Decision Science Letters 12 (2023) 211–224

Contents lists available at GrowingScience

Decision Science Letters

homepage: www.GrowingScience.com/dsl

Decision-making model for the effective e-services adoption in the Indian educational organizations

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C H R O N I C L E

Article history:
Received: November 28, 2022
Received in revised format: December 27, 2022
Accepted: February 8, 2023
Available online: February 8, 2023

Keywords:
E-service
E-service adoption
Decision-making model
Fuzzy DEMATEL
Fuzzy TOPSIS
Educational organizations

A B S T R A C T

Due to the advances in wireless network environments, consumers/end-user behaviors continue to expand in cyberspace. Similarly, university students (i.e. universities' consumers) can easily shift from one university to another. In recent years, decision-makers in educational organizations have faced multi-criteria decision making (MCDM) problems in e-service adoption in order to improve quality standards and maintain students' retention in highly competitive education environments. Generally, many required criteria in MCDM cannot be evaluated accurately since accurate data cannot be obtained from the decision makers' assessments. Thus, this research aims to propose a decision-making model for identifying the factors that highly impact on e-service adoption in educational organizations. This new model combined the fuzzy Decision MAking Trial and Evaluation Laboratory (fuzzy DEMATEL) and fuzzy Techniques for Order of Preference by Similarity to Ideal Solution (fuzzy TOPSIS) to weight the interactions among the factors which were defined from a comprehensive review of literature and to determine the relative importance of these factors. The findings from our new proposed model: fuzzy DEMATEL-TOPSIS showed that environmental factors are the most important for effective e-service adoption among educational organizations in India. The proposed decision making model could guide educational organizations to improve their decisions related to technology adoption in their organizations. The conclusions and practical insights gleaned from this research could also hopefully be useful to school authorities in assisting with the adoption, acceptance, and usage of e-services.

1. Introduction

Due to the advances in wireless network environments, consumers/end-user behaviors continue to expand in cyberspace (Rust & Lemon, 2001). Many businesses have shifted from product-based organizations to service-based organizations (Luo et al., 2011) and from traditional systems (in-person or face-to-face) to virtual systems (online services) (Taherdoost, 2018). The organizations have increased higher potential profit margins from electronic services (e-services) due to service-cost decrease. Consequently, many businesses and organizations have decided to use information and communication technology to minimize and/or eliminate client-staff contacts (Menezes, 2016). However, since consumers have embraced technology faster than before, they will be more willing to tolerate high-quality e-service (Rust & Lemon, 2001) and they can easily alter their purchases from one website to another one (Kahraman et al., 2019; Huynh-Cam et al., 2022). Widespread consumer experiences of poor and/or inadequate e-services prevent the growth of businesses and loss of competitive advantage in global market environments (Rust & Lemon, 2001). E-service encompasses more than only the processing of orders, the answering of questions, emails, and requests for updates on their progress. E-service is intended to provide students with a more satisfying alternative to the traditional interactive flow of information (Rust & Lemon, 2001; Ataburo et al., 2017). E-services are advantageous to end-users and service providers. These advantages include improved service delivery, reduced service costs, more sophisticated user interactions, information that is both quick and

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doi: 10.5267/dsl.2023.2.003

sufficient, accessibility that is unrestricted by the constraints of time and space, flexibility and mobility, and useful service offerings. The level to which online service providers meet students' expectations is known as e-service quality during pre-transactions, while-transactions, and post-transactions (Demir et al., 2020; Ataburo et al., 2017). Hence, businesses should concentrate on all phases in the process of e-service adoption.

Likewise, universities are considered service-based businesses although the main objective is to impart knowledge (Demir et al., 2020). Universities' customers are mainly their students/learners. Therefore, universities have attempted to retain students by offering high-quality educational programs and services. In addition, universities have been assessed by users' satisfaction (i.e. students, teachers, non-teaching staff, and managers), and global assessments of quality and performance. Due to advances in technology and the Internet, classes and courses are offered without time and place boundaries. In particular, the COVID-19 epidemic has compelled universities worldwide to look for a fresh approach to managing their day-to-day operations (Demir et al., 2020; Carnevale & Hatak, 2020). Thus, many universities have served their students electronically, also known as e-services adoption in e-learning systems to maintain students' retention (Kahraman et al., 2020), to complete educational programs, to monitor students' learning progress (Huang et al., 2022), to generate income, and to offer various services (Demir et al., 2020). However, from available research, previous studies have evaluated e-services in the business sectors (Kaya et al., 2019; Jameel et al., 2021), and banking sectors (Jameel et al., 2021), but limited studies have focused on e-services in the educational sectors (Ali, 2019; Jameel et al., 2021).

There have been several attempts to implement e-services in the education sector. However, according to India's Ministry of Human Resource Development (MHRD), e-service adoption is a critical component of the country's educational services, and it still requires significant upgrades to serve as a central location for educational opportunities around the area. To attain a high rate of success, educational organizations itself must provide high-quality service and information and implement a unique e-service adoption strategy. Nevertheless, the sudden shift from in-person classes to virtual classes during the COVID-19 pandemic caused many problems related to e-service adoption. The gap in technological infrastructure, practices, and usage between developed and developing countries has become wider (Hassan et al., 2008). In addition, few countries are still facing issues such as skills, lack of scientific knowledge, sufficient capital to implement e-service, and develop suitable strategies to establish or promote e-teaching systems (Hassan et al., 2008; Joshi et al., 2020; Huang et al., 2022). In practice, the required infrastructure for efficient e-classes has not yet been attained by the majority of educational organizations, particularly in India. In order to participate in virtual classrooms, instructors and students needed access to sufficient technological resources. These resources included the internet, microphones, computers, and laptops (Huang et al., 2022). Thus, many previous researchers have focused on technology. In fact, technologies are considered supporting tools that hardly offer full e-service benefits to users: schools, leaders, managers, teachers, and students because successful e-service adoption depends on many critical factors, such as environment, technology, organization, and humans. Therefore, it is critical for educational organizations to consider e-service adoption fully in terms of decision making. In recent years, decision makers of education organizations have faced with multi-criteria decision marking (MCDM) problems for e-service adoption to improve high-quality e-services and maintain students' retention in highly competitive education environments. Generally, many required criteria in MCDM cannot be evaluated accurately since accurate data cannot be obtained from the decision-makers' assessments (Kahraman et al., 2020). Moreover, some criteria are only assessed subjectively (Huang et al., 2022). Therefore, there is a high demand for MCDM methods.

