# A Scientific Review to Emerging Role of Digital Transformation in Higher Education Institutions Towards Sustainability

**Maria Zuraiz¹, Muhammad Javed¹\*, Muhammad Saud Khan², Hamid Masood Khan¹, Husnain Saleem¹, Muhammad Rehan¹, Aftab Ali¹**

¹Gomal University, Institute of Computing and Information Technology (ICIT), D.I.Khan, Pakistan
²Air University Aerospace and Aviation Campus Kamra, Attock, Pakistan.

**\*Corresponding Author:** Muhammad Javed
\*Assistant Professor, Institute of Computing and Information Technology (ICIT), D.I.Khan, Pakistan,
Email: Javed_gomal@gu.edu.pk, ORCID: *https://orcid.org/0000-0001-6884-6641*

## Abstract

Digital transformation plays a pivotal role in structuring and enhancing conventional learning methods in higher education institutions. This systematic literature review introduces the current pace of growing technology which is considered the catalyst for innovation. Education sectors have been influenced by the real-life implications of digital transformation which is now considered a novice and useful asset in terms of multifaceted benefits, these benefits have been studied and discussed in this systematic literature review till 2023. The overall composition combines contemporary and novel learning methods and identifies the factors that contribute to regulating the process of learning through digital transformation. To perform this study, research questions are formulated and these questions are properly addressed through an extensive literature review based on findings. It is concluded that RQ1 returns the top-ranking publications, countries, and institutions that contribute in using digital transformation in HEIs in an effective way, for example; HEIS Sustainable Development, Management of Workload in HEIs, Technology impact on Teaching Staff, and HEI's Digital transformation has gained substantial attention. To answer the RQ2, studies revealed the assessment of the Sustainability consciousness of educators and highlighted impending changes in values and consumer patterns using pedagogical technology. The last RQ3 is highlighting and addressed the potential factors to evaluate the student performance outcomes and Sustainability of educational performance.

**Keywords:** Digital Transformation, Higher education Institution, Technology Impact, Sustainability

## 1. Introduction

Financial gain and protecting the environment and society for coming generations must be prioritized in existing education programs as significant issues like climate change and pandemics require inevitable attention. Educational Institutions are key factors with core values in helping this world to make it a better place to live by encouraging generations to be a leader in the future and educating them to take care of their world which later on with their helping and energetic thoughts helps the UN agencies with their innovative plants to ensure better future through use of technologies and innovative ideas.

As an obligatory part of their core responsibilities, HEIs should implement practices with sustainability in their operative procedures, decisive process, and teaching methodologies. Resultantly implications of the sustainable procedures enable the learners to pursue their studies for long extended period which helps them and make them able to achieve goals with sustainable development and resolve the issues/problems that pertain to climate changes and pandemics by using technologies and improving the existing world with sustainability. Usage of Technology in the existing education system facilitates the learners to learn more about sustainability and keeps them motivated. A university degree is not yet required for learning on a formal level. To get data, you can use a variety of apps and websites. HEIs are undergoing a reinterpretation of their business models, changing their institutional structures as a result of this shift, which is driven by social and technological trends related to digital transformation.

There is limited research on the combination of digital technology and sustainability in higher education, despite their growing importance. Understanding this subject more completely requires additional research and involvement from a number of people. The objective of designed study is to examine the use of technology in higher education institutions as a means of promoting environmental sustainability. The study offers insightful information and establishes a research agenda by looking at the current status of the field, theoretical viewpoints, and potential possibilities. To gain a thorough understanding of the subject, it uses both content analysis and bibliometric analysis.

❖ ***Research Question 1.*** *How to integrate digital transformation in HEIs effective way with instructional design and pedagogical approaches.*

❖ **Research Question 2.** *Which best practices of digital transformation in HEIs can foster digital literacy among students, administrations, and educators in HEIs?*
❖ **Research Question 3.** *How can HEIs evaluate the role of digital transformation toward sustainability of educational performance and student outcomes in the future?*

This study is deliverance to theoretical and practical concepts by charting the current research land escape and examining the mode and suggesting practices that have sustainability in academic institutions of Higher Studies. It also distinguishes itself for its modus operand as the first review with the systematic abilities in this system to use both content analysis and scientific computer assisted review methodology.

## 2. Research Review

A revolutionary educational system that considers both the medium and long term as well as concerns about short-term economic growth is becoming more and more necessary. Education systems support future generations' rights to contribute to the evolution of a sustainable world in the face of the uncertainties that humanity faces due to pandemics, catastrophes, wars, and climate change. Higher education institutions (HEIs) are tasked with developing sustainable plans for society's growth (Kräusche and Pilz 2018) , particularly with regard to advancing the public's understanding and the careers of future leaders (Amaral, Martins, and Gouveia 2015).

