Ranking of barriers for the internet of things implementation in the E-learning platform

Vinay Kumar Yadav (vinayy245@gmail.com)
National Institute of Technology Kurukshetra https://orcid.org/0000-0003-2816-4077
Sanjeev Yadav
National Institute of Technology Kurukshetra

Research Article

Keywords: Internet of thing (IoT), Interpretive Structural Modelling (ISM), E-learning, Management Cross Impact Multiplications Applied to Classification (MICMAC)

Posted Date: September 28th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-936550/v1

Abstract

Learning through the Web or training via e-learning is rising exponentially and is gradually preferred by conventional ways of education and training. This massive change is directly related to digital computer technological advancement. The transformation driven by innovation in computer technology has enhanced the reach of e-learning and education, making the process of sharing knowledge easy, clear, and efficient. The E-learning system relies on various success factors from several viewpoints, such as framework, organisational alignment, instructor, and student support. This paper aims to identify the critical barriers to the Internet of Thing implementation in e-learning and to establish a relational relationship between identified barriers using the Interpretive Structural Modelling approach. This paper has established some primary barriers that are useful for Internet of Things implementation in E-learning by research scholars and industrial practitioners. For the study of the driving force and dependency power of the E-learning barrier, Interpretive Structural Modelling methodology was used to classify interrelationships between barriers for improved understanding and relationships between these barriers, and Management Cross Impact Multiplications were conducted to estimate the magnitude of these relationships. Applied to classification analysis, which is used for analysing the driving power and dependence power of E-learning barriers.

1. Introduction

E-learning is a cutting-edge learning and teaching approach that improves education and learning processes in an online environment [1, 2]. E-learning platforms, which are except in time and place, provide training and learning opportunities and play a key role in promoting new methods of teaching [3]. It is noted that numerous developing nations have introduced and implemented e-learning for education. It can involve a full focus on the learning platform, integrated e-learning, or a conventional blackboard classroom with e-learning.

Despite its benefits, the complete and effective implementation of E-learning has yet to be achieved [4]. If E-learning is effectively incorporated in the education sector, several potential advantages can be seen. Previous research has shown that critical success factors (CSFs) play a key role in the successful implementation of e-learning. Besides, it's also been shown that essential factors of different dimensions can have different effects on the e-learning system [5–7]. Thus, it is important that the analysis and resource allocation of the E-learning CSFs be specifically examined and that a proposed framework of the success factors of E-learning is presented.

Figure 1 shows the basic framework of this research. The e-learning system relies on various success factors from several viewpoints, such as framework, organisational alignment, instructor, and student support. Therefore, to make it more competitive and efficient, the effects of critical success factors (CSFs) on the E-learning system must be critically evaluated. Interpretive Structural Modelling (ISM) was used in this current paper to study the diversified aspects of various dimensions of the web-based E-learning system. Through the literature review, the current paper quantified the CSFs along with their 8 factors associated with the web-based e-learning framework and was further analysed. Besides, each factor's effect was successfully derived. From the literature review, eight key E-learning barriers are identified which curb the efficiency of the E-learning system. After identifying the barriers, the influencing power of each barrier in the e-learning is found based on the driving and dependent power calculated in the MICMAC analysis. There are various techniques available for providing a structure-based relationship of the enablers, such as The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Analytical Hierarchical Process (AHP), but they cannot provide a quantified view of the inter-relationships. Hence, for the quantification of the interrelationships of any sophisticated system, an integrated MICMAC-based ISM approach may be applied. Therefore, based on expert and academic opinions, the ISM technique is used for developing contextual relations between the variables. Based on this, a complex relationship is converted into a simpler relationship. Furthermore, this paper is divided into five sections: a literature review in Sect. 2, research methodology and numerical illustration in Sect. 3, discussion of findings in Sect. 4, and conclusion in Sect. 5.

