



# Students' attitude towards use of ICT as tool of learning: a structural equation modelling (SEM) approach

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## Abstract

This paper assessed the students' attitudes towards the use of ICT as a tool of learning by using the technology acceptance model. Primary data has been collected from six public and private universities in Bangladesh collected on perceived enjoyment, self-efficacy, ease of use, usefulness, and attitude towards ICT. The study used the technology acceptance model (TAM) and used the structural equation model (SEM) for statistical analysis. The data's reliability and adequacy were assessed using KMO, Bartlett's test, and Cronbach's alpha. Confirmatory factor analysis (CFA) was used to examine the relationship between observed variables and latent variables. The reliability and validity of the model were also assessed using estimating composed reliability (CR) and average variable extraction (AVE). The study used a structural equation model to examine the relationship between constructs and covariance analysis. The results showed that the sample was adequate and the data was valid and reliable. The CFA model was a good fit, and the observed variable positively relates to the constructs. The study found that two external variables indirectly influence students' attitudes towards ICT use, but perceived ease of use and self-efficacy had a direct and positive impact on perceived usefulness. These variables positively and significantly influence students' attitudes towards ICT as a learning tool.

**Keywords** TAM · SEM · Perceived enjoyment · Perceived ease of use · Perceived usefulness · Attitude towards use

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## Introduction

Students' attitude refers to the willingness and ability to learn, which also shows the satisfaction of the student from learning. In other words, it is the feelings of the students which may be positive or negative. So, students' attitude towards the use of Information and Communication Technology (ICT) refers to the desirability of the students to learn ICT and the positive or negative feeling toward ICT. Students' attitudes toward ICT in the learning process in institutions are the important drivers of their desirability to use the ICT (Sanders and Morrison-Shetlar 2001 as cited in Alghazo 2006) and to pursue ICT as a segment of their lifetime learning process (Pelgrum and Plomp 1996; Fco and Garcia 2001). To invest momentous time and money in instructional technologies in educational institutions (schools and universities) around the world, it is very important in the modern time (McDonald 2004).

ICT is the technologies that provide store, transmit, retrieve, receive or manipulate access to information through telecommunication. The four major functions of ICT are—communication, data management, marketing and process improvement. ICT provides better, quicker and newer ways to interact with each other, seek help or gain access to information and learn electronically. ICT promotes the skills of higher order thinking which includes planning, evaluating, monitoring and analyzing. ICT has now become a part and parcel of the learning process. It promotes communicative learning experiences, impulse and inspires students to learn. It also promotes comfortable and collaborative learning, helps in understanding of rigorous concepts and thoughts, aids students to achieve valuable skills, caters to various learning styles and helps in group works. Online based learning or E-learning is becoming popular, replacing the chalkboard with smart boards, students can interact with their own smart phones or laptops by which they may know about new things. There are huge numbers of tutorials or online classes by which students can learn by sitting at home. Students have access to thousands of online books, journals, pdf, images, diagrams, charts, data, videos, maps, games, animation and many other options which makes the learning process much easier. Thousands of E-book collections and large number of journals and articles are available that help in higher study and make more efficient and rewarding. Also, there are huge online reference materials such as Encyclopaedia, Wikipedia, Britannica offering large amount of content through multimedia and interactive links. ICT helps students to operate and explore their own learning, to find out solution of typical real-world problems, imagine creatively and critically, assign moral decision-making, communicative work, and address universal issues and ideas.

ICT has impact on education and learning process to determine both the concept of ICT usage and the effects on experience of student more broadly at university level (Conole et al. 2006). Information and communication technology potentially promote participation of physically disabled students in educational performance. Including ICTs' especially smart phones, computers and the internet, into learning in education sector to develop students' "digital skill" has become a momentous issue in both rapidly developing and developed countries (Lidstrom and Hemmingsson 2014). Use of ICT in education (learning process) during Covid-19 crisis has fully changed the scenario. In March, 2020 government of Bangladesh makes a declara-

tion about emergency closure of educational institutions. In this pandemic situation, distance learning or e-learning has gained huge priority in educational activities such as Zoom, a video communication system. Here, it can also include Facebook, WhatsApp, Messenger and YouTube channels. In a word, most of the institutions have started online based communicative teaching-learning which was not familiar before the pandemic situation. University Grant Commissions (UGC) of Bangladesh took the challenge and introduced policies requiring all universities to go digital, to continue teaching and learning activities. Within four months, an average of 3800 classes started to held online daily with more than 220,000 students. 147 out of 153 public and private universities in the country have been receiving support from Bangladesh Research and Education Network (BdREN) to teach online.