## 2.1 Related Work

It is becoming more and more important to put in place a revolutionary educational system that takes into consideration both the long and medium term as well as concerns about short-term economic growth. In light of the uncertainties that humanity faces as a result of pandemics, catastrophes, wars, and climate change, education systems encourage future generations' rights to contribute to the expansion of a sustainable world. The duty of creating sustainable plans for society's growth falls to higher education institutions (HEIs) (Kräusche and Pilz 2018), particularly in light of increasing public knowledge and future leaders' professional paths (Amaral, Martins, and Gouveia 2015). The context involves providing students with a long-term learning opportunity so they can lead different organizations and institutions in their future endeavors and act in specific ways The existing strategies support in reducing climate change and assembling the Sustainable Development Goals (SDGs) (Leal Filho et al. 2020). Therefore, all HEIs are furnished with knowledgeable leaders. However, providing such people with the necessary education and training in sustainability is crucialv(Amaral, Martins, and Gouveia 2015). In this sense, the 2030 Agenda's support, distribution, and achievement of the SDGs all rely on digital transformation (DT) (Arnold, Vogel, and Ulber 2021). In context of confronting and understanding, the difficulties related to the SDGs, students must quickly gain information, skills, and motivation, which is supported by the connection between quality education and technology (González-Zamar, Ortiz Jiménez, et al. 2020).

It has been noted that HEIs' premises are no longer the sole venues where people can acquire knowledge. Additionally, it can be found on a variety of platforms, including open-source browsers, programmers, and encyclopedias. These platforms are made to help those who are eager to learn about various and emerging subjects (Valdés, y Alpera, and Cerdá Suárez 2021). Because of this tendency, HEIs have long been the hub for the creation and sharing of knowledge. The social and technological tendencies of DT are causing some important changes in these early stages (Nurhas et al. 2022; Nikou and Aavakare 2021). These signs suggest a change in institutional paradigm, a redefinition of business models , and a possible organizational restructuring (Benavides et al. 2020; Rodríguez-Abitia and Bribiesca-Correa 2021). There is a deficiency of exhaustive and rigorous academic study, particularly in the domain of higher education, despite the fact that digital demands and sustainability already have a propensity to interact in practise (George, Merrill, and Schillebeeckx 2021). HEIs standardize management approaches focused on sustainable development using digital technology (Pu, Tanamee, and Jiang 2022). It also necessitates additional study and viewpoints on it (Eltawil, Mostafa, and Matsushita 2021).

(Tarafdar, Tu, and Ragu-Nathan 2010; Tushman and Nadler 1978) discovered overabundance and an organization's incapacity to handle the never-ending surrounding workload, especially while using a digital strategy in terms of the expanding higher education sector. According to a study by (van Knippenberg et al. 2015), employees used to devote less than half of their time really doing the work that they were hired to do. This was especially true for UK HEIs. Academic personnel have been obliged to take on more administrative duties due to the concentration of functions as a result of the decline in administrator roles in the UK sector (Ryttberg and Geschwind 2021).

Academic employees now self-manage many tasks that were formerly performed by support workers. Therefore, the workload has increased and job Satisfaction has decreased. The centralization of support personnel may be a mistake since it frequently leads to a lack of awareness of certain departments and academic tasks. Thus, it implies that localized IT competence is required to offer 24/7 assistance (Ryttberg and Geschwind 2021; Andrews, Boyne, and Mostafa 2017). It is believed that greater staffing in support jobs at HE institutions will result from centralization in the public sector.

The experience of educators with technology is greatly influenced by organizational structure and leadership (Gorrell 2023). ICT implementation can be severely impacted by a lack of leadership and inadequate competence of staff (Nograšek and Vintar 2011). Organizational issues, such as heavy workloads combined with e-learning, leadership style, and work culture, might have an impact on educators' mental health and contribute to burnout and technostress (Gabbiadini, Paganin, and Simbula 2023). A lack of institutional resources and inadequate ICT abilities may cause teachers or educators to feel technologically strained (Penado Abilleira et al. 2021). For HEIs to implement technology effectively, a suitable IT infrastructure, organisational solutions, and support services are required (L. Li and Wang 2021; Donner 2023).

**Table.1:** *Exploration of Existing Trends and Technologies in Digital Learning and their Approaches*

| Topic | Findings |
| --- | --- |
| **HEIS sustainable development** | Higher education institutions (HEIs) are essential for progress because they train future leaders and broaden people's awareness of sustainability. developing sustainably. |
| | HEIs should promote expansion that is sustainable in terms of their worries about educational challenges, decision-making processes, and infrastructure. |
| | In the 2030 Agenda, United Nations and the Sustainable Development Goals (SDGs) are referred as important documents. Both are greatly helped by digital transformation (DT). |
| | When technology is used in conjunction with high-quality learning, students are better equipped to comprehend and address issues connected to the SDGs |
| **HEIS's digital transformation** | Digital transformation (DT) is a social and technical trend that is profoundly affecting HEIs. |
| | Digital transformation (DT) developments in society and technology are having a significant influence on HEIs. |
| | In-depth research is mandatory to properly comprehend management strategies that successfully amalgamate digital technology and growth with sustainability in higher learning. |
| **Management of workload in Heis** | HEIs may see an unanticipated increase in workload as a result of implementing a digital strategy. |
| | Centralizing support employees at HEIs may raise effort and reduce job satisfaction among academic staff. |
| | To provide fast support and avoid a lack of acquaintance with certain departments and academic duties, localized IT competence is advised. |
| **Technology's impact on teaching staff** | Leadership and organizational structure in an organization have an impact on how a teacher uses technology. |
| | The effective use of ICT can be negatively impacted by poor leadership and under qualified employees. |
| | Demanding workloads, leadership styles, and workplace cultures, which can cause techno stress and burnout, can have an effect on teachers' mental health. |
| | Due to the lack of institutional resources and ICT expertise, teachers may encounter technological pressure. |
| | For HEIs to use technology, there must be efficient organizational solutions, support services, and a solid IT infrastructure. |

These results highlight how crucial it is to achieve effective and seamless technology integration in higher education through sustainable development, digital transformation, workload management, and support for the teaching staff.

