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Barriers to the Adoption of E-Learning in Higher Education Institutes (HEI): An ISM Approach

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ABSTRACT

E-learning has the potential to revolutionize higher education institutes (HEIs), yet its adoption faces significant barriers. This study aims to identify and analyze the interdependent relationships among these barriers within the HEIs. This research classifies e-learning adoption barriers into different levels through an interpretive structural modelling (ISM-MICMAC) to prioritize and explore their contextual relationships. The findings reveal that the financial constraints barriers are the primary barriers, followed by the limited technological infrastructure, inadequate policy and institutional support, and technical support challenges. While the study acknowledges potential limitations, such as overlooked barriers and possible biases in expert opinions, it offers actionable insights for policymakers and managers to address these challenges. By providing strategies for overcoming barriers, this research supports the effective and seamless integration of e-learning systems in HEIs, establishing a strong foundation for future advancements.

KEYWORDS

E-learning, Higher Education Institutes HEI, Barriers, ISM

1. INTRODUCTION

Technological improvements have significantly impacted our daily lives, including the education sector. Businesses need to adopt digital technologies and build dynamic IT capabilities and flexible IT skills (Yoshkuni et al., 2024). Advancements in technology have created both opportunities and challenges for organizations, particularly higher education institutes (HEIs) (Pavel *et al.*, 2015). The use of information and communication technology (ICT) in higher education institutions (HEIs) has stimulated innovation and improved quality education delivery(Gyamfi and Gyaase, 2017; Haque *et al.,* 2024; Martins *et al*., 2024). The adoption of online platforms for knowledge sharing has played a significant role in fostering creativity among students, thereby driving innovation in higher education (Zhang *et al.,* 2019). Since the early 2000s, there has been a growing trend toward establishing online learning systems. In the modern era, e-learning has emerged as an essential approach to teaching and learning, benefiting both educators and students (Giannakos *et al*., 2022; Gamdi and Samarji, 2016). Wu *et al*. (2010) describe e-learning as the using internet or intranet technologies to conduct lectures

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or access educational resources online. Furthermore, e-learning and information and communication technologies (ICTs) have significantly transformed teaching methodologies, research practices, and educational strategies (Djeki *et al*., 2022; MILIĆEVIĆ *et al*., 2021; Pavel *et al*., 2015).

Many educational institutes now offer their services online, either partially or entirely. Further, over the last ten years, several online and e-learning platforms have been launched by various businesses in partnership with HEIs, including Coursera, Udemy, Skillshare, and MasterClass. Several schools and universities have implemented e-learning solutions from companies like Wee-learning, Blackboard, and Desire2Learn. It has been observed that the students are more likely to adopt e-learning platforms with positive system attributes because they are seen as simpler to use (Hubalovsky *et al*., 2019; Pituch and Lee, 2006). At the same time, e-learning's social effect and mutual trust component motivate students to collaborate to learn and be satisfied (Zhang *et al*., 2019).

ICT advancements have made it possible for educational establishments like colleges, universities, and schools to implement online e-learning and training platforms (Buntak *et al*., 2021; Valverde-Berrocoso *et al*., 2020). However, a variety of obstacles to e-learning systems deter instructors from changing their methods of instruction (Gamdi and Samarji, 2016). In nations like Australia, Saudi Arabia, Sweden, Taiwan, Tanzania, and the USA, for instance, barriers included a lack of funding, a lack of faculty training, a lack of technology infrastructure, the requirement for structured online courses, and student competency (Alammary *et al*., 2022; Stecuła and Wolniak, 2022).

Similarly, across Asia, countries like Iraq and Vietnam have encountered substantial obstacles in adopting e-learning, including poor internet quality, inadequate technological infrastructure, insufficient funding, and a lack of proper training (Al-Azawei *et al*., 2016; El-Sabagh, 2021; Jamil and Muschert, 2024; Nguyen *et al*., 2020). Eli-Chukwu *et al*. (2023) concluded that the absence of e-learning curriculum, the lack of ICT usage and indadequate infrastructure were critical barriers in the integration of e-learning in Nigeria's HEI amid the Covid-19. Further, Abdelfattah et al. (2023) highlighted that the e-learning system currently in use remains underdeveloped, facing significant challenges such as limited public awareness regarding technological knowledge and essential skills, along with issues of user acceptance and technology adoption. India, too, grapples with numerous challenges in embracing and implementing e-learning. During the COVID-19 lockdown, many universities in India transitioned to online education. However, this shift proved to be both arduous and fraught with difficulties due to limited resources, low levels of awareness, and a general lack of proficiency in e-learning tools (Sathiyamoorthy *et al*., 2023). There are several critical elements that hinder the successful application of e-learning in higher education. These barriers may be interrelated to each other. So understanding how these barriers relate to one another is essential for successful e-learning implementation since these obstacles may influence the implementation process and their impact varies depending on the degree of interaction.

It is crucial to identify and model these significant barriers while also understanding their interconnections to develop and implement effective strategies for adopting e-learning. The current study aims to investigate the following research questions:

1) What are the current critical barriers to adoption of e-learning in HEI?
2) What is the interdependent contextual relations among the barriers in the adoption of e learning in HEIs ?

The remainder of the paper is organized as follows: Section 2 summarizes the latest findings on e-learning in academics and points up barriers to its uptake. The employed research approach is described in Section 3. The steps that make up the ISM-MICMAC analysis technique for modeling e-learning barriers are explained in Section 4. While Section 5 offers the ramifications and Section 6 summarizes the findings and discusses their implications. Section 8 wraps up the research paper with the limitations along with the scope of further research.

2. LITERATURE REVIEW

2.1 E-Learning and Education

E-learning is defined as "E-learning refers to education delivered through technology, allowing learners to achieve specific learning objectives without the need for the instructor and learner to be physically present in the same location." (O'Neill, 2024). The term "e-learning" is increasingly only used to refer to online-based training, or educational materials that are distributed over a network via a web browser.

The emergence of interactive Web 2.0 technologies marked a shift toward student-centered teaching and learning approaches in higher education. As technology continues to advance, e-learning in higher education evolves, creating new possibilities for both students and educators(Gamdi and Samarji, 2016). E-learning in higher education continues to progress alongside emerging technologies, offering enhanced opportunities for both students and faculty (Hassanzadeh *et al*., 2012; Noorulhasan et al., 2017). However, its success faces substantial challenges, not only in terms of lack of infrastructure and logistics but also in absence of pedagogy and content development. Effective integration of e-learning technology across the diverse activities and teaching-learning processes within higher education institutions (HEIs) requires a comprehensive and strategically planned approach.