This study developed a model for decision making by combining the fuzzy Decision MAking Trial and Evaluation Laboratory (fuzzy DEMATEL) and fuzzy Technique for Order of Preference by Similarity to Ideal Solution (fuzzy TOPSIS) approach. Our proposed Fuzzy DEMATEL-TOPSIS model is used to identify necessary factors for the effective adoption of e-services in educational organizations since the fuzzy DEMATEL-TOPSIS model is frequently applied in a range of decision making issues (Büyüközkan & Çifçi, 2012; Vinodh et al., 2016; Nilashi et al., 2019; Zhang & Su, 2019; Wen et al., 2021).. A fuzzy DEMATEL approach was applied to identify the relative importance of the various dimensions and the weights assigned to each component. The fuzzy TOPSIS approach was applied to evaluate and rank the identified factors which are essential for e-service adoption in educational organizations.

The arisen key research topic is that "what factors impact the effectiveness of e-service adoption within the educational organizations". Although the topic of identifying important factors for e-service adoption has attracted various studies, many previous researchers focused on technology. Those studies have been ignored the model development in the contest of e-services adoption. Therefore, this study can assist educational organizations to consider e-service adoption fully in terms of decision making. Our study contributions are as follows:

First, our proposed model for e-service adoption is based on technological, institutional, user readiness, and environmental dimensions. Second, previous studies were conducted from the perspective of students and teachers. Our proposed model is based on high-level (e.g. heads of departments and deans) perspectives in educational organizations. Therefore, the data will be gathered from decision-makers who have experienced in teaching and administration from both private and public universities. Third, this study will use two different MCDM methods, namely fuzzy DEMATEL-TOPSIS to examine the data that are acquired from decision-makers who have been working at both private and public colleges. The results of this study, with the insights gained from its practical application, should hopefully be useful for school authorities in their efforts to promote the adoption, acceptance, and utilization of high-quality e-services.

The following section introduces a review of related works on e-service adoption, determined dimensions, and factors based on literature that served as the foundation of this study, and developed a model for e-service adoption. Section 3 presents the applied methods: fuzzy DEMATEL-TOPSIS and data collection. The findings of the analysis are discussed in Section 4. Finally, this study will end with conclusions and future research directions.

2. Model development for e-services adoption

2.1 Related works on e-service adoption

The term "e-service" in educational organizations refers to web-based services where all or some of the business dealings between the student and the educational organizations are carried out through the internet (Taherdoost, 2018). Therefore, for organizations, in order to thrive in the highly competitive global market conditions of recent years, they should strengthen their use of e-services in the best possible manner (Demir et al., 2020). However, from available literature, there have only been a few studies that focused on the use of online services or e-services. For instance, Solvak et al. (2019) focused on the population level adoption of e-services provided by electronic teaching. The research conducted by Featherman et al. (2010) on a financial service product (online fee payments by students) revealed that lowering the risk of privacy invasion and the negative impacts it might have can increase the use of e-services in the education system. Ray and Bala (2019) explained a new avenue of using Structured Equation Modelling (SEM) by Natural Language Processing (NLP) methods on teachers' inputs that were available in various social platforms to promote university programs in the education sector. Ray et al. (2019) investigated the viewpoints of students and service providers on the variables that influence the e-service adoption issues in rural India to improve the spread of e-service technology for social development. Nevertheless, from available research, none of the published studies focused on the fuzzy DEMATEL-TOPSIS approach for e-service adoption in educational organizations. In addition, limited research identified important factors for e-service adoption from the perceptions of various types of users, such as students, teachers, non-teaching staff, school leaders, and managers in Indian educational organizations.

2.2 Identified dimensions and factors for e-service adoption in educational organizations

For decades, several academics have focused on the problem of critical dimensions and factors for e-services adoption in the educational organizations. In particular, Parasuraman et al. (2005) proposed seven aspects to consider: institutional planning and assistance, budget for technologies, security concerns, understanding of e-learning, online teaching and assessments in home environment settings, privacy, and responsiveness. Al-Shamayleh et al. (2015) conducted research at Jordanian organization to determine the impacts of six factors, including student ability and willingness to use e-service platforms, institutional planning and assistance, lack of e-learning culture, government policy, budget for technologies, security concern, and e-dialog. Shahzad et al. (2021) measured the impact of these factors: teacher skills for e-service adoption, service quality, information quality, budget for technologies, and user satisfaction on the success of e-learning portals at several Malaysian educational organizations from the students' points of view. They concluded that the system quality had a substantial effect on the level of pleasure experienced by students and as a result, it would improve the success of e-teaching portals. Throughout the COVID-19 outbreak, Adnan and Anwar (2020) investigated the perspectives of students in Pakistan who were enrolled in either an undergraduate or postgraduate programme towards online education. They underlined the fact that owing to technical and user readiness, response time, environment, and lack of e-learning culture, online learning is unable to match the expectations in impoverished nations such as Pakistan. At the University of Bahrain, Ali (2019) suggested using six factors to evaluate websites: student ability and willingness to use e-service platforms, understanding of e-learning, online teaching and assessments in home environment settings, government policy, and e-dialog. According to Leonnard (2019), the following characteristics should be considered when evaluating the impact of e-service adoption on the e-satisfaction of students: lack of basic facilities, online teaching, and assessments in home environment settings, teacher skills for e-service adoption (the ability of educators to use e-services), and e-dialog.Nevertheless, from the available literature, most studies have addressed technical issues and problems related to students. Research on the dimensions and factors related to teachers, non-teaching staff, school leaders, and managers in e-services have been very limited. Hence, this study focused on four dimensions: technology, institutional, user readiness, and environment. The identified dimensions and factors for each dimension through a systematic literature review are shown in Table 1.