## 3. Methodology

This research enabled coupling of analysis with both qualitative content and quantitative content scientific research base methodology as a part of multi component approach. In order to review and conclude the effect of multiple categories that includes subject's writer and institutions common nations (Zupic and Čater 2015). On the other side analysis with qualitative content is used to rigorously explain of phenomena using concept and category (Elo and Kyngäs 2008).

For bibliometric analysis, researchers typically use databases like Scopus and the Web of Science. The largest and most complete database of social science research. For this inquiry, the literature was sourced through Scopus (Terán-Yépez, Jiménez-Castillo, and Sánchez-Pérez 2021). The preliminary step in the research practice is to find the relevant search phrases in Scopus Database. The use of "AND" and "OR" Boolean operators, as well as

terminology linked to sustainability, higher education, and digital transformation, were first merged. Based on earlier field research, these search terms were selected (Donthu, Kumar, and Pattnaik 2020). Information was sought using the "AND" and "OR" Boolean operators, together with the terms "virtual," "digital," "ICT," "emerging technology," "sustainability," "sustainable development," "SDG," "3030 Agenda," "higher education," "HEI," and "university." (Alonso-García et al. 2019; Benavides et al. 2020).

The plan shown in Fig.1 served as the foundation for our sample selection, which was done in accordance with the PRISMA framework (Moher et al. 2009).

• During the earliest stages of our investigation, we found 1971 articles thanks to the Scopus database. We examined the headings, descriptions, and keywords of every form of content.

• By narrowing down the search process, topic-based publications such as business, management, accounting, social sciences, and environmental sciences have been selected. In the second phase of the methodology, 1187 scientific articles were found. Only scientific articles and reviews have been selected to compose the proposed study that guarantees the validity of the research based on 686 articles.

• In process of language selection process, scientific articles in English, Portuguese, and Spanish, led to the exclusion of 14 publications. There were ultimately 672 papers included as the final sample.

The study used MS Excel software to extract the abstracts and summaries of 72 research papers for content analysis. The papers have been selected in accordance with the search procedure's criteria. Two independent researchers monitored the process flow outlined in the search procedure selected the papers.
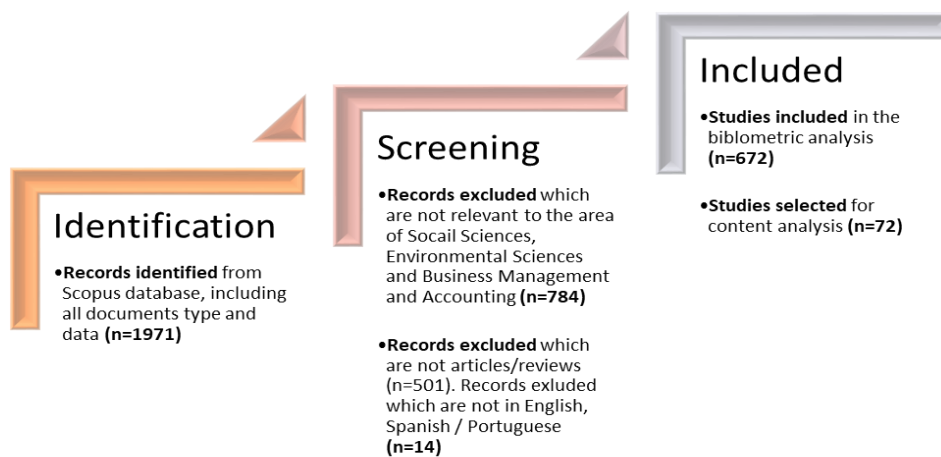


*Fig. 1: The PRISMA Framework for Bibliometric Analysis of Scientific Articles Selection*

To comprehend the link, a thorough descriptive analysis was performed. Between technological use in higher education and sustainability goals (**Research Question 1**). This inquiry covers ranking the top publications, countries, and organizations in the sector and charting the evolution of publishing numbers. We also conducted additional analysis to better understand the study landscape.

A collaborative writing analysis was conducted with an emphasis on the geographical locations of the authors in order to build a network of international cooperation (Uddin et al. 2012). A co-occurrence analysis can help identify the most important terms. Associated with the subject were found (Arita 2017). A bibliographic coupling data analysis was done to get insight into new research trends (Kessler 1963). The VOS viewer programme (version 1.6.17) (Alshahrani 2022) was used for this purpose in order to make the analysis easier. Using these analytical methods, researchers aimed to give a comprehensive overview of the research landscape, casting light on how higher education, digital revolution, and sustainability interact.