Table 1. Barriers to the adoption of e-learning in HEIs

S.No.	Barrier Code	Barrier	Barriers description	Reference
1	EB1	Inadequate Internet Connectivity	o Poor internet speed and reliability, especially in rural or underdeveloped areas.	Jamil and Muschert (2024), MILIĆEVIĆ, Violeta (2021), Nguyen et al. (2020)
2	EB2	Limited Technological Infrastructure	o Shortage of devices, servers, and software necessary for seamless e-learning.	Qazi et al. (2024), Assareh and Bidokht (2011), Naveed et al. (2017)
3	EB3	Financial Constraints	o Insufficient funding for developing and sustaining e-learning systems.	MILIĆEVIĆ, Violeta (2021), Jokiaho et al. (2018), Naveed et al. (2017)
4	EB4	Insufficient Faculty Training	o Lack of training programs to equip educators with the skills to effectively use e-learning tools.	Candel et al., (2024), Qazi et al., (2024)
5	EB5	Low Digital Literacy Among Students	o Students may lack the technical skills required to navigate e-learning platforms.	Latrous & Khadraoui, (2020), Assareh and Bidokht (2011), Jokiaho et al., (2018)
6	EB6	Resistance to Change	o Hesitance among faculty, students, and institutions to transition from traditional to online education.	Gamadi and samarji (2016), Latrous & Khadraoui (2020), Qazi et al., (2024)
7	EB7	Pedagogical Challenges	o Difficulties in creating engaging, interactive, and student-focused digital content.	Qazi et al., (2024), Assareh and Bidokht (2011), Jokiaho et al., (2018)
8	EB8	Time Constraints	o Educators and administrators may not have sufficient time to adapt or develop online teaching strategies.	Jokiaho et al., (2018), Naveed et al., (2017)
9	EB9	Cultural and Social Barriers	o Cultural skepticism about e-learning and its effectiveness compared to traditional education.	Latrous & Khadraoui, (2020), Jokiaho et al., (2018), Naveed et al., (2017)

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Table 1. Continued

S.No.	Barrier Code	Barrier	Barriers description	Reference
10	EB10	Language Barriers	• Limited availability of content in regional or local languages, hindering accessibility.	Buntak et al., (2021), Latrous & Khadraoui, (2020), Gamadi and samarji (2016)
11	EB11	Digital Divide	• Inequities in access to technology, creating gaps between socio-economic groups or rural and urban populations.	Jamil & Muschert, (2024), MILIĆEVIĆ et al.,(2021), Assareh and Bidokht (2011)
12	EB12	Quality Assurance Issues	• Concerns about maintaining academic standards, content accuracy, and effective assessment in online settings.	Jamil & Muschert, (2024); Wang et al., (2023), Jokiaho et al., (2018)
13	EB13	Security and Privacy Risks	• There are threats like cyberattacks, data breaches, and misuse of personal information.	Gamadi and samarji (2016), Jokiaho et al., (2018)
14	EB14	Inadequate Policy and Institutional Support	• Lack of strategic planning, leadership, and policies to guide e-learning implementation.	Gamadi and samarji (2016), Qazi et al., (2024), Naveed et al., (2017)
15	EB15	Technical Support Challenges	• Absence of robust technical support teams to address issues faced by faculty and students promptly.	MILIĆEVIĆ, Violeta (2021), Qazi et al., 2024,Jokiaho et al., (2018)

2.2 E-Learning Adoption Barriers in Education Management System

Even though there are many potential benefits to integrate e-learning with EMS, there are still several problems and barriers that prevent widespread implementation of the technology.

Qazi *et al*., (2024) studied the barriers and facilatators of e-learning in an emerging economy and identified the key barriers to e-learning integration in HEI as lack of resources and training, lack of infrastructure, inadequate policies, absence of positive mindset and attitude, reservations and concerns, government and regulatory body. Assareh and Hosseini Bidokht, (2011) concluded lack of learner confidence and expertise in using computers, access to computing facilities, attitudes towards computer and ICT usage, absence of a strong infrastructure, and lack of skilled instruction team as critical barriers to the adoption of e-learning. Jokiaho *et al*., (2018) highlighted similar issues in the context of higher education, identifying the lack of user-friendliness of the learning management systems, lack of infrastructure, and lack of organizational support, teachers' lack of knowledge and skills, lack of hardware and software as significant barriers to the assimilation of the e-learning in the HEI. Gamadi and Samarji (2016) identified faculty members‟ perceptions towards technology integration, the inaccessibility, and unavailability of the needed software and hardware, the lack of associated technical and institutional support, absence of technical support, resistance to change, and finally the lack of time and funding as crucial barriers to the adoption of e-learning in HEI. (Naveed *et al*., 2017).

3. RESEARCH METHODOLOGY

This research proposes an ISM-MICMAC methodology to achieve the decision objectives of determining the interdependent relations among the barriers ISM is utilized to create a hierarchical model based on the contextual relationship among the crucial e-learning barriers (Debnath *et al*., 2023; Mondal *et al*., 2023; Rehman and Seth, 2023). Warfield (1974) proposed the ISM methodology (Karmaker *et al*., 2021) for evaluating complex interrelationships between variables. By measuring

the impact of each variable on the others, it establishes a hierarchical structure (Agrawal and Narain, 2023). This approach uses graph theory and matrix algebra to identify a model's visual representation.

The following is a list of the crucial phases of the ISM technique (Yadav *et al*., 2020):

Step1: Determine the pertinent factors: A variety of techniques, including literature reviews, expert opinion gathering, and survey administration, can be used to identify variables.

Table 2. SSIM

	EB1	EB2	EB3	EB4	EB5	EB6	EB7	EB8	EB9	EB10	EB11	EB12	EB13	EB14	EB15
EB1		A	A	O	O	O	O	O	O	O	V	V	V	A	A
EB2			A	V	V	O	V	V	O	O	V	V	V	A	X
EB3				V	O	O	V	O	O	O	O	O	O	A	V
EB4					O	A	V	A	A	O	A	O	O	O	O
EB5						A	O	O	A	O	A	O	O	O	O
EB6							O	O	X	O	O	O	O	O	O
EB7								A	O	A	A	O	O	A	O
EB8									O	O	O	V	O	O	O
EB9										O	X	O	O	A	A
EB10											O	A	O	O	O
EB11												A	O	A	O
EB12													X	A	A
EB13														O	A
EB14															X
EB15															

Step 2: Determine the contextual link between the relevant factors

A contextual relationship between the variables is found and formed based on the study's goal. Warfield (1994) distinguished between four different kinds of relationships: temporal, neutral, influencing, and comparative.