2. Literature Review

In the literature review, eight critical success factors for IoT implementation in e-learning platforms have been identified as given below:

Table 1
The critical success factor for IoT implementation in an E-learning system.

Barriers No.	Barriers	Briefs Description	References
B1	Cloud Data Security	This aspect focuses on the risks and problems involved with the introduction of cloud computing. Using e-Learning by Cloud is more about conventional eLearning. It is easy to manage security upgrades, data protection, and user knowledge, which can not only improve device conviction but also decrease total costs for users.	[8]
B2	Ineffective data sharing	The authority's staff and dealer relationships can efficiently implement IoT in E-learning by giving proper instruction and guidelines to get suitable data and techniques by conducting a presentation and various training plans to resolve barriers.	[9–10]
B3	Internet of Thing	This aspect focuses on the IT framework to provide teaching materials and strategies. which covers reliability, performance, ease of practice, safety and security, privacy, and knowledge.	[10–15]
B4	Level of Collaboration	This aspect explores the extent of coordination between academic staff. which involves a lack of social involvement, oversight of the project staff, and management assistance.	[9–10, 13, 16]
B5	Technology Knowledge	This aspect focuses on the experience of the use of technology for both students and teachers. which involves the practice of computer machines, the use of application software, and the interaction of communication.	[9, 13–16]
B6	Learning Environment	It observes the learning environment and the services offered to both teachers and students. This includes a blended learning model, network bandwidth, digital learning, and connectivity and navigation.	[9, 13–16]
B7	Knowledge Management	This aspect refers to the management expertise of faculty members and administration within the educational institution. This covers the executive team, distribution and maintenance management, management skills, critical thinking, and execution skills.	[9, 10, 14, 16]
B8	Instructional Design	This aspect focuses on the educational system to fulfil the goals of the university. It involves the quality of content, conceptual insight, instructional methods, and learning strategies.	[9, 13, 14]

The above barriers have been identified based on the literature review for implementing IoT in E-learning systems. The ISM methodology was used to create a relationship for identified critical success factors. ISM methodology has been implemented in several areas as given below in Table 2.

Table 2
Literature review of ISM

Author Name	Description
Rupesh Tiwari,2013	The ISM approach is implemented in transportation to solve the complicated conditions for fulfilling consumers’ needs [16].
George Pramod,2014	Identified all barriers in the milling industry based on the ISM approach. [17].
Ravi Kant,2015	identified relationships between SCM barriers based on the ISM and MICAMAC [18].
R Dubey and T Singh,2015	ISM and MICMAC were used to connect the barriers of the lean-based industry [19]

3. Ism Methodology

The ISM technique is a model-based process for generating a systematic structure between interlinked entities. This technique is mainly used when the variables are interdependent. This method converts the complicated relationship between the variables into a simple level-based structure, which is easy to understand. This method consists of three steps as discussed below:

Step I

Develop a Structural Self-Interaction Matrix (SSIM) between the identified entities as shown in Table 3 and Table 4. In this step, the initial reachable matrix has been obtained.

Table 3
SSIM

	B1	B2	B3	B4	B5	B6	B7	B8
B1	-	O	O	A	V	A	V	X
B2		-	O	O	V	A	V	A
B3			-	O	V	V	V	V
B4				-	O	V	O	V
B5					-	O	O	V
B6						-	O	O
B7							-	O
B8								-

Table 4
Initial Reachability Matrix

	B1	B2	B3	B4	B5	B6	B7	B8
B1	1	0	0	0	1	0	1	1
B2	0	1	0	0	1	0	1	0
B3	0	0	1	0	1	1	1	1
B4	1	0	0	1	0	1	0	1
B5	0	0	0	0	1	0	0	1
B6	1	1	0	0	0	1	0	0
B7	0	0	0	0	0	0	1	0
B8	1	1	0	0	0	0	0	1

Step II

Using the transitive rule, the finale reachable matrix (FRM) was obtained in this step. Based on this matrix, driving power and dependence power have been calculated as shown in Table 5. By using this table, MICMAC analysis has been done to find out different cluster categories for the barriers as shown in Fig. 2.