Researchers identified the 50 most important articles for studying subjects using a unique methodology. On the basis of similar references, the bibliographic coupling method compares two articles to assess how similar they are (Zupic and Čater 2015). 46 publications were found to have the highest total link strength based on this method using the MS Excel program. Following careful consideration of their abstracts, 26 of these papers have been selected for in-depth content study (Elo and Kyngäs 2008). In the 26 articles, it is examined how technology is improving education and promoting sustainability. However, the depth of this particular subject of study was not very deep in the other 20 papers.

Researchers divided 26 publications into three distinct groups based on how similar they utilized the MS Excel software. This made things simpler for them to carefully read the papers. This grouping technique made it quicker to understand the study context and made it possible to evaluate the data in a systematic manner.

To answer the proposed research questions about the diversity of ideas within the discipline (**Research Question 2**), the researchers looked at how often two papers appeared in the external literature at the same time (Small 1973).

The 672 papers with the most significant references were selected for analysis from the Scopus database. Using the MS Excel software, based on the number of citations, the researchers found that there were 46 papers, distributed among seven clusters. Then, a thorough examination of the 46 publications' content followed. A total of 72 publications were thoroughly analyzed using co-citation analysis (46.articles). and bibliographic-coupling. (26. publications).

In order to react to, a co-occurrence analysis of words used in articles published between 2019 and 2022 was completed. Study (**Research Question 3**) focused on potential future study areas in the area. In addition to this inquiry, the contents of the 26 previously chosen publications' bibliographies were looked into. It is essential to keep in mind what the results of the bibliographic coupling technique may show. Published literary works recently (Zupic and Čater 2015).

## 4. Findings and Analysis
### 4.1 A summary of recent developments in digital transformation for higher education sustainability
The data in Fig. 2 indicate a gradual rise in publications from 1995 to 2021, demonstrating a rise in academic curiosity about how to maintain the digital transformation in HEIs. When the COVID-19 epidemic began in the years between 2020 and 2023, several articles were written and released. 118 articles were published in 2020 and 142 in 2021. 2022 saw the publication of 196 papers with the heading "Digital Transformation in Higher Education." The usage of technology in higher education increased throughout this time period, following a long-term trend (Rodríguez Bolívar, Garde Sánchez, and López Hernández 2013). The COVID-19 pandemic, however, forced enterprises to start a DT process right away, demanding changes to their existing models and practices (Nurhas et al. 2022), as well as academic research into innovative protocols, methods, and technology.
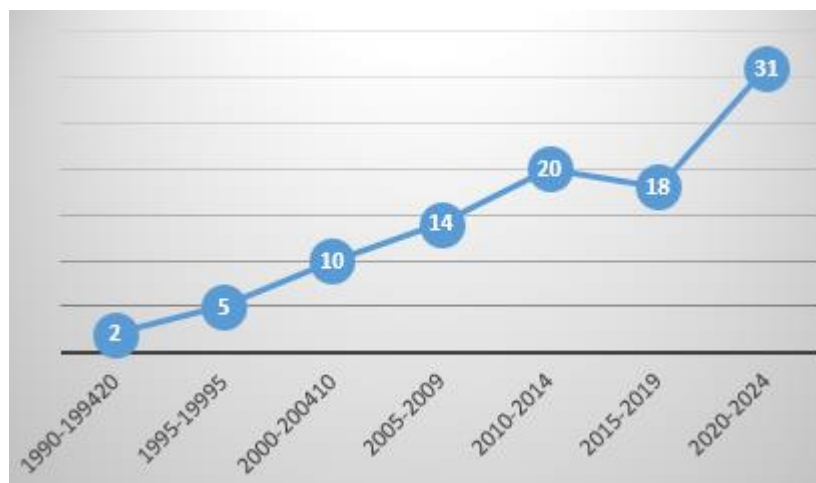