Step 3: Structural self-interaction matrix (SSIM) for e-learning barriers

During the SSIM creation process, the symbols V, A, X, and O are utilized for establishing the context-related interrelationship among the barriers. They are described as follows –

Letter ‘V’ represents barrier x helps in the achievement of barrier y;
Letter ‘A’ represents barrier y helps in the achievement of barrier x;
Letter ‘X’ represents barriers x and y help in the achievement of each other i.e there is a reciprocating relation between the two barriers; and
Letter 'O' represents barriers x and y are not dependent on each other, i.e. no relationship exists between them.

Step 4: Develop the Initial Reachability Matrix (IRM)

Table 3. IRM

	EB1	EB2	EB 3	EB 4	EB5	EB 6	EB 7	EB 8	EB 9	EB10	EB11	EB12	EB 13	EB14	EB15
EB1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0
EB2	1	1	0	1	1	0	1	1	0	0	1	1	1	0	1
EB3	1	1	1	1	0	0	1	0	0	0	0	0	0	0	1
EB4	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
EB5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
EB6	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0
EB7	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
EB8	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0
EB9	0	0	0	1	1	1	0	0	1	0	1	0	0	0	0
EB10	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
EB11	0	0	0	1	1	0	1	0	1	0	1	0	0	0	0
EB12	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0
EB13	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
EB14	1	1	1	0	0	0	1	0	1	0	1	1	0	1	1
EB15	1	1	0	0	0	0	0	0	1	0	0	1	1	1	1

Using the substitution principles, IRM is created from the SSIM by substituting 0 or 1 in place of symbols V, A, X, and O. The IRM, so obtained, is an array of binary values 0, and 1 that depicts the direct relations between the barriers within the relationship diagram.

For the symbol V in the cell (p, q) of the SSIM, entry in cell (p, q) is 1, and entry in cell (q, p) of the IRM is 0;

For the symbol A in the cell (p, q) of the SSIM, entry in cell (p, q) is 0, and entry in cell (q, p) of the IRM is 0;

For the symbol X in the cell (p, q) of the SSIM, entry in both the cell (p, q) and in cell (q, p) of the IRM is 1.

Table 4. FRM

																Driving power
EB1	1	0	0	1*	1*	0	1*	0	1*	1*	1	1	1	0	0	9
EB2	1	1	0	1	1	1*	1	1	1*	1*	1	1	1	1*	1	14
EB3	1	1	1	1	1*	1*	1	1*	1*	1*	1*	1*	1*	1*	1	15
EB4	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	2
EB5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
EB6	0	0	0	1	1	1	1*	0	1	0	1*	0	0	0	0	6
EB7	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
EB8	0	0	0	1	0	0	1	1	0	1*	1*	1	1*	0	0	7
EB9	0	0	0	1	1	1	1*	0	1	0	1	0	0	0	0	6

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Table 4. Continued

																Driving power
EB10	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
EB11	0	0	0	1	1	1*	1	0	1	0	1	0	0	0	0	6
EB12	0	0	0	1*	1*	1*	1*	0	1*	1	1	1	1	0	0	9
EB13	0	0	0	1*	1*	1*	1*	0	1*	1*	1*	1	1	0	0	9
EB14	1	1	1	1*	1*	1*	1	1*	1	1*	1	1	1*	1	1	15
EB15	1	1	1*	1*	1*	1*	1*	1*	1	1*	1*	1	1	1	1	15
Dependent power	5	4	3	12	11	9	14	5	10	9	11	8	8	4	4	

For the symbol O in the cell (p, q) of the SSIM, entry in both the cell (p, q) and in cell (q, p) of the IRM is 0.

Step 5: Final reachability matrix FRM

FRM is generated from the IRM (Initial Reachability Matrix) through the process of transitivity check on the IRM data (Sushil, 2017). Transitivity, the fundamental premise underlying the ISM method, states that when the factor "X" is linked to "Y" and "Y" is linked to "Z," then, in essence, "X" is linked to "Z" Henceforth, value 0 in the cell (p, q) of IRM should be substituted with a 1* as per the principles of the transitivity. The cells of the matrix where the transitivity rule has been used are indicated by a (1*) in place of 1(Kamble *et al*., 2019).

Step 6: Level Partitioning of the e-learning Barriers

Level partitioning is done by separating these e-learning barriers into distinct independent levels to develop the ISM model. The reachability sets and antecedent sets for e-learning barriers are determined from the FRM.

Table 5. Level partitioning

	Reachability set	Antecedent set	Intersection	Level
EB1	1	1,2,3,14,15	1	V
EB2	2,15	2,3,14,15	2,15	VI
EB3				VII
EB4	4	1,2,3,4,8,9,11,12,13,14,15	4	II
EB5	5	1,2,3,5,6,9,11,12,13,14,15	5	I
EB6	6,9,11	2,3,6,9,11,12,13,14,15	6,9,11	III
EB7	7	1,2,3,4,5,6,9,7,8,9,10,11,12,13,14,15	7	I
EB8	8	2,3,8,14,15	8	V
EB9	6,9,11	1,2,3,6,9,11,12,13,14,15	6,9,11	III
EB10	10	1,2,3,8,9,12,13,14,15	10	II
EB11	6,9,11	1,2,3,6,8,9,11,12,13,14,15	6,9,11	III
EB12	12,13	1,2,3,8,12,13,14,15	12,13	IV
EB13	12,13	1,2,3,8,12,13,14,15	12,13	IV