Here the questions arise (1) about the attitude of students towards the use of ICT; (2) whether *Perceived Enjoyment has any impact on Perceived Ease of Use*; (3) whether *Self-efficacy has any effect on Perceived Usefulness*.

This study thus tries to find out students' attitude towards use of ICT as learning tool. ICT plays a major role in this modern world through serving multilevel functions in most of the essential aspects to society, like business, scientific progress, education, and communication. In face-to-face learning or at distance learning systems educational technology can be used by the following means: educational software, graphics-based calculators, internet, video and other telecommunication devices. ICT provides universal and easier access to information, communication and services for students. Technology spread and influences the assistance tools to accomplish students' expectations and needs of the society. Understanding TAM can lead to better use of technology that may help in increasing personal monitoring power, flexibility and efficient use of information. Positive attitude is an important determinant to achieve one's goals. With a positive frame of mind, one can make better decisions. Illustrating the opinions or attitudes of university students toward ICT as learning tool this study also reflects the current scenario, convenience and inconvenience of using technology in education in Bangladesh. The results would provide insight into the use of ICT as a teaching and learning tool. The study aims to evaluate students' attitudes towards ICT in Bangladesh's education sector, explore factors influencing their use, assess satisfaction and dissatisfaction with ICT in higher studies, and determine its impact on academic development.

The hypotheses tested in this study are—

*H<sub>1</sub>: Perceived Enjoyment has a positive and significant impact on Perceived Ease of Use*

*H<sub>2</sub>: Self-efficacy has a positive and significant impact on Perceived Usefulness*

*H<sub>3</sub>: Perceived Ease of Use has a positive and significant impact on Perceived Usefulness*

*H<sub>4</sub>: Perceived Ease of Use has a positive and significant impact on Attitude towards Use*

*H<sub>5</sub>: Perceived Usefulness has a positive and significant impact on Attitude towards Use*

Rest of the paper is arranged as follows: second part presents the existing literature on students' attitude towards use of ICT as tool of learning. The third part presents methodology, where the study design, sampling and data management are depicted. The fourth part presents result and discussion of the findings from the assessment of data. The fifth part shows the economics of students' attitudes toward use of ICT and the final part draws a concluding remark.

## Review of literature

Initially TAM is proposed by Davis (1989) and it is indeed information technology theory that model responses of users to adopt and use a particular technology (Yusuf Dauda and Lee 2015). A number of researchers expanded TAM model and applied to various technologies including short message service (Muk and Chung 2015), teleconferencing (Park et al. 2014), and e-learning (Cheung and Vogel 2013). To adopt a technology, the application of that perceived to be easier to use than another is more apparently to be accepted by users (Davis 1989). Davis et al. (1992) concludes perceived usefulness as to person's perceptions concerning the outcome of experience. Attitude towards use as characterized by Davis (1989) refers to an aptitude that is disclosed by assessing a particular entity with some degree of favor or disfavor. Review of major empirical studies are presented in Table 1.

The review of literature reveals that majority of the studies avoid the influence of external variable and suggest for adding new variables in the future research. Since no research has been done in the target area in this context, it is anticipated that the current study would come out with a useful conclusion.

## Conceptual and theoretical framework

Based on the Theory of Reasoned Action (TRA) (Fishbein 1980), TAM was developed by Fred Davis and Richard Bagozzi (Davis 1989; Davis et al. 1992). The TRA is a model that shows the relationship among beliefs, norms, attitudes, and behavior of human. It is generally used to predict how an individual perform based on their existing attitudes and behavioral intentions. TAM is an extensional form of Theory of Reasoned Action. TAM replaces many TRA attitude variables with its two major variables- ease of use and usefulness. The first TAM model was designed for doctoral thesis by Davis (1989). It is the most attractive and efficient addition in the Theory of Reasoned Action. TAM promotes the better prediction of the use of information and communication technology. TAM also promotes the development of skill; digital learning and can lead to better productivity. Though many models have been proposed previously in the field of information and communication systems to describe the relationship, it is this model which has been broadly accepted and used.

