Factors Affecting the Adoption of Cloud Based Learning Management System: A Decision Approach via Fuzzy Z-AHP

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Abstract

Nowadays the evolution of the technologies regarding the online learning has influenced the field of education. The acceptance of a new technology is evaluated according the unified theory of acceptance and use of technology 2 (UTAUT2). The main aim of the study is to estimate the impact that has each of the constructs of the model UTAUT2 related with the behavioural intention of using a cloud based learning platform. The decision making methodology proposed in this study is fuzzy analytical hierarchic process with Z-numbers (Fuzzy Z-AHP). The data were collected through a survey of 400 samples from students of the University "Aleksander Moisiu" of Durres during 2020-2022. The findings of the research concluded that the most important construct of UTAUT2 is Habit. The findings help higher education policymakers to make better decisions related with the factors that influence most the cloud based learning management platform.

Keywords: *Fuzzy Z-AHP, cloud based learning, constructs, UTAUT2, fuzzy numbers*

1. Introduction

The instantaneous advances in technology have affected the way of teaching in higher education. This evolution has been realized by integrating online learning systems. A platform that is designed to assist the scheme of online learning is a cloud based Learning Management System[1]. The cloud based learning platforms used in the educational institutions include: Moodle, Blackboard, Google Classroom etc. As a new trend, Google Classroom (GC) has been integrated recently and with great importance in the higher education [2]. The platform (GC) has offered for the students some benefits with the tools such as e-mail, forums, assignments etc [3]. E-learning has been known as electronic learning via internet tool that allows teachers and students to interact together [4]. The online learning according the academic field

aimed to form good students with deep knowledge. Google Classroom was introduced in 2014 as a learning management platform [5] , and has been evaluated as the best used in terms of discussing new knowledge out of time and distance. The platform (GC) is evaluated as the most prevalent tool that has been integrated into higher education [2]. During the years are formed several theoretical models for understanding acceptance and use of information technology: Theory of Reason Action (TRA) [6], the Technology Acceptance Model (TAM) [7], the Theory of Planned Behavior (TPB) [8], the Diffusion of Innovation Theory (DOI) [9], the Unified Theory of Acceptance and Use of Technology (UTAUT) [10] and UTAUT2 [11]. In this study has been used the cloud based learning management platform and theory of acceptance and use of a new technology 2 (UTAUT2) to evaluate better its constructs that impact more the development of Google Classroom. The UTAUT2 has been formulated firstly by Venkatesh [10], and consists of 8 constructs: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Hedonic Motivation (HM), Habit (HT), Behavioral Intention (BI) and Use Behavior (UB). PE is defined as the student's belief that using (GC) is useful in learning productivity. EE is defined as the level of ease of use for (GC). SI is defined as the degree of student's influence by close friends, regarding the issue that the use of Google Classroom is important in the learning process. FC indicates the confidence degree in technical support when using Google Classroom [12], [13]. HM defines the satisfaction of using Google Classroom in relation to traditional learning [14]. SI indicates the impact that colleagues, instructors have on an individual in the use of a new technology [15]. HM is linked to the level of enjoyment or fun when is used a new technology. Habit is linked to automatic behaviors of an individual using a new technology [11]. BI is related with an individual`s intention in using a new technology in the future [11]. HT is related with the automatic behavior of students using the Google Classroom platform. BI indicates student's intention in using Google Classroom in the future.

The multi criteria decision making problems (MCDM) are a group of methods focused in the selection of the best alternative for a complex problem [16]. The AHP method is the most popular method among them that decomposes a complex problem in a hierarchical structure. The method is extended [17] with fuzzy numbers [18] to deal with the uncertainty of a complex problem, as Fuzzy AHP (FAHP) in producing optimal decisions, and to tolerate the ambiguity and vagueness of information [19]. In the objective of this research is to analyze the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) model to estimate the effective constructs of an cloud based learning platform. In this method are used the trapezoidal fuzzy numbers, in order to better determine the most important constructs that impact the Behavioral Intention (BI) in using the e-learning platform developed for the students of the University "Aleksander Moisiu" Durres during 2020-2022. The framework of the study is shown in the figure 1.