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Table 5. Continued

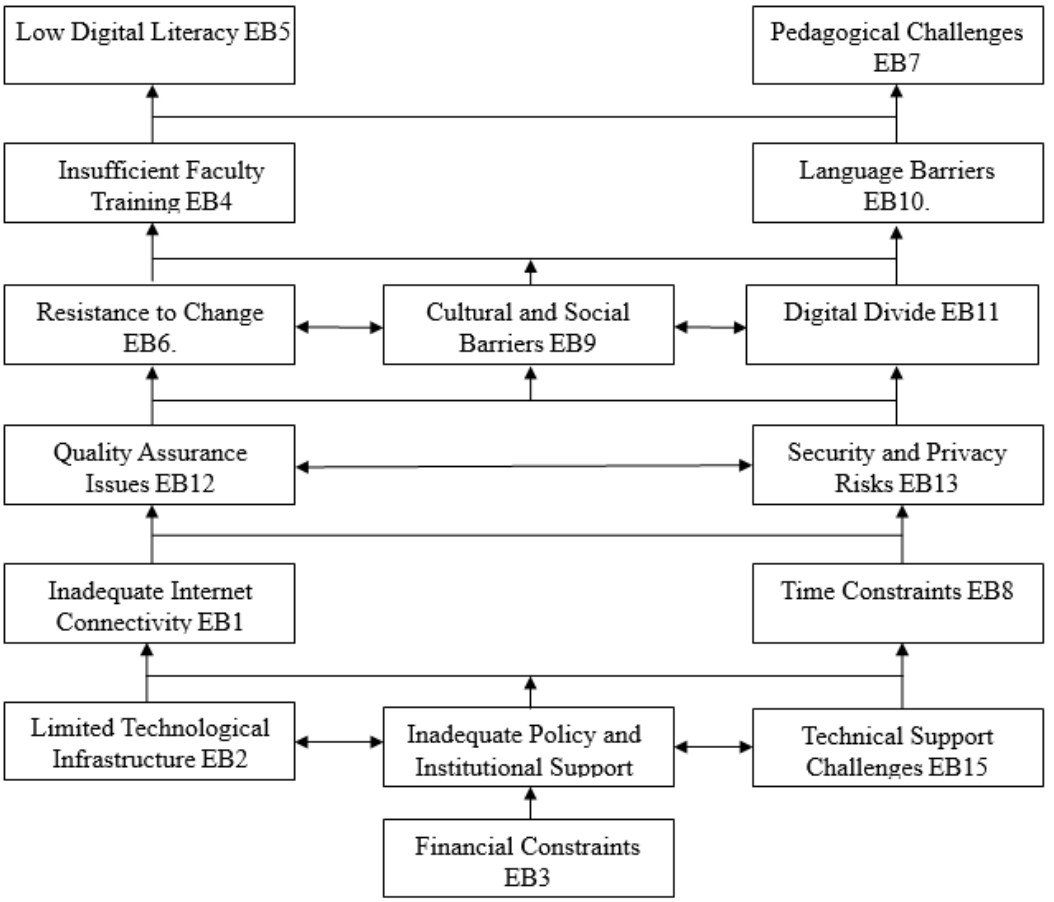
	Reachability set	Antecedent set	Intersection	Level
EB14	2,3,14,15	2,3,14,15	2,3,14,15	VI
EB15	2,3,14,15	2,3,14,15	2,3,14,15	VI

The reachability set of a barrier includes oneself as well as the remaining barriers which it assists in achieving. The antecedent set of a barrier comprises of oneself along with the barriers that help in accomplishing it. Then, the reachability set and antecedent set intersect to yield the intersection set for each e-learning barrier (Bin Khalid *et al*., 2016). Level I is designated to the e-learning barriers that have a reachability set similar to the intersection set. This concludes the first iteration. Then, the barriers that constituted Level I are discarded, and in Iteration 2, a similar approach is used while taking into account the remaining barriers. This iteration cycle proceeds until all the barriers are segregated into separate levels. All of the barriers underwent level-partitioning, which produced a consolidated seven-leveled hierarchical structure, as indicated in Table V.

Step 7: Interpretive Structural Model ISM

The ISM hierarchical structure is developed through the process of partitioning the barriers in the FRM into distinct levels. The ISM model consisted of the 15 barriers partitioned into the 7 distinct levels. The influence of one barrier on another barrier is shown by directed arrows, whereas two-way arrows depict the mutually beneficial influence of barriers on each other. Finally, a graph referred to as a digraph is obtained after the removal of transitivity from the figure. Fig. 1 displays the ISM model and its 15 barriers partitioned into 7 levels.

Figure 1. ISM structure



5.4 Cross impact Matrix Multiplication Applied to Classification (MICMAC) Analysis

MICMAC is the abbreviation of Matrice d' Impacts croises multiplication applique and classment and is done to determine the driving force and dependence power of barriers and then segregate the barriers into clusters accordingly (Yadav *et al.,* 2020). The driving force of a barrier is computed through the summation of every 1s in the row of the concerned barrier, and the dependent power of the barrier is calculated through the summation of all of the 1s in the column of the same barrier. The driving force of the barriers is drawn in the graph along the Y-axis and the dependence power is drawn along the X-axis in MICMAC graph analysis.

4. MODELLING THE BARRIERS INHIBITING THE IMPLEMENTATION OF E-LEARNING

4.1 Interpretative Structural Modeling

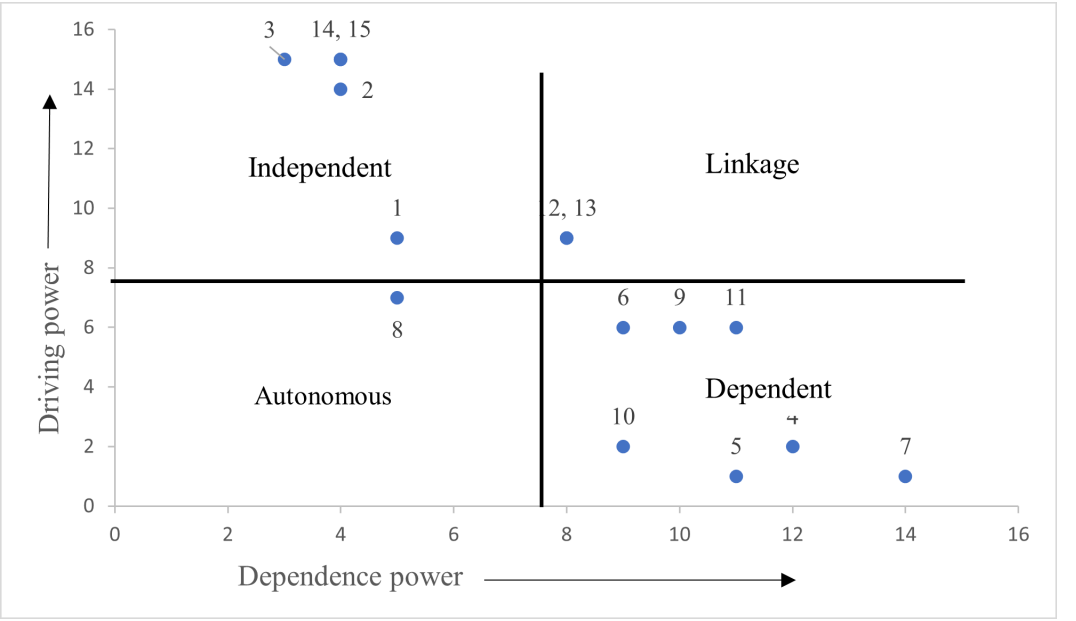
The following subsections provide an explanation of the tasks that were involved in the development of the ISM model.