The framework of traditional Technology Acceptance Model is given below (Fig. 1).

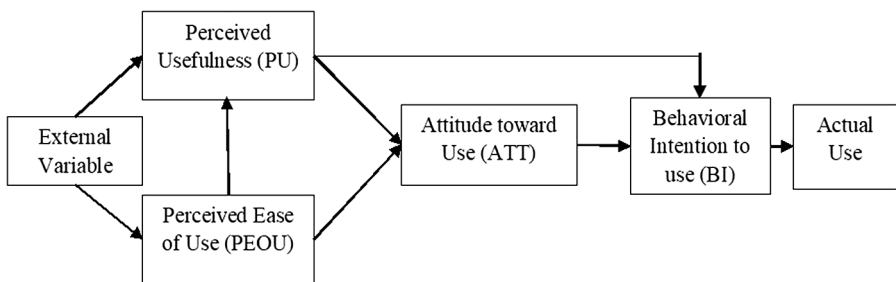
When users adopted an information technology, two major factors or determinants enhances their decision on when and how they will use it. The first determinant is the

**Table 1** Review of empirical studies

Author	Country/region	Variables	Methods	Key findings
Nair and Das (2012)	India (Kerala)	Latent-ATU Observed PEOU, PU	Traditional TAM, SEM approach	Ease of use and usefulness both has significant impact on attitude toward use of technology
Edmunds et al. (2012)	UK	Latent-system usage/user acceptance Observed-PEOU, PU	Revised TAM. Using ANOVA model	Technology increases awareness of benefits and effectiveness of work and the use of ICT influenced by intentions to careers after study and experience of work. During course study, work and social activity ICT becomes more integrated
Ofori (2019)	Google/Internet survey	Latent-ATU Observed-PEOU, PU	Traditional TAM, using histograms and tables	During lessons the use of digital tools positively impact the students and they believe that technology makes learning flexible and self-paced
Yang and Kwok (2017)	Singapore	Latent-ATT Observed-PEOU, PU	Cross-sectional survey Qualitative and quantitative data analysis	Engagement, communication, information gathering, collaboration and efficiency are five major factors that support use of ICT. Usability, ICT competency, internet connectivity and technical issues are four factors that create difficulties towards using ICT
Salgotra and Roma (2018)	India (Jammu)	Latent-ATT Observed-PEOU, PU	Revised TAM Using SEM approach	39% students have positive attitude which is a good number, 26% have average attitude and 35% don't have good attitude towards use of ICT
Afshari et al. (2013)	Malaysia	Latent-ATU Observed-PEOU, PU, subjective norm	Revised TAM Using SEM approach	The correlation between attitude towards CALL and both variables (PU and PEOU) are very strong
Ernst et al. (2014)	Germany	Latent-ATU (PEOU, PE, PU) Observed-didactic circle constructs	Combining didactic circle with TAM	All didactic circle constructs have positive and significant influence on ATU i.e.— PEOU, PE, PU
Li et al. (2019)	China	Latent-ATU, Observed-PEOU, PU, Policy	Revised TAM SEM approach	Attitude toward using technology has been influenced by perceived usefulness, perceived ease of use and national policy
Teo and Zhou (2014)	Singapore	Latent-ATU, BI Observed-PEOU, PU	Traditional TAM, SEM approach	Perceived usefulness and attitude toward use were significant determinants of the intention to use technology, while perceived ease of use influenced intention to use technology through attitude toward use
Mugo et al. (2017)	Kenya	Latent-ATU Observed-PEOU, PU	Partial application of TAM	The factors of usefulness and ease of use influences students' perception about m-learning

**Table 1** (continued)

Author	Country/region	Variables	Methods	Key findings
Agarwal and Ahuja (2013)	India (Agra)	Computer attitude scale	Mean, standard deviation and t' test	Students'- teachers has positive attitude towards the use of ICT but there exists no significant relationship between the attitude towards use and academic achievement
Renny et al. (2013)	Internet Survey	Latent-ATU Observed-PEOU, PU, Trust	Revised TAM	The influence of perceived usefulness on the attitudes towards usability of airlines ticket reservation is powerful than perceived ease of use and trust
Hamid et al. (2016)	Malaysia	Latent-continuance intention Observed-PEOU, PU	Revised TAM	At total 56% variance perceived ease of use and perceived usefulness were positively related to intention to use e-government
Alsamaydai (2014)	Jordan	Latent-ATU, BI Observed-PEOU, PU, Experience, Quality factors	Revised TAM	There exists stronger positive relation between attitude towards use of mobile banking service and also strongest positive relation between the perceived ease of use and experiences

**Fig. 1** Technology acceptance model proposed by Davis

systems Perceived Ease of Use and the other determinant is the systems Perceived Usefulness, which are the main factors for their Attitude towards Use and Behavioral intention to use. There are some external factors also included in the technology acceptance model (Table 2).