Table 5
FRM

	B1	B2	B3	B4	B5	B6	B7	B8	Driving power
B1	1	1*	0	0	1	0	1	1	5
B2	0	1	0	0	1	0	1	1*	4
B3	1*	1*	1	0	1	1	1	1	7
B4	1	1*	0	1	1*	1	1*	1	7
B5	1*	1*	0	0	1	0	0	1	4
B6	1	1	0	0	1*	1	1*	1*	6
B7	0	0	0	0	0	0	1	0	1
B8	1	1	0	0	1*	0	1*	1	5
Dependence power	6	7	1	1	7	3	7	7	39/39

Step III

In this step, by using iteration, different levels have been identified for making a systematic digraph model as shown in Tables 6, 7, and 8. Based on this iteration, Fig. 3 has been obtained.

Table 6
Initial Iteration

S no.	Reachability set	Antecedent set	Intersection set	Levels
01	1,2,5,7,8	1,3,4,5,6,8	1,5,8	
02	2,5,7,8	1,2,3,4,5,6,8	2,5,8	
03	1,2,3,5,6,7,8	3	3	
04	1,2,4,5,6,7,8	4	4	
05	1,2,5,8	1,2,3,4,5,6,8	1,2,5,8	Level 1
06	1,2,5,6,7,8	3,4,6	6	
07	7	1,2,3,4,6,7,8	7	Level 1
08	1,2,5,7,8	1,2,3,4,5,6,8	1,2,5,8	

Table 7
1st Iteration

S no.	Reachability set	Antecedent set	Intersection set	Levels
01	3,6	3	3	
02	4,6	4	4	
03	6	3,4,6	6	Level 2

Table 8
2nd Iteration

S no.	Reachability set	Antecedent set	Intersection set	Levels
01	3	3	3	Level 3
02	4	4	4	Level 3

4. Discussion

This paper has identified eight barriers to implementing IoT technology in e-learning platforms, namely, Cloud Data Security, ineffective data sharing, Internet of Things (IoT), level of collaboration, technology knowledge, learning environment, knowledge management, and instructional design. For effective IoT implementation in E-learning. This paper also develops an interrelationship between the identified barriers using the ISM approach. Based on the ISM approach and MICMAC analysis, it has been found that B3, B4 and B6 act as the main driver barriers. B1, B2, B5, and B8 are the linkage barriers. These barriers act as a link point between the driver and the dependent barrier. Finally, the B2, B5, B7 barrier has been found as a dependent barrier. There has been no barrier found in the autonomous quadrant. The interrelationship developed by this paper may help managers of the organisation identify and analyse the barriers to IoT implementation in e-learning.

5. Conclusion

This paper has identified different barriers, namely, cloud data security, ineffective data sharing, the Internet of Things (IoT), level of collaboration, technology knowledge, learning environment, knowledge management, and instructional design. Based on ISM and MICMAC analysis, identified barriers are categorised into four clusters, like linkage cluster, driver cluster, autonomous and dependent cluster. Furthermore, based on the ISM, a model of the interdependent barrier has to be developed. In this model, B1, B2, B5, B7, and B8 are found at level 1st and come under the dependent and linkage clusters. Similarly, B6 comes under the second level and driver's cluster. Finally, B3 and B4 are at level 3 and come under the driver cluster. In the future, this study may guide managers as well as researchers to implement this research in other e-learning organisations (Chegg) to achieve more competitiveness and sustainable goals. But this research has limitations in taking only a limited number of factors into account. Also, this research did not consider the extent of the dependency between the identified variables.

Declarations

Competing interests:

The authors declare no competing interests.