2.3 Developed model for e-service adoption

Based on previous research, we can conclude that most of studies on e-service adoption have been conducted from students or teachers point of views (Shahzad et al., 2021). Furthermore, it is discovered that institutional and user readiness for e-service adoption in developing countries are not investigated. Many educational organizations in India have still been in the early stages of e-services adoption. However, according to this study, the success of educational organizations in adopting e-services is related to an institutional readiness. As a result, the purpose of this research closes this gap by developing a decision-making model for e-service adoption in Indian educational organizations. The readiness of educational organizations for e-services is critical, as its adoption is still far from its full potential due to various adoption issues. The hierarchical model, as shown in Fig. 1, has three levels. Level 1 is the goal: decision on e-service adoption by educational organizations. Level 2 is the dimension levels including user readiness, institutional, environmental, and technological.

Level 3 is the factor level which includes 12 factors (Nilashi et al., 2019). The goal is to determine which dimension may have a significant impact on e-service adoption in educational organizations. Furthermore, determining the interactions among these dimensions and ranking the factors will be the contribution to this study.

Table 1
List of dimensions and factors for e-service adoption in educational organizations

Dimensions	Factors	Meaning	Sources
User readiness (D1)	Teacher skills for e-service adoption (Ability of educators to use e-services) (F1)	Teachers gained low levels of computer skills and were unconfident to the use of advanced technology for e-services adoption.	Shahzad et al. (2021); Adnan & Anwar (2020); Leonnard (2019)
	Understanding of e-learning (Acquiring an awareness and knowledge by usage of e-learning) (F2)	This comprehension will increase trust in the benefits and contributions of e-service adoption.	Parasuraman et al. (2005); Adnan & Anwar (2020); Leonnard (2019)
	Student ability and willingness to use e-service platforms (F3)	This measures students' skills, ability, and willingness to use learning-service platforms.	Demir et al. (2020); Al-Shamayleh et al. (2015); Leonnard (2019)
Institutional (D2)	Organizations planning and assistance (F4)	Organization availability of quality infrastructure investment, technical assistance, and considerable resources.	Huang et al. (2022); Ali (2019); Leonnard (2019)
	Organizations incentives and computer self-efficacy (F5)	Monetary incentives may be provided by an organization. Similarly, they can be accomplished through training that familiarizes teaching staff with the computer tools, raise their awareness, and encourage them to use e-services.	Adnan and Anwar (2020); Ali (2019); Leonnard (2019)
	Budgets for e-service adoption (F6)	Although, many organizations now lack advanced technology, educational organizations need sufficient financial resources to adopt advanced technology.	Huang et al. (2022); Parasuraman et al. (2005); Al-Shamayleh et al. (2015); Shahzad et al. (2021)
Environmental (D3)	Online teaching and assessments in home environment settings (F7)	Regular interruptions at home disrupt the continuity and result in erroneous assessments and evaluations in the home environment setting.	Joshi et al. (2020); Parasuraman et al. (2005); Ali (2019)
	Lack of e-learning culture (F8)	Lack of participant interaction, "virtual" misrepresentation about the pedagogy used, and the distinction between e-learning and digital content distribution.	Demir et al. (2020); Al-Shamayleh et al. (2015); Leonnard (2019)
	Government policy (F9)	This factor reflects the legal framework for the educational organizations. The lack of proper regulations for the organization affects e-services adoption.	Huang et al. (2022); Al-Shamayleh et al. (2015); Adnan & Anwar (2020)
Technological (D4)	Lack of basic facilities (F10)	To conduct classes utilizing e-services, teachers need a suitable technological infrastructure (hardware, software, and the internet).	Joshi et al. (2020); Huang et al. (2022); Shahzad et al. (2021)
	E-dialog (F11)	Two-way communication is to elicit information from consumers (e-service users, such as teachers, students, staffs, managers) and then use it to personalize products (online classes or e-learning systems) offering.	Rust and Lemon (2001); Al-Shamayleh et al. (2015); Ali (2019)
	Security concern (F12)	Security is an issue for teachers who utilize open-source software in their online classes.	Huang et al. (2022); Parasuraman et al. (2005); Al-Shamayleh et al. (2015)