**Fig.2:** *Analyzing Publication Trends through Years*

There are 159 periodicals in total, found to use to compose Literature. According to bibliometric data the top 10 journals are displayed alongside article, citation, and impact factor (IF) total presented in Fig 3. On collecting scientific papers, 1914 publications, 494 citations, and a total of 521 articles found circulated in education sciences. There exist 464 articles and 15 citations in the interactive learning environment. With 142 publications and 1270 citations, sustainability reaches at the fourth-most active journal. There are fifteen papers in the International Journal of Sustainability in Higher Education, nine in the Journal of Industrial Ecology, and seven in the International Journal of Emerging. Moreover, nine publications in the Journal of Industrial Ecology has been found. The Journal of Cleaner Production is found to be cited 337 times and had 16 publications, placing it second rank. The Journal of Cleaner Production was cited 337 times and had 16 publications, placing it second. The Journal of Education and Information Technologies, volume 8, has 3211 publications.
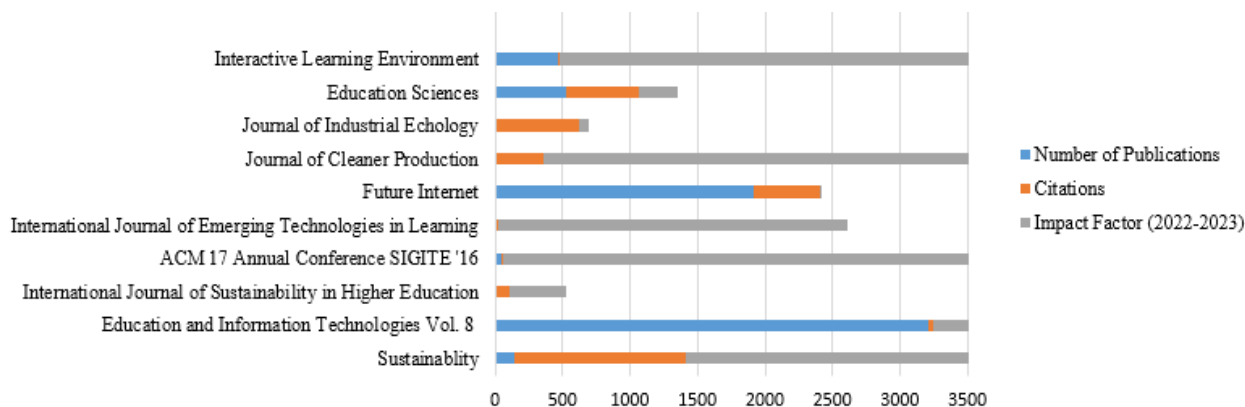
***Fig.3:*** *Overview of Emerging Publication Impact and Citations Towards Sustainability in Digital Transformation*

With 165 publications, the University of Michigan (USA) is the most Productive organization in the sector, According to Figure 4. With 155 articles, the University of Florida (USA) is in second place, and the Universität d'Alacant (Spain) is third. There are 78 and 75 publications, respectively, from Indira Gandhi National Open University (India) and Arizona State University (USA). The University of California (USA) has 66 publications, compared to 68 from Universiti Teknologi Malaysia (Malaysia). The Boston Consulting Group (USA) and the University of Virginia worked together on 61 papers. Each university has 12 publications, including the University of South Africa (South Africa), Universität de València (Spain), and Universidad de Granada (Spain). are the next three institutions behind The Open University (UK), which has produced 35 articles. 35 articles from The Open University (UK) have been published.



***Fig.4:*** *shows the most successful institutions in higher education in terms of DT towards sustainability*

Fig.5, depicted that, co-authorship analysis provides insight into global networks of collaboration. The first of the four groups, which the study concludes is distinct from the other three, includes members from Mexico, Canada, Australia, France, Ecuador, Ghana, India, Colombia, the Switzerland, Norway, South Africa, Sweden, Spain, Netherlands and the United States. The second group is represented by Portugal, Austria, Brazil, Finland, Belgium, Greece, Hungary, Italy, Poland, Romania and Argentina while the. third group is made up of Bulgaria.
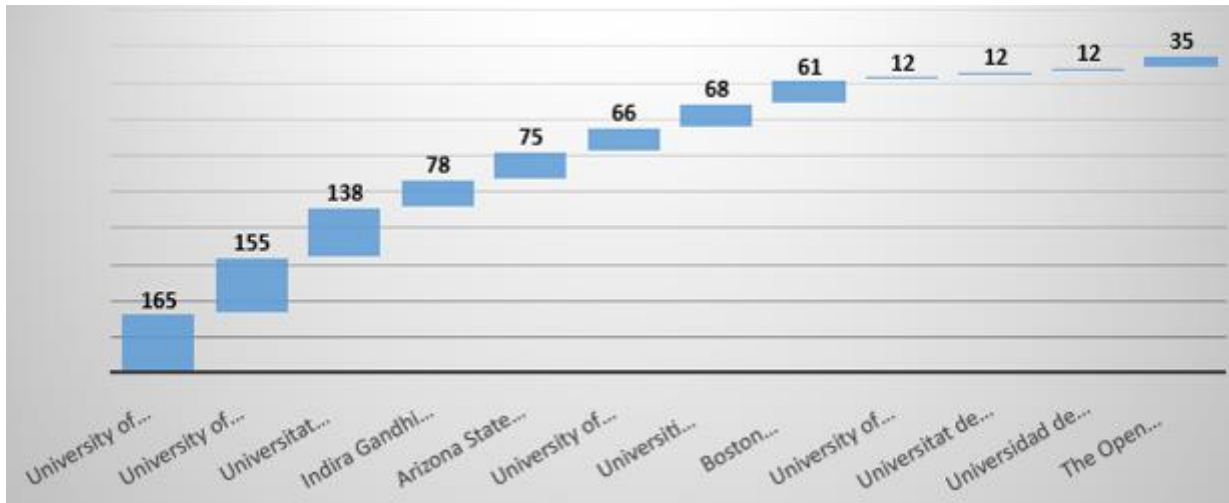
**Fig.5:** *Analysis of Publication growth in universities globally*

Researchers examined the frequency of word pairings in order to identify the most pertinent terms linked with the subject. There were initially 2351 words in all. Less frequently used terms and words that were not relevant were eliminated. Fig. 6 showed the remaining 113 words in total.



