 3 reveals the names of 37 countries in which there are publication which include articles related to sustainable development. Among the 67 shortlisted articles by some 158 authors, the majority are from the United States of America with 50 authors and 7 articles. The United Kingdom, Australia, Netherlands, Malaysia, Brazil, and China are also major countries whose researchers are involved in studying matters related to sustainable development. Countries such as Norway, Spain, Slovenia, Latvia, India, Dubai, Czech Republic, Ugandan, Belgium, Kenya, Ghana, Botswana, Thailand, Portuguese, South Africa, Iran, and Greece, are not represented in the Web of Science data-base.

However, guided by the concepts of digitalization and knowledge sharing, there exist abundant opportunities for researchers all countries to become involved in studying various aspects of sustainable development in local contexts.

Table 3. Classification of Articles by Country, Author, and Number of Articles

	Country	No. of authors	No. of articles		Country	No. of authors	No. of articles
1	USA	50	7	19	Bangladesh	2	2
2	UK	11	4	20	Italy	2	2
3	Australia	10	4	21	Norway	1	2
4	Netherlands	8	3	22	Spain	1	1
5	Malaysia	8	3	23	Slovenia	1	1
6	Brazil	8	2	24	Latvia	1	1
7	Republic of Benin	6	1	25	India	1	2
8	France	5	2	26	Dubai	1	1
9	China	5	3	27	Czech R.	1	1
10	Germany	4	3	28	Ugandan	1	1
11	Rwanda	4	2	29	Belgium	1	1
12	Denmark	3	1	30	Kenya	1	1
13	Sweden	3	1	31	Ghana	1	1
14	Japan	3	2	32	Botswana	1	1
15	Sri Lanka	3	2	33	Thailand	1	2
16	Switzerland	2	1	34	Portuguese	1	1
17	Cyprus	2	1	35	South Africa	1	1
18	Iceland	2	1	36	Iran	1	1
				37	Greece	1	1

3.4 Article classification based on research method and design

Table 4 shows a detailed description of research methods used in the study of sustainable development by researchers in higher education. Survey methods (19) was the

most prominent. It is interesting to note that industry researchers also were active, particularly with case studies. Some 10 articles were ‘conceptual and theoretical base studies’ (10). There were a number of ‘literature reviews’ (5), and ‘view point’ articles (9).

In terms of empirical research, in addition to surveys, interviews and focus group discussions, no one method stands out. However, researchers, including Lordache-Platis (2020) and Spiker et al., (2021), have begun building a theoretical foundation and developing frameworks which are equally beneficial for the stakeholders in academic research.

Table 4. Article Classification by Research Method and Design

Methods	Source	Methods	Source	
Case study (7)	Crawford & Cifuentes-Faura, 2022;	Conceptual and theoretical models (10)	lordache-Platis, M, 2020	
	Garvis & Sheridan, 2017;		Spiker et al., 2021	
	Popescu et al., 2020;		Kienzler & Fontanesi, 2017	
	Rennie et al.,2011; Caniglia et al.,		Nweeia & Peeters, 2021	
	2018;		Curaj et al., 2020	
	Dlouhá et al., 2013;		Brandão et al., 2022	
	McCowan et al., 2022; Lebron et al.,		Wiltshier & Edwards, 2014	
	2020		Senevirathne et al., 2021	
	Lebid et al., 2021		Noy et al., 2021	
	Kulathunga., 2020		Bacon et al., 2011	
Survey (19)	Hilty et al., 2017	Literature reviews (5)	Popova et al., 2021	
	Poudel et al., 2021		MacKinnon et al., 2016	
	Saleh & Atan, 2021		Younie et al., 2018	
	King et al.,2021		Nen et al.,2017	
	Obrecht et al., 2022		Arquilla et al., 2018	
	Kandakatla & Palla, 2021		Koeslag-Kreunen et al., 2018	
	Islam et al., 2021		Ndayambaje et al., 2019	
	Freitas et al., 2020		Wolff et al., 2019	
	Wezel et al., 2018		Focus group (1)	Funk & Johanna, 2021
	Senanuch et al.,2022			View point (9)
Yusuf et al., 2021	Jean-Marie, 2018			
Hasan et al., 2022	Warner, 2017			
Allahyari et al., 2017	View point (9)	Osman et al., 2017		
Gomes et al., 2022.		Karunaratne, 2021.		
Mordang et al., 2021				

Normally, empirical research consists mainly of quantitative, qualitative, and triangulation as methods. The results of this present research show that qualitative and quantitative research have been the main research designs – around 30 published articles. Empirical qualitative research includes case study-based approaches involving practical case applications.

About 19 articles, ‘desk-type’ qualitative research, include conceptual models or theoretically based studies (10) and some 19 articles employed empirical quantitative research (survey-based studies).

Practical triangulation was the least adopted design. ‘Desk’ qualitative methods include literature reviews (5) and Viewpoints (9).

The significant gap in research methods appears to be ‘empirical triangulation’ (Bryant al., 2018, Karunaratne & Thashmee, 2021).

3.5 Classification of articles based on occupational sectors

Sustainable practices can also be a cross-occupational sector topic for analysis. Higher education contributes energy across many sectors. These sectors are vital to achieving sustainable development world-wide.

According to the previous classifications, surveys and case studies appear to be favored among the researchers. Table 5 reports on the literature across the various sectors.