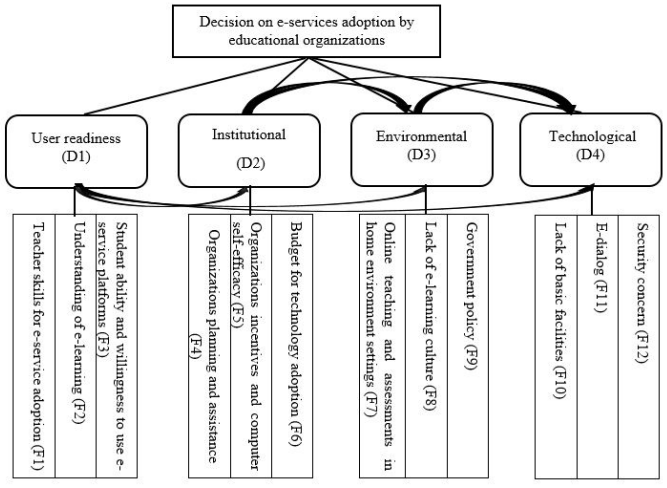

Fig. 1. Proposed model for e-services adoption

3. Applied methods in this study

In this study, we applied the fuzzy DEMATEL-TOPSIS approach to conduct data analysis to discover the relative significance of the various factors and the connections that exist among these factors in the model. The employed approach will be discussed in detail in the following sections.

3.1 Fuzzy DEMATEL process

This study uses the fuzzy DEMATEL method to assess the interactions among various dimensions of the proposed decision-making model. The experts' inputs were based on their own subjective experiences and therefore, the resulting conclusion may have very few ambiguities and errors. Fuzzy set theory is a valuable technique for efficiently addressing issues of imprecision and ambiguity. As a result, the fuzzy number and the traditional DEMATEL method are both included in this research to take advantage of the possibilities of fuzzy sets.

Furthermore, the MCDM approach is required to construct an extended crisp for decision-making situations occurring in a fuzzy environment. By combining triangular fuzzy numbers (TFNs) with five linguistic terms, as indicated in Table 2, the DEMATEL approach was used to arrive at the results.

Table 2
Fuzzy scale for data collection

Fuzzy values	Linguistic terms
(0.75,1,1)	Very high influence (VH)
(0.5,0.75,1)	High influence (H)
(0.25,0.5,0.75)	Low influence (L)
(0,0.25,0.5)	Very low influence (VL)
(0,0,0.25)	No influence (NO)

Similarly, MCDM approaches have been used with TFNs and trapezoidal numbers (Nalluri & Chen, 2022). This study utilized the TFNs to improve the overall analysis effectively. The fuzzy DEMATEL analysis steps in this study were adapted from Huang et al. (2022) as follows

Step-1: Developing the impact matrix in preparation for linguistic evaluation

The inputs from the experts were used to develop the linguistic impact evaluation matrix which applied a five-point fuzzy scale as shown in Table 2. The impact matrix was used to analyze the influence of one dimension on the other two dimensions. The xij is a symbol that illustrates the impact that dimension i over dimension j. It is important to take notice that the value at the intersection of the diagonals of the direct inflectional matrix, i=j is zero (i.e. 0,0,0). A non-negative n × n matrix may be generated by the individual decision-makers using the formula Xk = [xkij]. As a result, the N number of matrices (X1, X2, etc.) is determined by the N different experts.

Step-2: Generating the fuzzy direct relation matrix (A)

In order to represent the fuzziness that existing in the assessments, fuzzy language terminology was developed (Nalluri & Chen, 2022). To describe an undefined event, each linguistic term was written in the order of very high (VH), high (H), very low (VL) influence, and no influence (NO) (Table 2) because that order was the most promising highest potential value but the least feasible. Fig. 2 illustrates a linguistic value between 0 and 1 coming from the world of conversation (Huang et al., 2022).

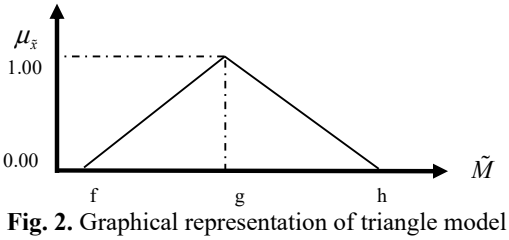

Fig. 2. Graphical representation of triangle model

Table 2 shows the fuzzy linguistic scale which was used to translate the effect ratings into the linguistic values. In addition, in order to simplify the explanation of a fuzzy event and to gain a deeper comprehension, this research used a triplet (f, g, h) to present every fuzzy linguistic value. The assumed equation is $X_{ij}^{k} = f_{ij}^{k}, g_{ij}^{k}, h_{ij}^{k}$, where $1 \leq k \leq K$, is the k^{th} participant in the study for the degree to which dimension i influences dimension j. An n × n matrix was created if 'K' is the number of experts, with the possible values of k being 1, 2, 3, 4, etc.... "n" denotes the total number of people who took part in the study in Eq. (1).

$$a_{ij} = \frac{1}{k\sum x^{kij}} \quad (1)$$

After that, as part of the defuzzification process, the fuzzy numbers were changed into crisp numbers, which paves the way for matrix operations to be carried out. Defuzzification of the fuzzy direct relation matrix (A) is accomplished by the use of Eq. (2).

$$I_T = \frac{1}{6}(f + 4g + h) \quad (2)$$

Step-3: Remodelling normalized initial direct relation matrix (D)

$$m = \min\left[\frac{1}{\max\Sigma_{j=1}^{n}|a_{ij}|}, \frac{1}{\max\Sigma_{i=1}^{n}|a_{ij}|}\right] \quad (3)$$

$$D = m \text{ X } A \quad (4)$$

Step-4: Developing the total relation matrix

$$T = D - (I - D)^{-1} \quad (5)$$

Here, T: total relation matrix; I: identity matrix

Step-5: Estimating the sum of columns (C) and sum of rows (R)

$$R = [\sum_{j=1}^{n} t_{ij}]_{n \text{ X } 1} \quad (6)$$

$$C = [\sum_{i=1}^{n} t_{ij}]_{1 \text{ X } n} \quad (7)$$

The value of R indicates the total influence dimension *i* on dimension *j*. The letter C signifies the total influence that dimension *i* had because of dimension *j*.