**Fig.6:** *Analysis of Publication Rate Country Wise*

There is no doubt that technology has been advanced throughout history, between 2014 and 2016, research was conducted on a range of subjects such as how industrial estates are effecting the environment and leading to environmental hazards such as Carbon Dioxide Emissions, and how to adopt and select the products That will not lead to the production of Environmental Hazards, how to use the internet responsibly and how to build digital libraries. The 2016–2018 research examined technology, online education, and other crucial subjects, including educating people to safeguard the environment. Additionally, they discussed novel and fascinating topics like virtual reality. Researchers' attention in 2018 and 2019 was divided across several subjects. Some of these included teacher training, social media use, and technology-based learning. They also considered how to educate people about climate change and how to make cities smarter. There are numerous studies conducted on the use of technology in education, including flipped classrooms and online courses. Using tools like VOS viewer, a content analysis of 26 publications using ATLAS.ti and Zotero was done to ascertain how the digital revolution has benefited sustainability in higher education. The VOS viewer's recommendation for the articles with the highest overall link strength was used to choose for Analysis purpose.

**Table.2:** *Proposed Studies based on Digital Transformation towards Sustainability in HEIs*

| References | Inspecting the success in the Higher Education sustainability with the help of the digital transformation. |
|---|---|
| (Arnold, Vogel, and Ulber 2021; González-Zamar, Ortiz Jiménez, et al. 2020) (Daniela et al. 2018; Colás-Bravo, Magnoler, and Conde-Jiménez 2018; Alahmari et al. 2019; Leal Filho et al. 2021) | Encouraging DT in Sustainability Competencies |

| (Cavicchi 2021; Filter et al. 2020; Caniglia et al. 2018; Giesenbauer and Müller-Christ 2020; Paniccia and Baiocco 2018; Rodríguez Bolívar, Garde Sánchez, and López Hernández 2013; Fraga-Lamas et al. 2019) | An innovative and sustainable campus strategy |
|---|---|
| (Bracco et al. 2018; Griffiths et al. 2019; Schina et al. 2020; Mâță, Clipa, and Tzafilkou 2020; González-Zamar, Ortiz Jiménez, et al. 2020; González-Zamar, Abad-Segura, et al. 2020; Aristovnik et al. 2020; Benta et al. 2015; Brudermann et al. 2019; Coman et al. 2020; Espino-Díaz et al. 2020; Pu, Tanamee, and Jiang 2022) | Theoretical Investigation of Sustainable Practices via DT in HEIs |

The plethora of 17 publications that were published between 2013 and 2022 talk about how technological improvements could encourage sustainability in higher education. While many publications employ techniques like experiments or surveys to evaluate or quantify occurrences, others depend on tools like content analysis and interviews to obtain an understanding of how people behave or act. In this context, the development of sustainable competencies at the professorial, student, and institutional levels is the main emphasis of the application of digital transformation technologies.

In addition to examining how technology influences teaching and learning for sustainable development, researchers have also assessed the sustainability consciousness of professors and studied potential changes in values and consumer patterns using pedagogical technology.

A student-led study has examined how the COVID-19 epidemic has adversely made an impact on education for sustainable development under the umbrella of higher education. There are so many given opportunities for diversified pedagogies methods through an e-learning environment in addition to using technology with virtual reality to encourage pro-environmental behavior, as there is an increasing focus on incorporating virtual international collaboration for the initiatives that have sustainability (Cavicchi 2021; Filter et al. 2020; Caniglia et al. 2018). In order to enhance sustainable growth at the institutional level, scholarly literature has proposed paradigms and approaches for integrating technology into higher education (Giesenbauer and Müller-Christ 2020). endeavors in technology transfer, for example. Making it easier for colleges to publicize their initiatives having sustainability can boost their legitimacy and accountability (Paniccia and Baiocco 2018; Rodríguez Bolívar, Garde Sánchez, and López Hernández 2013).

6 new research papers on sustainable and intelligent campus activities use hybrid, qualitative and quantitative analysis methodologies. As per (Fraga-Lamas et al. 2019), a "smart campus" is one that has improved. infrastructure that connects intelligent sensors and actuators to the equipment, supplies, and students present on a university campus in order to gather data and communicate. Multiple technologies utilised in campus buildings to promote sustainability are discussed in the study on smart and sustainable campuses (Bracco et al. 2018; Griffiths et al. 2019).

This also includes academics' views on the digitization of higher education (Mâță, Clipa, and Tzafilkou 2020) and students' ability to incorporate SDG components into robotics projects (Schina et al. 2020). It also looks at how Higher Education Institutions (HEIs) may efficiently and sustainably carry out their instructional operations (Arnold, Vogel, and Ulber 2021).