References

1. Zare M, Pahl C, Rahnama H, Nilashi M, Mardani A, Ibrahim O and Ahmadi H 2016 Multi-criteria decision making approach in e-learning: A systematic review and classification *Applied Soft Computing* **45** 108–28
2. Samsudeen S N and Mohamed R 2019 University students' intention to use e-learning systems *Interactive Technology and Smart Education* **16** 219–38
3. Alhabeeb A and Rowley J 2018 E-learning critical success factors: Comparing perspectives from academic staff and students *Computers & Education* **127** 1–12
4. Gamdi M A and Samarji A 2016 Perceived barriers TOWARDS E-learning by faculty members at a recently established University in Saudi Arabia *International Journal of Information and Education Technology* **6** 23–8
5. Noorulhasan Q, Muhammad A H, Sanober S, Rafik M and 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**
6. Ahmad N, Quadri N, Qureshi M and Alam M 2018 Relationship modeling of critical success factors for enhancing sustainability and performance in e-learning *Sustainability* **10** 4776
7. Naveed Q N, Qureshi M R, Alsayed A O, Ahmad N, Sanober S and Shah A 2017 Assimilating e-learning barriers using an interpretive structural modeling (ism) *2017 4th IEEE International Conference on Engineering Technologies and Applied Sciences (ICETAS)*
8. El Mhouti A, Erradi M and Nasseh A 2017 Using cloud computing services in e-learning process: Benefits and challenges *Education and Information Technologies* **23** 893–909
9. Noorulhasan Q, Muhammad A H, Sanober S, Rafik M and 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**
10. Anggrainingsih R, Umam M Z and Setiadi H 2018 Determining e-learning success factor in higher education based on user perspective using Fuzzy ahp *MATEC Web of Conferences* **154** 03011
11. Alhabeeb A and Rowley J 2018 E-learning critical success factors: Comparing perspectives from academic staff and students *Computers & Education* **127** 1–12

12. Tan B S and Wong S L 2020 Learning principles of accounting in ICT-SUPPORTED learning environments of MALAYSIAN Secondary schools: FUTURE-ORIENTED APPROACH *Research and Practice in Technology Enhanced Learning* **15**
13. Priatna T, Maylawati D S, Sugilar H and Ramdhani M A 2020 Key success factors of e-learning implementation in higher education *International Journal of Emerging Technologies in Learning (iJET)* **15** 101
14. Alhabeeb A and Rowley J 2017 Critical success factors for elearning in Saudi arabian universities *International Journal of Educational Management* **31** 131–47
15. Behzadian M, Khanmohammadi Otaghsara S, Yazdani M and Ignatius J 2012 A state-of THE-ART survey Of TOPSIS applications *Expert Systems with Applications* **39** 13051–69
16. Tiwari R K 2013 Identification of factors affecting reverse chain performance in relation to customer satisfaction using ISM Modelling & MICMAC Analysis *Uncertain Supply Chain Management* 237–52
17. George J P and Pramod V R 2014 An interpretive structural model (ISM) analysis approach in steel re rolling mills (SRRMs) *Int. J. Res. Eng. Technol* 2, no. **4** 161–174.
18. Ravi V 2015 Analysis of interactions among barriers of eco-efficiency in electronics packaging industry *Journal of Cleaner Production* **101** 16–25
19. Dubey R and Singh T 2015 Understanding complex relationship among JIT, lean behaviour, TQM and their antecedents using interpretive structural modelling and fuzzy MICMAC analysis *The TQM Journal* **27** 42–62