Generally, TAM is used in different sectors. According to Fig. 2, TAM can be used in E-Governance, E-learning, Internet Stock Trading, Internet Banking, Online Shopping and E- Ticketing. E learning refers to the learning system that is obtained through internet. E-learning is also referred to as technology enhanced learning.

**Table 2** The definitions of TAM's initial constructs in brief

Construct	Definition
Perceived ease of use	The use of the particular system technology will be effortless (Davis et al. 1989).
Perceived Usefulness	The use of the particular system technology can be improving a person's quality of job/work/task or someone perceives the technology to be useful for what he/she wants to do (Davis et al. 1989)
Attitude toward use	The general impression of the particular technology to the people (Ajzen 1991)
Behavioral Intention to use	The factor that leads people to use the particular technology and which may influence by the attitude toward use (Ajzen 1991)
Actual system use	The end point of the model which refers how often a person uses the particular technology (Straub et al. 1995)
External factors	The other factors that influence the attitude toward use of the particular technology

Source Ernst et al. (2014)

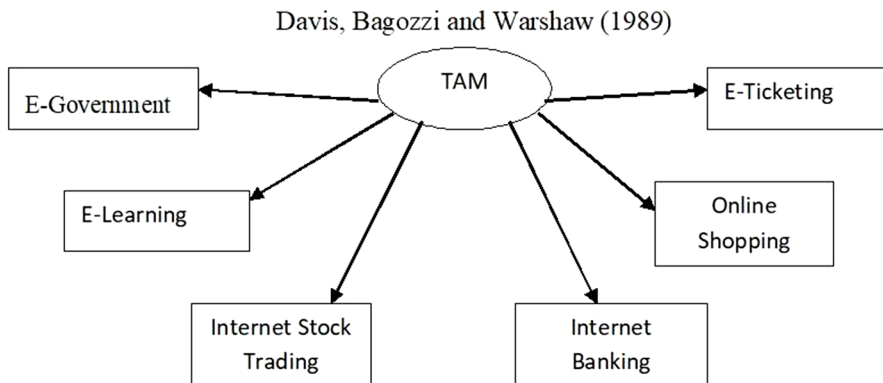


Fig. 2 Implementation of TAM

## Data and methodology

### Data

This study is based on primary data. For the purpose, 3 public and 3 private universities are chosen purposively for the collection of data. The chosen public universities are Dhaka University which is situated in the capital (Dhaka), University of Chittagong, which situated in Chattogram and Comilla University which situated in Cumilla district of Bangladesh. The chosen private universities are University of Asia Pacific and Green University which are situated in Dhaka and the Leading University of Sylhet.

Simple random sampling has been used to collect data. Anderson and Gerbing (1988) suggested that 100–150 respondents is the minimum sample size to get satisfactory result while using SEM, while Boomsma (1982, 1985) recommended a mini-

imum sample size of 100–200 for using SEM. Most researchers would recommend using at least 200/5 or 10 cases per parameter (Kline 2011). Following the existing literature, 300 respondents have been interviewed in this study to get satisfactory result.

### Variable view

External variables are the variables which are not developed in the model but influence the other major variables (Table 3). Variables can also be classified into Latent or constructs and Observed variables or indicators in SEM. Observed variables are the variables which are directly asked. Latent variables are those which are not directly asked but are determined by the observed variables.

### Data collection tool and technique

To analyze students' attitude through TAM, a survey was conducted by using a structured questionnaire from 407 university students of selected universities to get information on demographic profile, gender, educational qualification and types of the institution. Mainly, the questionnaire was based on TAM variables, where Perceived Enjoyment items, Self-efficacy items, Perceived Ease of Use items, Perceived Usefulness items and Attitude toward Use items were inquired. Five-point Likert scale was employed to explain the degree of acceptance as strongly agree, agree, partially agree, disagree and strongly disagree.