Step-6: Drawing the cause and effect graph

A graph depicting cause and effect was constructed with the help of the dataset (R+C; R-C). Utilizing the horizontal axis, which is shown by R+C, is necessary to determine the prominence and total effects in terms of influenced and influencing power. The cause-and-effect relationship between dimensions is represented by the R-C axis, which is run vertically. If the value of the (R-C) dimension is positive, it is then considered part of the cause category. Similarly, a dimension is considered to impact if its value on the R-C axis is negative and greater than zero (Nalluri & Chen, 2022). In addition, the cause-effect graph was utilized to map major linkages among the dimensions to emphasize how dependent they are on one another using arrows.

3.2 Fuzzy TOPSIS

The fuzzy TOPSIS approach is effective in finding the optimal response to a problem facing a high-level of ambiguity by using the viewpoints of specialists inside a framework for making decisions based on many factors (Nilashi et al., 2019). The fuzzy TOPSIS approach based on many factors is widely used when dealing with decision-making challenges (Vinodh et al., 2016). Therefore, this study used the fuzzy TOPSIS approach to identify the most relevant factors for decision-makers to consider before implementing e-services in educational organizations. Table 3 presents the information was acquired utilizing TOPSIS scales which were used in the process of data collection.

Table 3
The correspondence of fuzzy scale

Fuzzy values	Linguistic terms
(0.85,0.95,1)	Very High
(0.70,0.80,0.90)	High
(0.50,0.65,0.80)	Medium High
(0.30,0.50,0.70)	Medium
(0.20,0.35,0.50)	Medium Low
(0.10,0.20,0.30)	Low
(0,0.05,0.15)	Very Low

To resolve a decision-making problem with m dimensions and n factors Ai = (1, 2..., *n*), the following stages need to be carried out to determine which factors are the most useful for k experts Dr (*r* = 1, 2..., k). The steps in performing the procedure are outlined in the following sections.

Step-1: The weights of factors and alternative ratings are computed the following Eq. (8) and Eq. (9).

$$w_j = \frac{1}{k}\left[w_j^1 + w_j^2 + \cdots + w_j^k\right] \tag{8}$$

$$x_{ij} = \frac{1}{k}\left[x_{ij}^1 + x_{ij}^r + \cdots + x_j^k\right] \tag{9}$$

where the weight of the *j*th criterion (C_j) is expressed by W_r^j.

Step-2: Using the following Eqs. (10 and 11) to create the fuzzy decision matrices for the factors and the alternative (D).

$$W = [w_1 + w_2 + \cdots + w_m] \tag{10}$$

$$\mathrm{D}= \begin{matrix} \\ \mathrm{A_1} \\ \mathrm{A_j} \\ \mathrm{A_n} \end{matrix} \begin{bmatrix} X_{11} & X_{12} & X_{1\mathrm{j}} & X_{1\mathrm{m}} \\ . & . & . & . \\ . & . & . & . \\ X_{\mathrm{n}1} & X_{\mathrm{n}2} & X_{\mathrm{nj}} & X_{\mathrm{nm}} \end{bmatrix} \tag{11}$$

Step-3: Using the following Eqs. (12,13 and 14) to construct the normalized fuzzy decision matrix (R).

$$R = \left[\mathrm{r_{ij}}\right]_{\mathrm{m\times n}} \tag{12}$$

$$\mathrm{r}_{ij} = \left(\frac{l_{\mathrm{ij}}}{u_{\mathrm{ij}}^+},\ \frac{m_{\mathrm{ij}}}{u_{\mathrm{j}}^+},\ \frac{u_{\mathrm{ij}}}{u_{\mathrm{j}}^+}\right) \text{ and } u_j^+ = max_i u_{ij}(\text{benefit criteria}) \tag{13}$$

$$\mathrm{r}_{ij} = \left(\frac{l_j^-}{u_{\mathrm{ij}}},\ \frac{l_j^-}{m_{\mathrm{ij}}},\ \frac{l_j^-}{l_{\mathrm{ij}}}\right) \text{ and } l_j^- = max_i l_{ij}(\text{cost criteria}) \tag{14}$$

Step-4: Generating the weighted normalize decision matrix (V) using the following Eq. (15).

$$V = \left[v_{\mathrm{ij}}\right]_{\mathrm{m\times n,}} v_{ij} = \mathrm{X_{ij}} \times \mathrm{w_j} \tag{15}$$

Step-5: Estimating the Fuzzy Positive Ideal Solution (FPIS, A^+) and the Fuzzy Negative Ideal Solution (FNIS, A^-) by the following Eqs (16 and 17).

$$A^+ = \left\{v_1^+, v_j^+, \ldots, v_m^+\right\} \tag{16}$$

$$A^- = \left\{v_1^-, v_j^-, \ldots, v_m^-\right\} \tag{17}$$

where $v_j^+ = (1,1,1)$ and $v_j^- = (0,0,0)$.