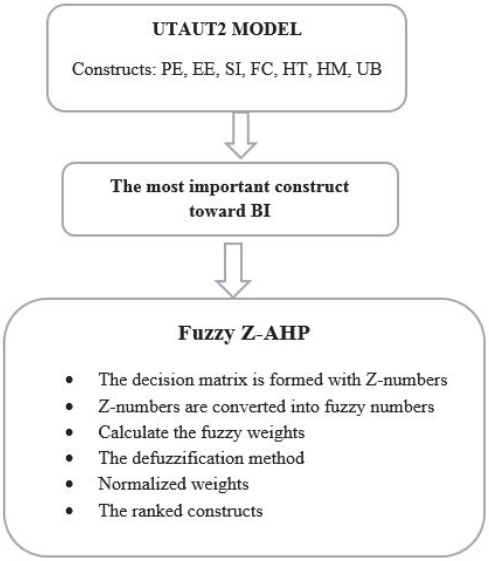

Figure 1. Fuzzy method and UTAUT2 model

2. Literature Review

There have been several studies that have evaluated the impact of Google Classroom in some fields of study. In the study of Jordan and Duckett [20] are compared Blackboard and Google Classroom. The results of this study showed that students preferred Google Classroom because it was easy to use, free mobile apps, so all these benefits makes the work easy in group. In the study of Jakkaew and Hemrungrote [2], employed the UTAUT2 theory in a course of Introduction to Information Technology, have found out that students agree that GC is good and easy to use tool. Some previous works have used the AHP method and other MCDM methods in Learning Measurement Systems and less to the Fuzzy Z-AHP method. Qendraj et al have hybridized the two approaches PLS-SEM and Fuzzy Z-AHP to obtain an optimal result for the UTAUT2 theory [21]. Y. A. Turker [22] has evaluate the LMS systems by using FAHP with TFN and two other methods, fuzzy Topsis and an Integrated Method. In the study has been showed that the content management and development is the most important criteria. Yassine AFA [23] applied FAHP in increasing the effectiveness of teaching to massive open online courses (MOOCS) and to determine the most widespread MOOCS. Qendraj et al estimated the online learning via Google Classroom platform, for students of bachelor and master degree in math courses for four Albanian Universities [24].

Kosova et al in their study assessed the urban resilience of Durres County, Albania, and its regions and municipalities that share the same urban and geographical characteristics using the AHP and Electre III methods [25]. Our study proposes a method for ranking the constructs that impact most the behavioral intention while using the online learning platform (GC).

3. Sample Collection

The survey that was distributed via Google Form for the cloud based learning platform, was adopted by Venkatesh et al [11], Jakkaew and Hemrungrote. [2]. It was submitted by 400 students of the online courses during the period May 2020-July 2022, University Aleksander Moisiu" Durres, Albania. Students have completed voluntarily the questions form after studying their subject and done the exam. All of them had used the Google Classroom platform. The survey used 5-likert scales, measuring the items from "strongly disagree", "disagree", "neutral", "agree" and "strongly agree", referring the constructs and their alternatives.

4. Fuzzy Z-AHP Method

MCDM problems are focused in the selection of a best choice for o complex problem [16]. The expansion of AHP is in fact FAHP [26] in producing better decisions, and to tolerate the ambiguity and vagueness of information [19]. To deal with uncertainty [17] the AHP is expressed with fuzzy numbers [18], as Fuzzy Z-AHP. Fuzzy Z-numbers are represented with fuzzy reliability related to the fuzzy restriction [27]. The Z-number is denoted as $Z = (A, B)$. A is a fuzzy subset of the domain X of the uncertain variable Z, and B is a fuzzy subset that shows the probability or the reliability of X. Assume that $X = \{u_1, u_2, \dots, u_n\}$, and A a fuzzy set in X, $\mu_A: X \to [0,1]$ the membership function of the trapezoidal fuzzy number $u_i = (a_1, a_2, a_3, a_4)$ (See equation [1]), while the membership function for set B (see equation (2)). In table 1 and table 2 are shown the A and B types of fuzzy numbers.

$$\mu_A(u_i) = \begin{cases} \frac{u_i - a_1}{a_2 - a_1} & a_1 \le x \le a_2 \\ 1 & a_2 \le x \le a_3 \\ \frac{a_3 - u_i}{a_4 - a_3} & a_3 \le x \le a_4 \\ 0 & x \ne [a_1, a_4] \end{cases} \quad (1)$$

$$\mu_B(u_i) = \begin{cases} \frac{u_i - b_1}{b_2 - b} & b_1 \le u_i \le b_2 \\ \frac{b_3 - u_i}{b_3 - b_2} & b_2 \le u_i \le b_3 \\ 0 & b_3 < u_i \le +\infty \end{cases} \quad (2)$$