### Analysis of data

To analyze the collected information based on TAM, Structural Equation Model which is generally used to measure the qualitative data into quantitative form was used. Data are presented in graphs, charts and analyzed by simple statistical tool in SPSS 25 and AMOS 23.

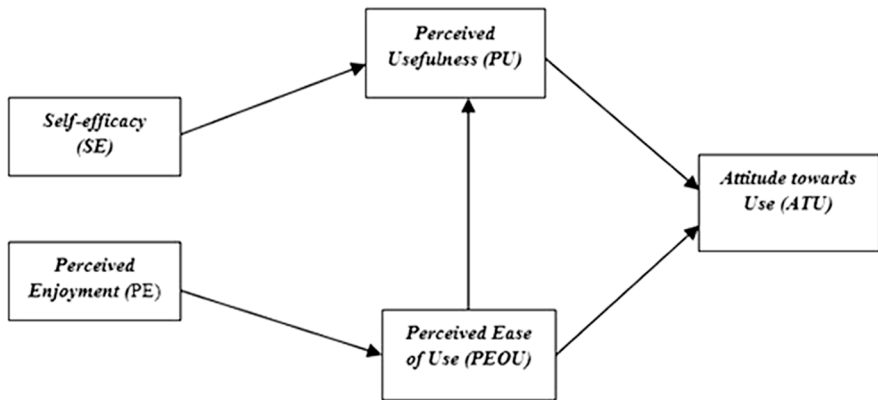
### Research model

To assess the students' attitude towards use of ICT as tool of learning, the study employed a revised TAM (Fig. 3). In this perspective, two variables named Perceived Enjoyment and Self-efficacy were included as external variable to the traditional

**Table 3** Description of the variables

Constructs	Notation	Variable types	Number of indicators
Perceived enjoyment	PE	Latent and external	3
Self-efficacy	SE	Latent and external	3
Perceived ease of use	PEOU	Latent and major	5
Perceived usefulness	PU	Latent and major	5
Attitude towards use	ATU	Latent and major	5





**Fig. 3** Revised TAM model for the study

TAM which was proposed by Davis (1989). The revised model has expected that PE has a positive impact on PEOU, SE has a positive impact on PU, PEOU has a positive impact on PU, PEOU has a positive impact on ATU and PU has a positive impact on ATU.

### Statistical analysis

To statistically analyze the collected information the study, test the sample adequacy, validity and reliability, confirmatory factor analysis, structural equation model.

### Sampling adequacy

To check the sampling size adequacy, we have used KMO and Bartlett's Test. Kaiser-Meyer-Olkin (KMO) test refers to the stability of the data for structure detection.

### Reliability test

The reliability can be illustrated in two ways- Cronbach's Alpha and Composite Reliability. Cronbach's Alpha shows internal data consistency. Composite reliability is estimated after conducting Confirmatory Factor Analysis (CFA). In this analysis both ways are employed. Before conducting CFA, we have checked the reliability by using Cronbach's Alpha.

### Confirmatory factor analysis

CFA is a statistical procedure which is generally used to verify the observed variables. It is also known as measurement model. In this part, it can be decided either the measurement theory have to confirm or reject. The decision has been taken to depend on the values of model fit. The model fit indices are the CMIN/df (Normed chi-square), GFI, AGFI, TLI, CFI, NFI, RMSEA etc. To get better results the study

used modification indices which refers that there exists relationship between the error terms.

### Validity and reliability test

The validity of the data can be checked through the estimates of the CFA. There are two types of validity- convergent validity and discriminant validity. The convergent validity refers that two latent variables or constructs are related. Discriminant validity employs when it is supposed that the measurements are not highly correlated. In the current analysis the validity of the model checked by the convergent validity. The convergent validity index is Average Variable Extracted (AVE). The reliability of the model is also checked by Composite reliability, which is employed while using CFA. The study follows both approaches to show the reliability.

### The assessment of structural equation model

SEM is a measurement method which is used to analyze qualitative information into quantitative system. As followed, structural equation is multivariate statistical analysis procedure that is used to analyze structural relationship between the indicators and the constructs and testing significance between the constructs. Structural equation model can be constructed through Covariance Analysis or Partial Least Square method. Covariance Analysis is more powerful and reliable. It is based on Covariance matrix; a confirmatory method. The study uses covariance analysis. The following TAM is gone through a structural form, so after fulfilling all criteria above the study conducted structural model. In this part also modification of indices used to get better results which shows that there has relationship between the error terms.