Higher education holds the highest number of articles published on the subject of sustainable development (20), followed by two sectors, Pedagogy (8), and Medical (8).

It appears that research related to sustainable development becomes more critical to sectors which are most affected by sustainability such as agriculture and management, for example. Sectors such as the study of societies (sociology) are increasingly concerned about digitalization, knowledge sharing, and sustainable practices in higher education.

Digitalization, computer science, the natural environment, business management, zoology, and tourism are sectors which are relying more heavily on knowledge sharing.

Practitioners in these sectors face a dual challenge because of the rapid expansion in the use of digital technology and, thus, the need for updating of knowledge and technical skills, and the implications for higher education.

Table 5. Classification According to Occupational Sectors

Industry	No. publications	Industry	No. publications
Agriculture	6	Medicine	8
Computer science	1	Natural disasters	2
Enterprise	1	Pedagogy	8
Food	1	Sociology	4
Higher education	20	Tourism	1
Land	1	Zoology	1
Management	3		

3.6 Discussion

The present study reports on a detailed analysis of published articles over the more recent five years and listed in the Web of Science, a domain still in its early stages. Many more threads are still to be added.

From 2016 and onwards, the number and range of articles related to sustainable development have fluctuated, reaching a peak in 2021. The topics, too, have become more varied, and now include occupational sectors such as education, agriculture, health, law, and tourism. It appears that for the management sector the topic of sustainability is a leading issue.

Some studies have contributed to building a theoretical base. However, very few helped link the developed theories through mathematical modeling. Although the concept of environmental sustainability gained importance in developed countries, it is emerged in some developing African countries and in the United Emirates (Islam et al., 2021).

Thirty-seven countries and 158 authors have made contributions to sustainable development research. An analysis of the data shows that researchers in developed countries are paying more attention than developing countries.

In recent years, developing countries such as *Rwanda, Sri Lanka, Cyprus, and Thailand* have gradually joined the research queue and have been highly successful in promoting digitalization and in expanding higher education in their countries. *The United States of America, United Kingdom, Australia and the Netherlands* have obvious advantages because of the size of their economies. Scholars from these countries have even led the number of research articles. They have adopted various methods, including surveys and conceptualization. Case analyses, focus groups, and, and opinion reviews have helped to identify issues.

Even though sustainability has become a more cutting-edge topic, there is room for more attention on the part of many sectors. This comprehensive analysis of the 67 articles shows that much more needs to be done, and can be done, whether by academics in the higher education sector, or by institutional sectors.

4. Conclusion(s) and Future directions

The purpose of this academic research study was to conduct a meta-analysis, a systematic review, of recent research into sustainable development. This has been accomplished by analyzing selected research articles from the WoS published after 2010 containing keywords "*digitalization, knowledge sharing, sustainable development, and higher education*" This search resulted in 67 research articles.

The significant findings indicate that quantitative surveys were the most form of enquiry. It appears that case-studies yielded important findings. However, few described the relationship between digitalization, knowledge sharing, and sustainable practices in higher education. Many explained that sustainable practices in higher education were inseparable from digitalization and knowledge sharing (García-Peñalvo, 2021). A few more recent studies were conceptual and theory-based, and several hinted at mathematical modeling. Among the quantitative studies, however structural equation modeling was virtually non-existent.

Researchers in the higher education sector have shown to be very adaptable in using various approaches in their studies of sustainable futures (Elmassah et al., 2021). In terms of nations, the USA, UK, and Australia have been the leading forces in the study sustainability (Spiker et al., 2021). Countries such as China, Germany, and France are also aware of the significance of sustainable practices. At the same time, some researchers in Rwanda and South Africa are also paying attention to the topic.

Almost half of the researchers used tools such as surveys, case studies, and conceptual models (Libid, et al., 2021). It should be noted that most of the models proposed by researchers have not been verified mathematically nor through any simulation-based tests. Most were quantitative in methodology, but very few focused on empirical triangulation or mathematical formulation-based approaches.

Some studies did describe digitally some aspect of sustainability including knowledge sharing across different occupational sectors, through case studies. Sustainable practices in higher education like revised or special courses, different teaching methods, and international sharing are hopeful.

The current search criteria for shortlisting articles only included the keywords 'digitalization & sustainable development in higher education' or 'knowledge sharing & sustainable development in higher education' as the research topics. Perhaps had other key words had been used, different results may have occurred.

Also, this present study only included journals from the Web of Science. But, in fact there are a great many well-known journals that contribute to research in sustainability. Similarly, the classification parameters employed in this study could have been increased and, thus, would have enriched the findings.

With respect to research gaps, mathematical modeling, and other empirical qualitative methods to would strengthen this domain of enquiry and perhaps enhance its applicability. Such multi-method approaches would also help integrate digitalization and knowledge sharing. Although various studies have identified some models and frameworks, no analysis could portray the detail or the precise relationship among these variables.

Future research prospects certainly demand studies aligning the existing achievements developed by researchers with modified models and mathematical surveys to address these gaps. The models will be expected to incorporate relevant variables.

Researchers should be mindful of what maybe a sensitive relationship among digitalization, knowledge sharing, and sustainable practices in higher education, for example. Some researchers have proposed frameworks but employed qualitative methodologies which could not express their strengths. It is recommended that researchers should test their models using more variables relevant to sustainable practices.

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