The final one is titled "Theoretical Exploration of Sustainable Practices in Higher Education Through Digital Transformation." The study is concerned with how ICT (Information & Communication Technologies) to promote sustainability in higher education are managed. To conceptualize how the digital revolution and sustainability in higher education are related, the study's literature assessments looked at academic works on educational technology (Abad-Segura, González-Zamar, Infante-Moro, et al. 2020) as well as research trends (Abad-Segura et al. 2020).

a thorough analysis of the information in the aforementioned Publications indicate that higher education institutions (HEIs) are now interested in digital transformation for sustainable growth. a popular literary theme that has had a big effect on a lot of programmers designed to guarantee sustainability in higher education. In order to educate about sustainability, new technologies like virtual reality, video games, and robotics are being incorporated into the classroom. In-person instruction is one of these strategies that can inspire individuals to care more about the environment. Moreover, this process appears to benefit from dynamic education that promotes collaboration

and critical thinking among pupils. According to global research, campus infrastructure at Higher Education Institutions (HEIs) prioritizes resource management. In higher education, creative and environmentally conscious campus planning techniques are gaining popularity in order to provide students with conducive learning environments, good health and wellbeing, Efforts to conserve physical resources through sustainable transportation, carbon reduction, governance, and other means Implementing these ingenious techniques. into action at universities and applying sustainable practices may have positive effects on the economy and the environment. These include cutting back on spending and consumption as well as lowering one's carbon footprint, reducing global warming, and reducing air pollution.

### 4.2 Conceptual frameworks for the digital revolution in higher education's direction of sustainability

To understand the potential points of view on the topic, a content analysis of 46 articles using co-citation analysis was performed **(Research Question 2).** The publications were picked using VOS reader software, and those with more links stood out more than those with fewer links. The 46 publications' titles were divided into seven groups: Table 3 (and the sidebar) cover e-learning, educational aspects of sustainable behaviors that are related to online educational approaches, examining broad issues relating to corporate social responsibility and digital transformation, as well as concepts and evaluations pertaining to education for sustainable development.

**Table.3:** *Summarized Literature Study based on DT and its sustainability in HEIs*

| References | Area | Explanations |
|---|---|---|
| (Aristovnik et al. 2020; Benta et al. 2015; Brudermann et al. 2019; Coman et al. 2020; Espino-Díaz et al. 2020; Lorente, Arrabal, and Pulido-Montes 2020; Popa et al. 2020; Zamora-Polo and Sánchez-Martín 2019; Zhang et al. 2020) | Electronic- learning. | research on topics 1 (Aristovnik et al. 2020; Coman et al. 2020), the COVID-19 pandemic's influence on instructional activities. proposals for strategies to enhance teachers' use of digital tools in the classroom, (Griffiths et al. 2019; Schina et al. 2020; Mâță, Clipa, and Tzafilkou 2020; Abad-Segura, González-Zamar, Luque-de la Rosa, et al. 2020; Benta et al. 2015; Brudermann et al. 2019), all examine the governmental and political ramifications of the e-learning issue. |
| (Evans et al. 2017; Gómez-Galán 2020; Murga-Menoyo 2015; Rieckmann 2012; Ryan and Deci 2000; Wiek, Withycombe, and Redman 2011; Zhu 2015) | The aspects of sustainable behavior relates to education | essential sustainability skills The primary subjects of Topic 2 are (Popa et al. 2020; Zamora-Polo and Sánchez-Martín 2019), and (Evans et al. 2017). Included are both internal and external factors that might affect the educational process. innovative teaching and learning techniques (Zhang et al. 2020). as well as other factors that might have an effect on the educational process (Espino-Díaz et al. 2020; Lorente, Arrabal, and Pulido-Montes 2020) and (Gómez-Galán 2020). |
| (Bruggeman et al. 2021; Edelhauser and Lupu-Dima 2020; Kioupi and Voulvoulis 2019; Manca 2020; Murphy 2020; Volery and Lord 2000) | Online Approaches | Most research on topic 3 is devoted to strategies, equipment, and plans for delivering online instruction, including the influence of social media platforms on educational activities (Wiek, Withycombe, and Redman 2011).the characteristics of an excellent professor (Murga-Menoyo 2015), and the crucial success factors. Strategies and components of online education (Bruggeman et al. 2021). |
| (González-Zamar, Abad-Segura, et al. 2020; Muñoz-Rodríguez et al. 2020; Napal, Mendióroz-Lacambra, and Peñalva 2020; Owens 2017; Perales Jarillo et al. 2019; Velazquez et al. 2006) | Review of sustainable performance measures in the academia. | By looking at how sustainability competence indicators were developed (Kioupi and Voulvoulis 2019), doing a review of the pertinent literature (Murphy 2020), recommending a sustainable university model (Volery and Lord 2000) and Topic 4 explains and looks at In education, sustainability (Manca 2020) Additionally, it looks at how students' sustainability capabilities are developing (Edelhauser and Lupu-Dima 2020). |
| (Azeiteiro et al. 2015; Dziubaniuk and Nyholm 2021; Lambrechts et al. 2013; Lozano et al. 2013a; | Analyzes assessments & proposal related methods for | By looking towards novel methods for teaching sustainability. (Napal, Mendióroz-Lacambra, and Peñalva 2020; Perales Jarillo et al. 2019), and evaluating its effectiveness. Topics (Muñoz-Rodríguez et al. 2020; |