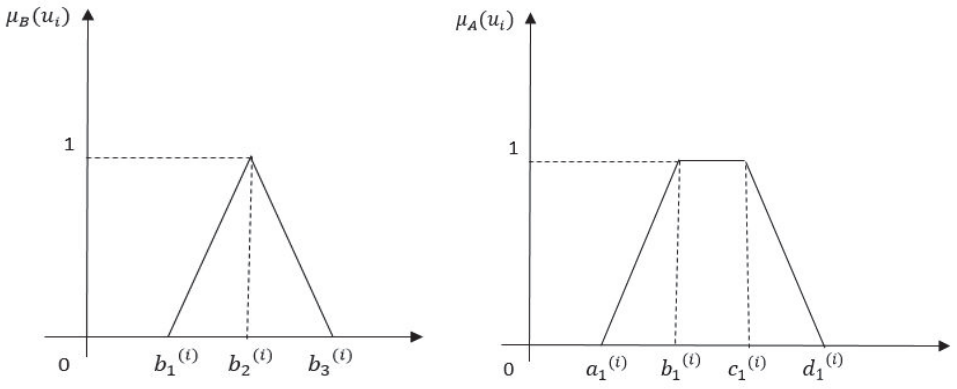

Figure 2. Z-number

Table 1. A restriction fuzzy trapezoidal number

Saaty scale	Restriction	Trapezoidal fuzzy numbers scale
1	Equal	(1,1,1,1)
3	Moderate	(2,2.5,3.5,4)
5	Strong	(4,4.5,5.5,6)
7	Very strong	(6,6.5,7.5,8)
9	Extremely strong	(8,8.5,9,9)
2	Intermediate values	(1,1.5,2.5,3)
4	Intermediate values	(3,3.5,4.5,5)
6	Intermediate values	(5,5.5,6.5,7)
8	Intermediate values	(7,7.5,8.5,9)

Table 2. B-reliability fuzzy number

Linguistic reliability	Triangular Z-fuzzy reliability scale
Equally	(1,1,1)
Moderately	(0.2, 0.3, 0.4)
Strongly	(0.4, 0.5, 0.6)
Very strongly	(0.6, 0.7, 0.8)
Extremely strong	(0.8, 0.9, 1)
Intermediate values	(0.1, 0.2, 0.3)
Intermediate values	(0.3, 0.4, 0.5)
Intermediate values	(0.5, 0.6, 0.7)
Intermediate values	(0.7, 0.8, 0.9)

Fuzzy Z-AHP is initialized by constructing the decision matrix via Z-fuuzy numbers

$Z = (A, B) = (u_1, u_2),\ u_1 \in A, u_2 \in B$, then Z-number is converted into a regular fuzzy number:

Firstly by converting the reliability (u_2) into a crisp number with the equation

$$\alpha = \frac{\int u_i \mu_B(u_1) du}{\int \mu_B(u_1) du} \quad (3)$$

$$Z^{\alpha} = \{u_i, \mu_{A^{\alpha}}(u_i) | \mu_{A^{\alpha}}(u_i) = \alpha \mu_A(u_i), u_i \in [0,1]\} \quad (4)$$

$$Z' = \left\{u_i, \mu_{Z'}(u_i) \middle| \mu_{Z'}(u_i) = \mu_A\left(\frac{u_i}{\sqrt{\alpha}}\right), \mu(u_i) \in [0,1]\right\} \quad (5)$$

After converting the Z-number into a regular fuzzy number Z' is formed the decision matrix with fuzzy numbers.

$$\tilde{A} = \begin{pmatrix} 1 & \cdots & \widetilde{\alpha_{1n}} \\ \vdots & \ddots & \vdots \\ \widetilde{\alpha_{n1}} & \cdots & 1 \end{pmatrix} \text{ where } \alpha_{ij} = \frac{1}{\alpha_{ji}} \quad (6)$$

$$\tilde{r}_i = \left(\prod_{i=1}^{n} \widetilde{\alpha_{ij}}\right)^{1/n} \quad (7)$$

$$\widetilde{\omega}_i = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \oplus \ldots \oplus \tilde{r}_n)^{-1} \quad (8)$$

The defuzzification values of the weights $\widetilde{\omega}_i$ are denoted with a_{ij} [14].

$$a_{ij} = \frac{\omega_i{}^{(1)} + 2\omega_i{}^{(2)} + 2\omega_i{}^{(3)} + \omega_i{}^{(4)}}{6} \quad (9)$$

The last step is to normalize the weights: $N_i = \frac{a_{ij}}{\sum a_{ij}}$ (10)

5. Results

The decision matrix constructed for the model UTAUT2 includes the importance that the constructs have toward the Behavioral Intention of using an online learning resulted to be consistent with IC=0.09351 less than 0.1. Applying equations (1)-(5) is formed the Z fuzzy number and the value α. After constructing the decision matrix with Z- numbers converted into fuzzy numbers are applied the equations (6)-(10). In table 3 are shown the results of equations (1)-(5) and in table 4 are the results of equations (6)-(10).