Figures

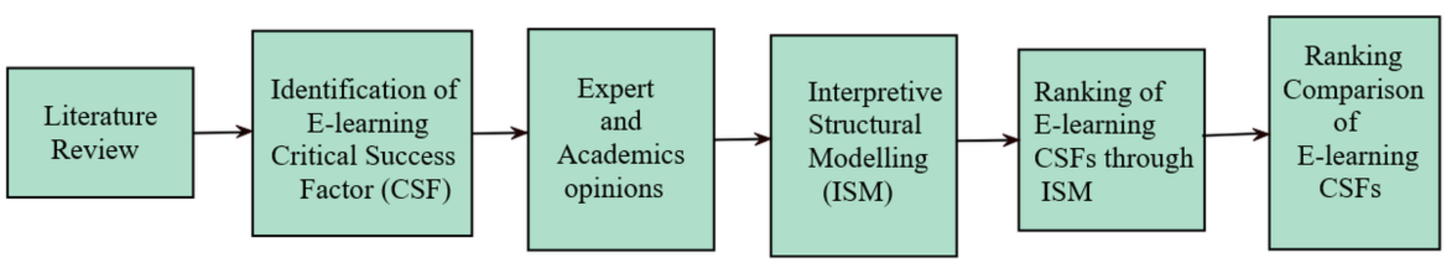

Figure 1

ISM based framework for ranking CSFs of E-learning system