Step-6: Calculating the distances indicated of each alternative from v_j^+ and v_j^- applying the following Eqs. (18- 20).

$$\mathrm{d}_i^+ = \sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{dv}(v_{ij}, v_j^+) \tag{18}$$

$$\mathrm{d}_{\mathrm{i}}^- = \sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{dv}(v_{ij}, v_j^-) \tag{19}$$

$$\mathrm{d(x,z)} = \sqrt{\frac{1}{3}\left[(l_x - l_z)^2 + (\mathrm{m}_x - \mathrm{m}_z)^2 + (u_x - u_z)^2\right]} \tag{20}$$

Step-7: Calculating the closeness coefficient CC_i using the following Eq. (21):

$$\mathrm{CC}_i = \frac{\mathrm{d}_{\mathrm{i}}^-}{\mathrm{d}_{\mathrm{i}}^+ + \mathrm{d}_{\mathrm{i}}^-} \tag{21}$$

Step-8: In decreasing order, determine the order of the alternatives based on CC_i.

3.3 Data collection

This research used a fuzzy DEMATEL-TOPSIS analysis to examine the variables, with the evaluation from the decision maker serving as the basis for the analysis. This study obtained the necessary data to perform a fuzzy DEMATEL-TOPSIS by employing a random sampling technique from educational organizations in India. Tabular representations of the scale used for data collection are shown in Tables 2 and 3.

The data were acquired from around one hundred different academics working at important educational organizations in India. To gather information, we employed a questionnaire survey. In addition, the questionnaire was broken up into three distinct sections before it was sent. Initially, a guideline was offered, and the process of filling out the questionnaire was discussed, to better familiarize respondents with the questionnaire and how it should be filled out. The next thing that needed to be filled out was the individual qualities of the person making the choice. In the end, we surveyed decision-makers to obtain their thoughts on the interrelationships between dimensions and variables using a fuzzy scale.

Table 4 shows the profiles of experts who participated in our study. As shown in Table 4, the individuals who make the decisions came from both public and private educational organizations. The majority has more than 10 years of teaching experiences in the classroom, and more than five years of working experience in administration in their respective organizations. In addition, each individual who had a hand in making decisions had a degree from one of Indian prestigious educational organizations.

Table 4
Profiles of experts

Methods	Sample size	Characteristics of experts				
		University type		Education level (majority)	Working experience	Working in administration
		Private	Public			
Fuzzy TOPSIS	37	18	19	Ph.D.	>10 years	>5 years
Fuzzy DEMATEL	62	44	18	Ph.D.	>10 years	>5 years

4. Results and discussions

4.1 Fuzzy DEMATEL analysis result

The distribution of the Fuzzy DEMATEL survey questionnaires was the first step in the data analysis process. This survey's primary goal was to identify the intersections among identified dimensions for the e-service adoption and to determine how important each dimension influences the decision of administrators to adopt e-services in educational organizations. The decision-makers in this survey were prompted to respond to the questions using the fuzzy scales as shown in Table 2. The information was organized into matrices for each decision-maker in order to carry out the Fuzzy DEMATEL steps described in the section above. The combined (average) matrix was determined in the initial step of this analysis using Eqs. (1-2) as shown in Table 5. Furthermore, the direct relationship matrix was determined through using Eqs. (3-4) as shown in Table 6. The T-matrix for all interactions could then be obtained by assessing the normalized initial direct matrix using Eq. (5) as shown in Table 7. We were derived C, R, R+C, and R-C from T-matrix after calculating it using Eqs. (6-7) as shown in Table 8.

Table 5
Average matrix

Dimensions	User readiness	Institutional	Environmental	Technological
User readiness	0.000	4.094	2.781	4.094
Institutional	3.688	0.000	2.188	3.469
Environmental	4.781	3.188	0.000	2.281
Technological	4.938	2.125	2.063	0.000

Table 6
The direct relationship matrix

Dimensions	User readiness	Institutional	Environmental	Technological
User readiness	0.000	0.305	0.207	0.305
Institutional	0.275	0.000	0.163	0.259
Environmental	0.357	0.238	0.000	0.170
Technological	0.368	0.159	0.154	0.000

Table 7
T-matrix

Dimensions	User readiness	Institutional	Environmental	Technological
User readiness	0.774*	0.830*	0.636	0.865*
Institutional	0.898*	0.527	0.553	0.763*
Environmental	1.008*	0.772*	0.451	0.755*
Technological	0.951*	0.666	0.545	0.556

*Less than or equal to Threshold value (0.720)

The data from Table 7 may be expressed in a model that illustrates the connections between the primary components based on T values, similar to that one in Fig. 2. The threshold value for constructing the connections in this model is derived by taking the values average included in the T-matrix. This value is then used as the basis for constructing the relationships. The model, in point of fact, shows important associations in the form of T values for impact rate. The influence rates of environmental (D3) dimensions on user readiness (D1), institutional (D2) technological (D4) are shown in Fig. 2 as T = 1.008, and T = 0.772, respectively. Furthermore, the influence rates of a technological dimension on the environmental and user readiness dimensions are T = 0.755 and T = 0.951, respectively. The findings also show that there is a significant relationship between institutional dimension (D2) on user readiness (D1) and technological (D4), with an influence rate of T = 0.898, and T= 0.763. Furthermore, the fuzzy DEMATEL analysis revealed that user readiness has no influence on the other dimensions in the model influencing the decision to adopt e-services in educational organizations. The interactions among the four dimensions are shown in Fig. 3. In fact, this graph shows that environmental, technological, and institutional dimensions are the net cause. Furthermore, the R-C result in Table 8 shows that the environmental dimension is the cause group and the other three dimensions are the effect group to implement e-services in educational organizations.