4.1.1 Determining the Contextual Relation Between Several Variables

After reading through pertinent literature and consulting with academic experts, 15 barriers to e-learning implementation were selected,, examined, and finalized for the ISM analysis. Twenty five scholar's who were knowledgeable about e-learning implementation barriers were invited. The criterion of the selection of the expert was that each of them had over seven years of academic experience and was well-versed in e-learning implementation. They were chosen from higher education institutions HEI's.

To determine the relationship between the barriers, the authors held roundtable talks with the academic specialists and they were asked to interpret the relations among the chosen barriers to the adoption of e-learning in HEI. By comparing barriers with one another, the experts' comments were coded to develop the SSIM using the standard ISM notations V, A, X, O, as described in Step 3 of the ISM methodology. The contextual relationships between the 15 barriers are shown in table II

Figure 2. MICMAC analysis



4.1.2 The Initial Matrix of Reachability

The IRM was built using the SSIM table as input and the conversion rules specified in Step 4 of the ISM technique to display the relationship between the barriers in binary form of 0 and 1.

4.1.3 Final Matrix of Reachability

The transitivity criterion, as specified in Step 5 of the ISM approach, was used to create the final reachability matrix (FRM). The transitivity is represented as 1* in FRM. The driving power and the dependent power of the barriers are also included in the FRM table. A variable's dependence power is the sum of all the factors, including itself, that could contribute to its achievement. The entire number of variables, including oneself, that a variable may assist is its driving power.

4.1.4 Level Divisions

Level partitioning, which includes the reachability, antecedent, and intersection sets along with the starting and final levels of every barrier, was created by adhering to Step 6 of the ISM methodology. The level partitioning of all 15 barriers was finished in seven iterations. The variables for each iteration's reachability set, antecedent set, and intersection set are shown in Table V.

Constructing an interpretative structural model,

The transitive linkages were added to create the initial diagraph. As seen in Figure 1, this final diagraph was then transformed into an ISM model by removing the indirect links.

The final ISM model illustrated in Figure 1 shows that two barriers occupy the highest level of the hierarchy (level 1), while a single barrier (EB3) is positioned at the lowest level (level 7). Financial constraint is the crucial barrier in the adoption of e learning in HEI as it occupies the bottom of the ISM structure.

ISM model shows that the financial constraint directly leads to limited technological infrastructure, inadequate policy and institutional support and technical support challenges. These barriers lead to the inadequate internet connectivity and time constraints barriers which in turn leads to the barrier's quality assurance issues and security and privacy risk of the academic data. These two barriers lead to the resistance to change, cultural and social barriers, and digital divide barriers. These barriers leads to the two barriers in level two insufficient faculty training and language barriers. Finally, the level one is occupied by the barrier low digital literacy among the students and pedagogical challenges.

4.2 Cross Impact Matrix Multiplication Applied to Classification (MICMAC) Analysis

.Here, the barriers to e-learning adoption were segregated in four different groups as per their driving force and dependence power.

Group I – Autonomous e-learning barriers: In this group, the barrier possesses weak driving power as well as the least dependence force. Barrier time constraints is part of this group.

Group II-dependent e-learning barriers - This group comprises of the barriers possessing weak driving force and high dependence power. Insufficient faculty training, low digital literacy among the students, resistance to change falls in this group.

Group III-linkage e-learning barriers - Barriers of this group has large driving force along with the strong dependence power. These barriers exhibit a certain level of uncertainty, and any alternation to the barriers creates a feedback impact that affects other interconnected barriers. Quality assurance issues and security and privacy risks, pedagogical challenges, cultural and social barriers, language barriers, and digital divide belong to this group.

Group IV-driving e-learning barriers. These barriers possess strong driving force along with weak dependence power. Inadequate internet connectivity, limited technological infrastructure, financial constraint, inadequate policy and institutional support and technical support challenge belongs to this group.

5. FINDINGS AND DISCUSSION

E-learning is a significant area of interest for both researchers and practitioners. However, its implementation in higher education institutions is challenging due to numerous barriers that hinder successful adoption. Therefore, identifying the most critical barriers is crucial. Additionally, it is essential to explore the influence of these barriers and understand how they are interrelated during E-learning implementation. Addressing these challenges is not straightforward and requires in-depth analysis. This research primarily aims to identify and examine the relationships among these barriers, as well as to analyze their driving forces and dependencies to facilitate the successful implementation

of e-learning. To achieve these objectives, the study employs an ISM-based model and MICMAC analysis to comprehensively understand the interactions among various barriers. This approach enables higher education institution management to focus on addressing the most impactful barriers, thereby facilitating the effective implementation of e-learning.

5.1 ISM Analysis

This study has identified 15 e-learning barriers based on the literature analysis and the views of academic experts and then, the ISM-MICMAC analysis is applied to interpret the contextual relationship among the barriers to develop the ISM structure. The biggest obstacle in the adoption of e-learning in HEI is a financial constraint (EB3), which is the foundation of the system and at the bottom of the ISM hierarchy (Level 7). It cannot be altered by any other barrier, although it can directly or indirectly affect other obstacles. The financial constraints in the integration of e-learning leads to the lack of institutional support in the form of limited technical infrastructure of hardware, software and technical support for addressing the issues for the adoption of the e learning. Lack of infrastructure causes the inadequate internet connectivity in the HEI which in turn expose the e-learning system to the risk of cyber-attacks, data-breaches making it possible the misuse of personal information of the stakeholders and compromise the quality of the effective assessment of the students in online settings and accuracy of the study material contents and its availability. These issues make the stakeholders resistance to adoption of the e-learning more profound and strengthen the cultural scepticism about e-learning. Further, the lack of a robust infrastructure for e- learning leads to a digital divide among the stakeholders due the inequitable access to technology, creating gaps among the socio-economic groups. All these factors like resistance to change, lack of infrastructure and inadequate internet connectivity leads to the insufficient training programs to equip the educators with the skills to effectively use e-learning tools. Besides these, digital divide, hindering accessibility, causes the obstacles in the development and limited availability of content in regional or local languages. Finally, absence of the skilled faculty for the e-learning programs leads to the lack the technical skills among the students required to navigate e-learning platforms, leading to low digital literacy among the students and pedagogical challenges like difficulties in creating engaging, interactive, and student-focused digital content.