| Molderez and Fonseca 2018; O'Riordan et al. 2020) | sustainable developments in academia | Owens 2017), and to universities. contributions to achieving the Sustainable Development Goals and goes thoroughly into education for sustainable development. (Azeiteiro et al. 2015). |
|---|---|---|
| (Abad-Segura, Cortés-García, and Belmonte-Ureña 2019; Akçayır and Akçayır 2017; Barbier and Burgess 2019; González-Zamar, Ortiz Jiménez, et al. 2020; N. Li and Kirkup 2007) | Expanding the umbrella of DT and corporate sectors elevating the social norms | A variety of topics are covered in Topic 6, including the use of expanded reality in institutional contexts. (Lambrechts et al. 2013) learner views towards technology Monitoring the Sustainable Development Goals' progress (O'Riordan et al. 2020) The importance of corporate social responsibility (CSR) to corporations is discussed in (Lozano et al. 2013b; Cabedo et al. 2018) |
| (Cabedo et al. 2018; Merchant et al. 2014; Potkonjak et al. 2016; Redel-Macías et al. 2016; Salmerón-Manzano and Manzano-Agugliaro 2018) | Virtual Education. | Virtual education moderate virtual worlds, virtual labs, and virtual reality are used. The impact of instructional techniques on the results of student learning (Akçayır and Akçayır 2017; Barbier and Burgess 2019; González-Zamar, Ortiz Jiménez, et al. 2020; N. Li and Kirkup 2007). |

## 5. Priorities for Future Research

After exhaustive analysis of the keyword co-occurrence related to publications from 2019 to 2022, the possible research areas for future studies on digital transformation for sustainability in higher education have been identified. The enhanced information analysis described in the successive sections has been designed. In the preliminary stage of co-occurrence study, 1416 total terms were identified. After phrases were eliminated, 114 important keywords with a frequency under two remained, along with other irrelevant keywords. It is found that the majority of latest plethora of publications covers the topics related to higher education, sustainability, e-learning, universities, COVID-19, digital learning, sustainability reporting, Sustainable Development Goals, Sustainable Development Management, digital technology, innovation, education for Sustainable Development, students, and blended learning. Taking into account the results of the study and an understanding of the core components of HEIs, the following four topics for further research were identified: education, campus operations, research, evaluation, and reporting (Lozano et al. 2013b; Kapitulčinová et al. 2018). These include collaborative research projects for sustainability, creating sustainable campuses utilizing smart technology, and encouraging innovation and sustainability within the setting of universities. One of these areas is employing digital technologies in education to support sustainable development. The established avenues of investigation are listed in Table 4 along with their suggested areas for additional study.

**Table.4:** *Identified Contributing Techniques for DT in Sustainability in HEIs*

| Research Statement | Future Research Questions |
|---|---|
| Developments with sustainability via Electronic Learning. | When used in teaching and learning activities, how do digital technologies aid students in long-term learning? What chances are there for global virtual partnerships and collaborations in sustainable development education? How are social injustice and climate change impacted by online teaching methods? |
| Smart technology for sustainable campuses | Which technological innovations are being used on campuses to promote sustainability? What factors affect or deter using technology to promote campus sustainability? What advantages does implementing sustainable technology at universities have for the economy, society, and environment? |
| Teamwork in research sustainability | How have technical advances facilitated cross-border research collaboration? What technological advancements have made it easier to analyze the data from research with sustainability? What particular technical training is required of researchers? |
| University Community can equip itself with Innovation. and sustainability. | What technical improvements can universities make to encourage innovation, entrepreneurship, and social change, as well as to advance the 2030 Agenda and the Sustainable Development Goals for HEIs? |

| Parameter of technologies in HEIs (digital governance) | How may technology help higher education institutions report on sustainability? |
|---|---|
| | What part may technology play in attempts to map sustainability in higher education? |
| | What connections exist between campus and IT. Might there be programs promoting sustainability? |

The main topic of the next research project will be e-learning for sustainable development. The remarkable blended learning and flipped classroom pedagogies deployed by ESD have received sufficient research attention. Through longitudinal study, it may be possible to learn more about how artificial intelligence, augmented reality, and virtual reality are used over the long run. Additional studies show that interactive online learning can improve language proficiency, support programs for online student mobility, and provide people with the digital skills they need to address global concerns. (Laufer et al. 2021; Bruhn-Zass 2022; Núñez-Canal, de Obesso, and Pérez-Rivero 2022). Thus, research in the future might concentrate on new collaborations and alliances for sustainable development and global education. The utilization of virtual exchanges as a strategy for internationalization in higher education is a novel and intriguing practice that is deserving of further study. According to future studies, the use of Internet resources may also help pupils engage with global concerns, alleviate social injustice, and stop human migration.

## 6. Conclusions and Future Work

Future research may concentrate on sustainable campuses supported by smart technologies. All across the world, HEIs have adopted digital technology; this trend is confirmed by the rise in the number of publications on the subject. Some studies neglect to include how colleges employ technology to support sustainability efforts and UN objectives. They must determine what is beneficial and what poses difficulties, such as reducing carbon emissions and conserving energy. This covers items like food, garbage, transportation, and other places on campus. Future studies should focus on the potential benefits of digital transformation for linkages between students, teachers, and researchers throughout the world. In particular, block chain, augmented reality, big data, artificial intelligence, and other technologies need to be explored.

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