Table 8
Fuzzy DEMATEL result

Dimensions	R	C	R+C	R-C
User readiness	3.105	3.631	6.735	-0.526
Institutional	2.742	2.796	5.537	-0.054
Environmental	2.986	2.186	5.172	0.800
Technological	2.718	2.938	5.656	-0.220

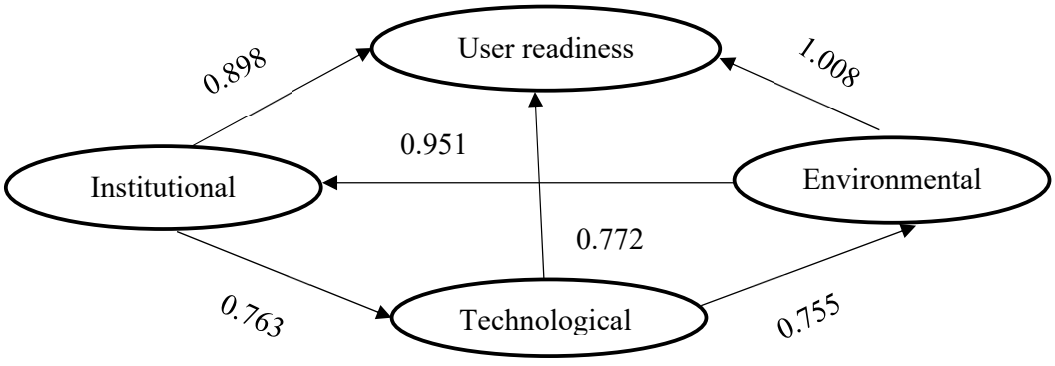

Fig. 3. The interactions graph among four dimensions

4.2 Fuzzy TOPSIS analysis results

Following data collection via the first questionnaire, a fuzzy TOPSIS questionnaire based on 7 scales was distributed, as shown in Table 3. The experts were assessed the relevance of each factor in the decision making model based on these linguistic scales as shown in Table 3. The linguistic terms and average scores corresponding to the average fuzzy scores of the user readiness, institutional, environmental, and technological factors are calculated using Eq. (8-21) and shown in Tables A1-A8 (Appendix A). The fuzzy TOPSIS analysis result with the final ranking of all factors are shown in Table 9. Based on this result, the factors of government policy (F9) from the environmental dimension and e-dialog (F11) from the technological dimension are key factors for the e-service adoption in the educational organizations from the decision-makers perspective. Therefore, policymakers and governments should develop frameworks or policies to improve advanced infrastructure and technology in the educational organizations. These policies could help improve e-services adoption in educational organizations, especially private organizations in India.

Table 9
Final and overall ranking of factors for the decision-making model

Factors	d_i^-	d_i^+	CC_i	Rank	Overall rank
F1	0.298	3.167	0.392	3	12
F2	0.321	3.198	0.421	2	11
F3	0.548	3.104	0.725	1	8
F4	0.404	3.421	0.522	3	10
F5	0.614	3.287	0.801	1	6
F6	0.578	3.333	0.751	2	7
F7	0.501	3.201	0.658	3	9
F8	0.645	3.158	0.849	2	5
F9	0.701	3.087	0.928	1	2
F10	0.655	3.189	0.860	3	4
F11	0.749	3.064	0.993	1	1
F12	0.704	3.154	0.927	2	3

4.3 Discussions

E-services adoption in educational organizations are key for improving the quality of the services and overcoming the COVID-19 pandemic (Ali, 2019), especially in developing countries (Huang et al., 2022). As a developing country, Shahzad et al. (2021) noted that there is a positive relationship between country literature rates that have caused the economic growth in India. However, e-services development or adoption among Indian educational organizations is still in its early stage compared to developed countries. Moreover, despite an expanding amount of research on online education and e-teaching, there has been little research on the development and uptake of e-services adoption in developing nations, particularly India.

This study has made an essential step towards filling the e-service adoption gap by identifying the most significant dimensions and factors faced by educational organizations in developing nations. We found that most private educational organizations in India have not developed an effective model for online education services due to a variety of concerns including user readiness, and institutional, technological, and environmental challenges. The present study results were determined that government policy was the primary factor for e-services adoption. Among all dimensions, decision-makers of a few educational organizations were more concerned the technological dimension. Their major concerns were about the shortage of advanced tools and technology available, and the shortage of well-trained teachers or professors. Therefore, the proposed decision making model in this study could significantly impact their decision to improve e-services adoption in their organizations.

This study's findings were supported by other published studies. Designers of e-services must make a great number of choices about the interactive experience provided by the service, such as the layout, design, and atmosphere of the whole platform. The choices made regarding the physical design of the product have an effect on the attitudes and emotive reactions of students. In addition, important aspects such as visual characteristics and navigation, to practical considerations including background, video, color, media, content, and sound contribute to user satisfaction and e-service quality (Kundu, 2022). This study's findings lend credence to these assertions. The usability (i.e. the quality of being easy, being convenient, and practical to use) of an e-service displays the student's capacity to acquire necessary information and to confirm a transaction with the least amount of possible efforts. In addition, usability has become a competitive criterion for the marketing success of e-services. If end-users feel that using the system could raise their productivity and performance, then there is a good chance that their level of happiness with the system would grow. To put it another way, end-users think the system is valuable if it can assist them to be more efficient and effective in their jobs. Our model shows the fact that educational organizations in India lack access to even the most fundamental technological capabilities which have a significant effect on whether or not they choose to implement e-services in their organizations.

5. Conclusions

In this study, we developed a decision making model for e-services adoption using the fuzzy DEMATEL-TOPSIS methodology. However, the findings of fuzzy DEMATEL analysis were revealed from the decision-maker's points of view. The graph in Fig. 3 shows that environmental, technological, and institutional dimensions are the net cause. Furthermore, the R -C result in Table 8 shows that the environmental dimension is the cause group among all dimensions of e-services adoption in educational organizations. In addition, Fuzzy TOPSIS results revealed the significance of every factor. The data analysis results revealed that the factors of government policy (F9) from the environmental dimension, and e-dialog (F11) from the technological dimension are key factors for the e-service adoption in the educational organization from the decision-maker's perspectives.