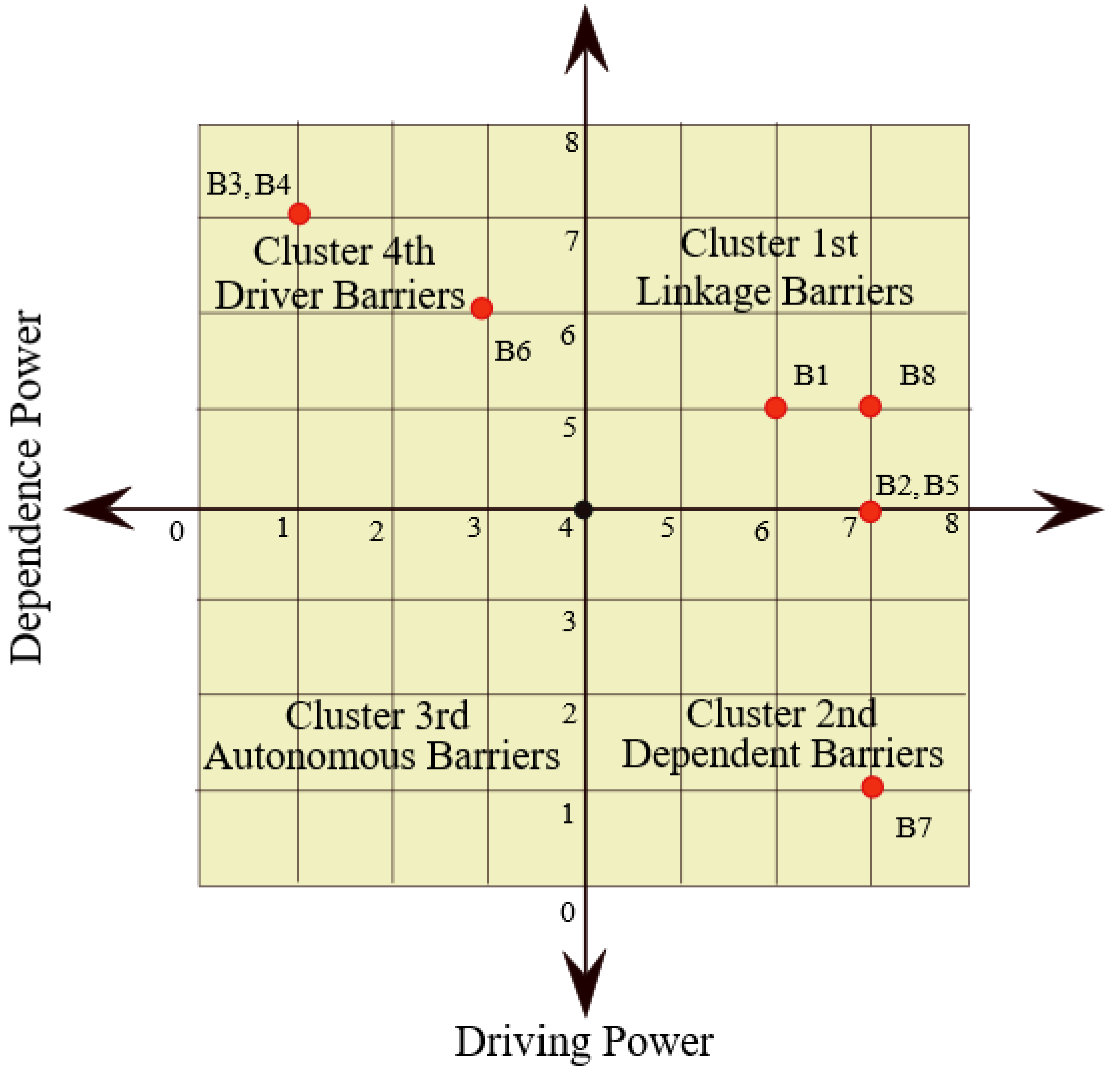

Figure 2

MICMAC analysis

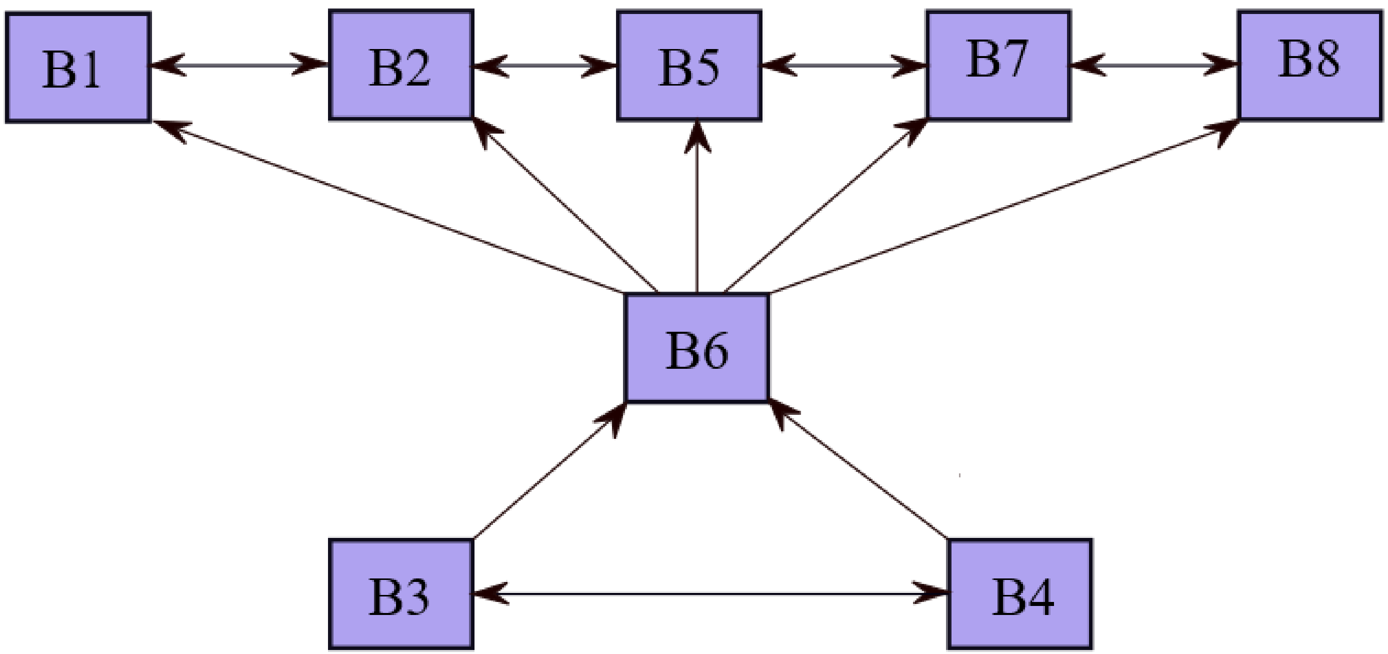

Figure 3

ISM model