Table 3. Z number and α value

	PE	EE	SI	FC	HT	HM	UB
PE	(1,1,1,1) (1)	(0.1,0.15,0.35,0.4) (0.1,0.2,0.3)	(0.13,0.2,0.46,0.53) (0.3, 0.4,0.5)	(1,1.5,2.5,3) (0.1,0.2, 0.3)	(0.01,0.15,0.17,0.3) (0.3,0.4,0.5)	(0.1,0.15,0.35,0.4) (0.1,0.2,0.3)	(0.2,0.3,0.7,0.8) (0.4,0.5,0.6)
EE	(3,3.5,4.5,5) (0.3, 0.4, 0.5)	(1,1,1,1) (1)	(0.05,0.15,0.25,0.35) (0.2,0.3,0.4)	(4,4.5,5.5,6) (0.4,0.5, 0.6)	(0.2,0.3,0.7,0.8) (0.4,0.5,0.6)	(2,2.5,3.5,4) (0.2, 0.3, 0.4)	(1,1.5,2.5,3) (0.1,0.2, 0.3)
SI	(2,2.5,3.5,4) (0.2, 0.3, 0.4)	(4,4.5,5.5,6) (0.4,0.5, 0.6)	(1,1,1,1) (1)	(6,6.5,7.5,8) (0.6,0.7, 0.8)	(0.1,0.15,0.35,0.4) (0.1,0.2,0.3)	(1,1.5,2.5,3) (0.1,0.2, 0.3)	(1,1.5,2.5,3) (0.1,0.2, 0.3)
FC	(0.2,0.3,0.7,0.8) (0.4,0.5,0.6)	(0.05,0.15,0.25,0.35) (0.2,0.3,0.4)	(0.04,0.1,0.18,0.24) (0.1,0.2,0.3)	(1,1,1,1) (1)	(0.04,0.1,0.18,0.24) (0.1,0.2,0.3)	(0.1,0.15,0.35,0.4) (0.1,0.2,0.3)	(0.2,0.3,0.7,0.8) (0.4,0.5,0.6)
HT	(5,5.5,6.5,7) (0.5, 0.6, 0.7)	(1,1.5,2.5,3) (0.1,0.2, 0.3)	(3,3.5,4.5,5) (0.3, 0.4, 0.5)	(6,6.5,7.5,8) (0.6,0.7, 0.8)	(1,1,1,1) (1,1,1)	(4,4.5,5.5,6) (0.4,0.5, 0.6)	(7,7.5,8.5,9) (0.7, 0.8, 0.9)
HM	(3,3.5,4.5,5) (0.3, 0.4, 0.5)	(0.13,0.2,0.46,0.53) (0.3, 0.4,0.5)	(0.2,0.3,0.7,0.8) (0.4,0.5,0.6)	(3,3.5,4.5,5) (0.3,0.4, 0.5)	(0.05,0.15,0.25,0.35) (0.2,0.3,0.4)	(1,1,1,1) (1)	(2,2.5,3.5,4) (0.2, 0.3, 0.4)
UB	(1,1.5,2.5,3) (0.1,0.2, 0.3)	(0.2,0.3,0.7,0.8) (0.4,0.5,0.6)	(0.2,0.3,0.7,0.8) (0.4,0.5,0.6)	(1,1.5,2.5,3) (0.1,0.2, 0.3)	(0.05,0.08,0.18,0.2) (0.1,0.2,0.3)	(0.13,0.2,0.46,0.53) (0.3,0.4,0.5)	(1,1,1,1) (1)

Table 4. The ranked constructs

	N_i	Rank
PE	0.043	6
EE	0.1472	3
SI	0.2217	2
FC	0.0289	7
HT	0.393	1
HM	0.10502	4
UB	0.06105	5

From the results Habit (HT) is the most important criteria referring all the others. HT indicates that the use of the online learning via the platform (GC) is converted as a habit for them in performing certain activities. The second ranked is (SI), related to (GC) they have found it useful for the online courses. The last important resulted to be the Facilitating Conditions (FC) because as the first time using (GC) they had difficulties in knowledge and resources.

6. Conclusions

This paper studied the impact of operating with an cloud based learning platform via Google Classroom, for students of

bachelor and master degree that have partecipated in online courses. The aim of the study was focused to assess the impact that the constructs of the UTAUT2 theory had toward the Behavioural Intention (BI) construct which are: Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Habit, Hedonic Motivation, and Use Behavior. The online survey via Google Form was developed for these students during the period may-june 2020-2022. Fuzzy Z-AHP method is evaluated as more effective of capturing a human judgment for complex decision problems. The findings orient that the most important construct was Habit (HT) and the last important was Facilitating Conditions (FC). There were some different online courses and also the results depand on the type of the subject they studied for. As a main factor that explains these results is found out for students to be for the first time online and learning for the first time a new platform. The study helps students and lecturers to interact together for the online learning. There are also some limitations, maybe in further studies to develop the survey even for some lecturers or teachers in college or hidh school in order to evaluate their difficulties and their adoption for a new cloud based learning platform.

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