The results of this research have significant ramifications for educational policymakers who want to encourage the adoption of e-services during a pandemic outbreak. The study's findings suggest that organizational administrators should improve technological expectancy because it has a significant relationship with teachers' readiness factors intention and attitude to adopt e-services. Decision-makers must determine the utility and benefits of teaching-service adoption if performance expectations are to be met. Furthermore, teachers who did not grasp the utility of technology were unable to adopt it. Teachers who teach online may be able to encourage their co-workers to switch to e-teaching or e-services. In addition, teachers that support and encourage their co-workers to use e-teaching may also receive a positive benefit. The educational organizations could also provide their support and encouragement to the teachers who are hesitant to use e-services. The lack of basic facilities evolves significantly implies that infrastructural support for virtual learning is firmly established in universities, and it can enable both behavioral intention and actual use. The university administration should schedule regular issue resolution and training sessions for professors so that they comprehend the system's complexities. During the COVID-19 pandemic, educational organization officials must instil in teachers a positive attitude towards the utility of online education. Finally, this study suggested that technological factors and environmental factor gaps are highly unlikely in the context of e-services adoption based on the interactions among the four dimensions. This could be explained by the fact that in contrast to other highly involved behaviors where the gap is very acute, the actual behavior under research (i.e., accessing e-services during a pandemic) is not as difficult to accomplish and does not require as much incentive or commitment. Instead, it is well suited to various lifestyles because many people now use e-services for a variety of purposes.

This study contains a number of theoretical and methodological limitations. In this investigation, a limited number of prepared variables for e-service adoption in educational organizations has been examined. It is possible that in further studies, researchers may investigate the effect of more factors or dimensions. In addition, the opinions of middle-level management positions were sought and considered throughout this research (e.g., department heads, deans, and administrators in educational organizations). Other studies might investigate the topic of e-services adoption from the organization's points of view. In addition, this research used multiple criterion decision-making approaches for factors assessment. Finding the links among elements may be accomplished in the future research with the use of Partial Least Squares-based Structural Equation Modelling (PLS-SME) to compare the findings of our proposed methods. In addition, the HOT-fit and TOE frameworks were used in the development of this study's adoption model. Additional organizational theories are recommended for further investigation. Last but not least, a sensitivity study is suggested for further research to illustrate the tenacity of Fuzzy TOPSIS and the accuracy of its findings by modifying the relative importance of the criterion weights in many different contexts.

Acknowledgement

This study was partially supported by National Science and Technology Council, Taiwan (Grant No. MOST 111-2410-H-324-006).

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Appendix A

Table A1

Average rating for each technological factor

Factors	Fuzzy rating
F1	(0.42,0.56,0.73)
F2	(0.51,0.66,0.89)
F3	(0.64,0.82,0.91)

Table A2

The linguistic terms correlate with the average fuzzy scores for the technological factors

Factors	Distance between linguistic terms and factors							Minimum Distance	Linguistic Term
	VH	H	MH	M	ML	L	VL		
F1	0.561	0.214	0.191	0.211	0.098	0.056	0.116	0.056	MH
F2	0.308	0.256	0.168	0.177	0.064	0.14	0.201	0.064	MH
F3	0.198	0.189	0.17	0.114	0.102	0.237	0.081	0.081	VH

Table A3

Average rating for each institutional factor

Factors	Fuzzy rating
F4	(0.32,0.46,0.66)
F5	(0.64,0.82,0.91)
F6	(0.79,0.89,0.91)

Table A4
The linguistic terms correlate with the average fuzzy scores for the institutional factors

Factors	Distance between linguistic terms and factors							Minimum Distance	Linguistic Term
	VH	H	MH	M	ML	L	VL		
F4	0.391	0.047	0.179	0.057	0.068	0.444	0.208	0.047	M
F5	0.478	0.247	0.202	0.081	0.248	0.093	0.147	0.081	VH
F6	0.277	0.098	0.401	0.107	0.401	0.071	0.098	0.071	H

Table A5
Average rating for each user readiness factor

Factors	Fuzzy rating
F7	(0.51,0.66,0.89)
F8	(0.42,0.56,0.73)
F9	(0.64,0.82,0.91)

Table A6
The linguistic terms correlate with the average fuzzy scores for the user readiness factors

Factors	Distance between linguistic terms and factors							Minimum Distance	Linguistic Term
	VH	H	MH	M	ML	L	VL		
F7	0.401	0.179	0.084	0.314	0.061	0.061	0.132	0.061	MH
F8	0.621	0.302	0.187	0.107	0.104	0.114	0.077	0.077	MH
F9	0.103	0.157	0.254	0.208	0.21	0.169	0.087	0.087	VH

Table A7
Average rating for each environmental factor

Factors	Fuzzy rating
F10	(0.79,0.89,0.91)
F11	(0.42,0.56,0.73)
F12	(0.51,0.66,0.89)

Table A8
The linguistic terms correlate with the average fuzzy scores for the environmental factors

Factors	Distance between linguistic terms and factors							Minimum Distance	Linguistic Term
	VH	H	MH	M	ML	L	VL		
F10	0.165	0.251	0.281	0.102	0.187	0.087	0.123	0.087	H
F11	0.189	0.306	0.086	0.057	0.177	0.201	0.144	0.057	MH
F12	0.201	0.145	0.103	0.169	0.201	0.054	0.109	0.054	MH