5.1.2 MICMAC Analysis

Figure 2 displays the findings from the MICMAC analysis. There are four groups comprising the 15 barriers. One significant outcome from the MICMAC analysis is that only one barrier inside the autonomous group, indicating that the factors that have been identified as e-learning barriers are very effective in hindering e-learning adoption in the education sector (Biswas and Gupta, 2019; Yadav et al., 2020).

Barriers such as the inadequate internet connectivity, limited technological infrastructure, financial constraints, inadequate policy and institutional support and technical support challenge, identified within the driving group, have a high driving power. Practitioners and decision-makers should prioritize these elements as the primary barriers because any change in these factors will influence other variables across all levels within the framework. Further analysis shows that insufficient faculty training, low digital literacy among the students, resistance to change are in the dependent group that has the great dependence power and less driving force. It is best to address the barriers that affect these barriers before trying to completely remove them for the successful amelioration of their effect at a later stage. Quality assurance issues and security and privacy risk, pedagogical challenges, cultural and social barriers, language barriers, and digital divide are situated within the linkage group of the graph. This implies that any modification made in any of the barriers will have a cascading effect on other barriers at various levels and generate feedback in return.

6. ACADEMIC AND MANAGERIAL IMPLICATIONS

This section offers valuable insights for researchers, managers, academics, and policymakers involved in educational institutions and startups adopting e-learning or developing online learning platforms. The findings of this study will aid managers and researchers in making well-informed decisions regarding the barriers to implementing e-learning within EMS in higher education institutions, both from theoretical and practical perspectives.

6.1 Academic Implications

An extensive review of the literature on the adoption of e-learning within educational management systems of HEI highlights a significant gap. Most studies have not thoroughly addressed the relations among the barriers hindering e-learning. This research bridges that gap by establishing contextual connections between e-learning barriers in HEI's. While previous works explored general e-learning adoption barriers, they largely overlooked contextual relations among the barriers prevalent in EMS. This study aims to address this limitation by examining critical barriers and developing hierarchical models to illustrate their contextual relationships.

As one of the pioneering studies to thoroughly analyze e-learning adoption barriers in EMS, it provides a deeper understanding of these barriers and their interdependencies, laying the groundwork for future research and innovation. Recognizing the challenge of addressing all barriers in a single study, this research identifies key barrier factors through expert opinions, industry reports, and existing literature. Using a two-phase ISM-MICMAC methodology, it categorizes these factors and uncovers their contextual relationships.

This study serves as a foundational step in advancing research on e-learning adoption barriers in HEI, encouraging further exploration and offering a framework for empirical investigations into these barriers. It also inspires future studies to focus on strategies for overcoming these challenges to facilitate successful e-learning implementation in HEI.

6.2 Managerial and Policy Implications

The findings of this research hold significant value for management and policy development. The proposed framework and results can aid policymakers, business leaders, and academics in pinpointing the critical barriers that hinder the adoption of e-learning in HEI's. Additionally, this study enriches existing knowledge by guiding policymakers and managers in making strategic decisions to address specific barriers, thereby mitigating their impact and contributing to the enhancement of educational sustainability.

The hierarchical model of barriers, developed using ISM, highlights the complex contextual interrelations among the barriers. This insight enables policymakers to formulate both immediate contingency measures and long-term strategies to effectively tackle the challenges associated with e-learning adoption.

This study highlights critical managerial and policy implications to overcome barriers to e-learning adoption in higher education institutions (HEIs). Financial constraints, identified as the root challenge, necessitate increased funding and resource allocation to improve technical infrastructure, including hardware, software, internet connectivity, and cybersecurity. Addressing the digital divide is essential, requiring equitable access to technology through subsidized devices, affordable internet, and rural technology hubs. Institutions must strengthen capacity building by providing educators with targeted training programs to enhance digital literacy, online pedagogical skills, and effective use of e-learning tools. To counter resistance and cultural skepticism, awareness campaigns should emphasize e-learning's benefits, engaging stakeholders like educators, students, and parents to build trust. Developing inclusive content in regional and local languages is vital to making platforms accessible to diverse learners. Additionally, improving students' digital literacy through foundational courses and support programs is crucial for successful navigation of e-learning systems. Policymakers must

integrate these solutions into national education strategies, fostering collaboration across technology, education, and government sectors.

By addressing these barriers systematically, HEIs can enhance e-learning's accessibility, mitigate risks like data breaches, and reduce pedagogical challenges. This approach ensures a robust, inclusive, and sustainable e-learning environment that bridges socio-economic and geographic divides, ultimately driving educational transformation.

7. CONCLUSIONS AND LIMITATIONS

The digitization of education has significantly expanded its reach across borders, with digital technologies complementing and, in some cases, replacing traditional teaching methods. E-learning offers promising solutions for digitized education, including efficient credential verification, transparent record-keeping, secure data sharing, and fostering collaboration and learning. However, the adoption of e-learning in HEI faces multiple barriers. This study identified 15 such barriers through an extensive literature review and expert input. Using a combined ISM-MICMAC methodology, the barriers were analyzed. The identified 15 key barriers were structured into a hierarchical model and categorized into four groups based on their driving and dependent powers using MICMAC analysis. This study shows that the financial constraints, being at the bottom of the ISM structure, are the major roadblock in the assimilation e-learning within the HEIs. The insufficient funds for developing the e-learning led to the weak infrastructure like lack of devices, servers, and software, poor internet speed for e-learning. So, government and institutions should provide the funds for development of the e-learning.

This research offers practical value by providing a framework for policymakers, entrepreneurs, and leaders to prioritize and address these barriers. The hierarchical model aids in devising short- and long-term strategies, contributing to education sustainability while ensuring smooth academic operations.

Nevertheless, the study has limitations. First, the model is based solely on expert opinions, introducing potential bias. Future research should incorporate diverse stakeholder perspectives for a broader understanding. Second, as the analysis is contextualized to India, the findings may not apply universally, necessitating studies across different economies. Third, the relationships among barriers lack statistical validation, which could be addressed in future research using structural equation modeling (SEM). Lastly, repeating this research in other business domains could yield valuable insights for broader applications.

CONFLICTS OF INTEREST

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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REFERENCES

Abdelfattah, F., Al Alawi, A. M., Dahleez, K. A., & El Saleh, A. (2023). Reviewing the critical challenges that influence the adoption of the e-learning system in higher educational institutions in the era of the COVID-19 pandemic. *Online Information Review*, *47*(7), 1225–1247. DOI: 10.1108/OIR-02-2022-0085

Agrawal, P., & Narain, R. (2023). BC59_Analysis of enablers for the digitalization of supply chain using an interpretive structural modelling approach. *International Journal of Productivity and Performance Management*, *72*(2). Advance online publication. DOI: 10.1108/IJPPM-09-2020-0481

Alammary, A., Alshaikh, M., & Alhogail, A. (2022). The impact of the COVID-19 pandemic on the adoption of e-learning among academics in Saudi Arabia. *Behaviour & Information Technology*, *41*(14). Advance online publication. DOI: 10.1080/0144929X.2021.1973106

Al-Azawei, A., Parslow, P., & Lundqvist, K. (2016). Barriers and opportunities of e-learning implementation in Iraq: A case of public universities. *International Review of Research in Open and Distance Learning*, *17*(5). Advance online publication. DOI: 10.19173/irrodl.v17i5.2501

Assareh, A., & Hosseini Bidokht, M. (2011). Barriers to E-teaching and E-learning. *Procedia Computer Science*, *3*, 791–795. Advance online publication. DOI: 10.1016/j.procs.2010.12.129

Bin Khalid, Z., Mufti, N. A., & Ahmad, Y. (2016), "BC3_Identifying and Modeling Barriers to Collaboration among Auto-parts Manufacturing SMEs", Pakistan Business Review, Vol. 18 No. 2.

Buntak, K., Mutavdžija, M., & Kovačić, M. (2021). Differences of E-Learning Systems With the Focus on Moodle and Blackboard Systems. *International Journal of E-Services and Mobile Applications*, *13*(1), 15–30. Advance online publication. DOI: 10.4018/IJESMA.2021010102

Candel, E. C., de-la-Peña, C., & Yuste, B. C. (2024). Pre-service teachers' perception of active learning methodologies in history: Flipped classroom and gamification in an e-learning environment. *Education and Information Technologies*, *29*(3), 3365–3387. Advance online publication. DOI: 10.1007/s10639-023-11924-0

Debnath, B., Bari, A. B. M. M., de Jesus Pacheco, D. A., & Karmaker, C. L. (2023). BC22_An integrated Best–Worst Method and Interpretive Structural Modeling approach for assessing the barriers to circular economy implementation. *Decision Analytics Journal*, *7*, 100250. Advance online publication. DOI: 10.1016/j.dajour.2023.100250

Djeki, E., Dégila, J., Bondiombouy, C., & Alhassan, M. H. (2022). E-learning bibliometric analysis from 2015 to 2020. *Journal of Computers in Education*, *9*(4), 727–754. Advance online publication. DOI: 10.1007/s40692-021-00218-4

El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education*, *18*(1), 53. Advance online publication. DOI: 10.1186/s41239-021-00289-4

Eli-Chukwu, N. C., Igbokwe, I. C., Ifebude, B., Nmadu, D., Iguodala, W., Uma, U., Onyeneke, R. U., & Akudo, F. U. (2023). Challenges confronting e-learning in higher education institutions in Nigeria amid Covid -19. *Journal of Applied Research in Higher Education*, *15*(1), 238–253. DOI: 10.1108/JARHE-09-2021-0346

Giannakos, M. N., Mikalef, P., & Pappas, I. O. (2022). Systematic Literature Review of E-Learning Capabilities to Enhance Organizational Learning. *Information Systems Frontiers*, *24*(2), 619–635. Advance online publication. DOI: 10.1007/s10796-020-10097-2 PMID: 33551669

Gyamfi, S. A., & Gyaase, P. O. (2017). Virtualization of university education: The impact of ICT-mediated learning environment on students' performance. *International Journal of E-Services and Mobile Applications*, *9*(4), 24–40. Advance online publication. DOI: 10.4018/IJESMA.2017100102

Haque, M. A., Haque, S., Zeba, S., Kumar, K., Ahmad, S., Rahman, M., Marisennayya, S., & Ahmed, L. (2024). Sustainable and efficient E-learning internet of things system through blockchain technology. *E-Learning and Digital Media*, *21*(3), 216–235. Advance online publication. DOI: 10.1177/20427530231156711

Hassanzadeh, A., Kanaani, F., & Elahi, S. (2012). A model for measuring e-learning systems success in universities. *Expert Systems with Applications*, *39*(12), 10959–10966. Advance online publication. DOI: 10.1016/j.eswa.2012.03.028

Hubalovsky, S., Hubalovska, M., & Musilek, M. (2019). Assessment of the influence of adaptive E-learning on learning effectiveness of primary school pupils. *Computers in Human Behavior*, *92*, 691–705. Advance online publication. DOI: 10.1016/j.chb.2018.05.033

Jamil, S., & Muschert, G. (2024). The COVID-19 Pandemic and E-Learning: The Digital Divide and Educational Crises in Pakistan's Universities. *The American Behavioral Scientist*, *68*(9), 1161–1179. Advance online publication. DOI: 10.1177/00027642231156779

Jokiaho, A., May, B., Specht, M., & Stoyanov, S. (2018). Barriers to using E Learning in an Advanced Way *International Journal of Advanced Corporate Learning*, *11*(1), 17. Advance online publication. DOI: 10.3991/ijac.v11i1.9235

Kamble, S. S., Gunasekaran, A., & Raut, R. D. (2019). BC2_Analysing the implementation barriers of dual cycling in port container terminal using interpretive structural modeling- Indian context. *International Journal of Logistics*, *22*(2), 119–137. Advance online publication. DOI: 10.1080/13675567.2018.1492531

Karmaker, C. L., Ahmed, T., Ahmed, S., Ali, S. M., Moktadir, M. A., & Kabir, G. (2021). BC27_Improving supply chain sustainability in the context of COVID-19 pandemic in an emerging economy: Exploring drivers using an integrated model. *Sustainable Production and Consumption*, *26*, 411–427. Advance online publication. DOI: 10.1016/j.spc.2020.09.019 PMID: 33015267

Latrous, W. O., & Khadraoui, M. (2020). Cultural challenges of e-learning experiences an exploratory research. *International Journal of E-Services and Mobile Applications*, *12*(3), 18–37. Advance online publication. DOI: 10.4018/IJESMA.2020070102

Martins, J., Gonçalves, R., & Branco, F. (2024). A bibliometric analysis and visualization of e-learning adoption using VOSviewer. *Universal Access in the Information Society*, *23*(3), 1177–1191. Advance online publication. DOI: 10.1007/s10209-022-00953-0 PMID: 36530863

Milićević, V., Denić, N., Milićević, Z., Arsić, L., Spasić-Stojković, M., Petković, D., Stojanović, J., Krkic, M., Milovančević, N. S., & Jovanović, A.MILIĆEVIĆ. (2021). E-learning perspectives in higher education institutions. *Technological Forecasting and Social Change*, *166*, 120618. Advance online publication. DOI: 10.1016/j.techfore.2021.120618

Mondal, S., Singh, S., & Gupta, H. (2023). BC24_Assessing enablers of green entrepreneurship in circular economy: An integrated approach. *Journal of Cleaner Production*, *388*, 135999. Advance online publication. DOI: 10.1016/j.jclepro.2023.135999

Naveed, Q. N., Qureshi, M. R. N., Alsayed, A. O., Muhammad, A. H., Sanober, S., & Shah, A. (2017), "Prioritizing barriers of E-Learning for effective teaching-learning using fuzzy analytic hierarchy process (FAHP)", 4th IEEE International Conference on Engineering Technologies and Applied Sciences, ICETAS 2017, Vol. 2018-January, DOI: 10.1109/ICETAS.2017.8277855

Nguyen, Q. L. H. T. T., Nguyen, P. T., Huynh, V. D. B., & Nguyen, L. T. (2020). Application Chang's extent analysis method for ranking barriers in the e-learning model based on multi-stakeholder decision making. *Universal Journal of Educational Research*, *8*(5), 1759–1766. Advance online publication. DOI: 10.13189/ujer.2020.080512

Noorulhasan, Q., Muhammad, A., Sanober, S., Rafik, M., & Shah, A. (2017). A Mixed Method Study for Investigating Critical Success Factors (CSFs) of E-Learning in Saudi Arabian Universities. *International Journal of Advanced Computer Science and Applications*, *8*(5). Advance online publication. DOI: 10.14569/IJACSA.2017.080522

O'Neill, A. (2024). Was humpty dumpty right?: Towards a functional definition of e-learning. *Education and Information Technologies*, *29*(2), 2093–2115. Advance online publication. DOI: 10.1007/s10639-023-11900-8

Pavel, A.-P., Fruth, A., & Neacsu, M.-N. (2015). ICT and E-Learning – Catalysts for Innovation and Quality in Higher Education. *Procedia Economics and Finance*, *23*, 704–711. Advance online publication. DOI: 10.1016/S2212-5671(15)00409-8

Pituch, K. A., & Lee, Y. (2006). The influence of system characteristics on e-learning use. *Computers & Education*, *47*(2), 222–244. Advance online publication. DOI: 10.1016/j.compedu.2004.10.007

Qazi, M. A., Sharif, M. A., & Akhlaq, A. (2024). Barriers and facilitators to adoption of e-learning in higher education institutions of Pakistan during COVID-19: Perspectives from an emerging economy. *Journal of Science and Technology Policy Management*, *15*(1), 31–52. Advance online publication. DOI: 10.1108/JSTPM-01-2022-0002

Rehman, M. A., & Seth, D. (2023). BC23_Investigation and modeling of electric vehicle enablers (EVE) for successful penetration in context to India: Mitigating the effect of urban sprawl on transportation. *Environmental Science and Pollution Research International*, *30*(49), 107118–107137. Advance online publication. DOI: 10.1007/s11356-023-26022-4 PMID: 36849689

Sathiyamoorthy, R., Ramesh, V. L., Chettri, M., Ziephru, S., & Kamath, R. (2023). Enablers and Barriers to Online Education in India: A Systematic Review. *International Journal of Educational Reform*, 10567879231202485. Advance online publication. DOI: 10.1177/10567879231202485

Stecuła, K., & Wolniak, R. (2022). Advantages and Disadvantages of E-Learning Innovations during COVID-19 Pandemic in Higher Education in Poland. *Journal of Open Innovation*, *8*(3), 159. Advance online publication. DOI: 10.3390/joitmc8030159

Sushil. (2017), "Multi-criteria valuation of flexibility initiatives using integrated TISM–IRP with a big data framework", Production Planning and Control, Vol. 28 No. 11–12, .DOI: 10.1080/09537287.2017.1336794

Valverde-Berrocoso, J., del Carmen Garrido-Arroyo, M., Burgos-Videla, C., & Morales-Cevallos, M. B. (2020). *Trends in educational research about e-Learning: A systematic literature review (2009-2018).* Sustainability., DOI: 10.3390/su12125153

Wang, Y. M., Wei, C. L., Chen, W. J., & Wang, Y. S. (2023). Revisiting the E-Learning Systems Success Model in the Post-COVID-19 Age: The Role of Monitoring Quality. *International Journal of Human-Computer Interaction*. Advance online publication. DOI: 10.1080/10447318.2023.2231278

Warfield, J. (1994). *Science of Generic Design: Managing Complexity through Systems Design*. Iowa State Press.

Warfield, J. N. (1974). C27 Toward Interpretation of Complex Structural Models. *IEEE Transactions on Systems, Man, and Cybernetics*, *4*(5), 405–417. Advance online publication. DOI: 10.1109/TSMC.1974.4309336

Williams, P. (2019). Does competency-based education with blockchain signal a new mission for universities? *Journal of Higher Education Policy and Management*, *41*(1), 104–117. DOI: 10.1080/1360080X.2018.1520491

Yadav, V. S., Singh, A. R., Raut, R. D., & Govindarajan, U. H. (2020). BC17_Blockchain technology adoption barriers in the Indian agricultural supply chain: An integrated approach. *Resources, Conservation and Recycling*, *161*, 104877. Advance online publication. DOI: 10.1016/j.resconrec.2020.104877

Yoshikuni, A. C., Dwivedi, R., Kamal, M. M., Zhou, D., Dwivedi, P., & Apolinário, S. A dynamic information technology capability model for fostering innovation in digital transformation, Journal of Innovation & Knowledge, Volume 9, Issue 4, 2024, 100589, ISSN 2444-569X, DOI: 10.1016/j.jik.2024.100589

Zhang, X., Meng, Y., Ordóñez de Pablos, P., & Sun, Y. (2019). Learning analytics in collaborative learning supported by Slack: From the perspective of engagement. *Computers in Human Behavior*, *92*, 625–633. Advance online publication. DOI: 10.1016/j.chb.2017.08.012

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