*Summary criteria of goodness of fit of CFA or SEM that researchers often use are—*

a. *Absolute Model Fit:*

1. Root Mean Square Error of Approximation (RMSEA) should be less than 0.08 (Browne and Cudeck 1992)
2. Goodness of Fit Index (GFI) is ( $> 0.90$ ) is acceptable (Byrne 1994)

b. *Incremental Fit:*

1. Comparative Fit Index (CFI) is ( $> 0.90$ ) is acceptable (Kline 2005; Hooper et al. 2008).
2. Normed Fit Index (NFI) is ( $> 0.90$ ) is acceptable (Byrne 1994).
3. Tucker Lewis Index (TLI) is ( $> 0.90$ ) is acceptable (Kline 2005; Hooper et al. 2008).
4. Incremental Fit Index (IFI) is ( $> 0.90$ ) is acceptable (Kline 2005; Hooper et al. 2008).

c. *Parsimonious Fit:*

**Table 4** Demographic characteristics of the sample

Gender:
Male- 148 (49.33%), Female- 152 (50.67%)
Educational qualification/level:
Undergraduate-135 (45%), Graduate-117 (39%), Postgraduate- 48 (16%)
Types of the university:
Public-164 (54.67%), Private-136 (45.33%)

**Table 5** KMO and Bartlett's test

KMO and Bartlett's test		
Kaiser-Meyer-Olkin measure of sampling adequacy		0.921
Bartlett's test of sphericity	Approx. Chi-Square	3501.445
	Df (Sig.)	210 (0.000)

1. Adjustment Goodness of Fit Index is less than GFI is acceptable (Kline 2005; Hooper et al. 2008).
2. Chi-square/ df (minimum discrepancy) is less than 3 (Kline 1998; Ullman 2001).

## Results and discussion

### Demographic profile

Table 4 shows that there are 148 male respondents (49.33%) and 153 females (50.67%). 135 respondents are undergraduate (45%), 117 are graduates (39%) and 48 are postgraduate (16%). 164 (54.67%) of the total participants are from public universities and 134 (45.33%) are from private universities (Table 4).

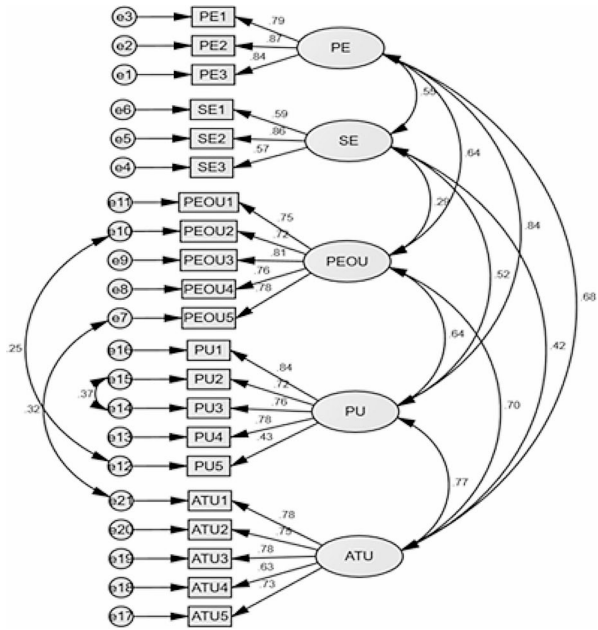
## Tests for quality of the instrument and model

### Sample adequacy test

The sample adequacy is tested by KMO and Bartlett's test which is used for factor analysis. KMO and Bartlett's test is conducted with all the observed variables through dimension reduction (Table 5).

If the value of KMO is between 0.8 and 1, it indicates the sampling is adequate. If the KMO values less than 0.6, it indicates the sampling is not adequate and remedial action should be taken. Here the KMO and Bartlett's value is 0.921 (Table 5) which is significant and indicates that the sampling is adequate (Appendix B1).

**Fig. 4** Confirmatory factor analysis



**Table 6** Reliability statistics

Cronbach's alpha	Cronbach's alpha based on standardized items	No of items
0.928	0.928	21

**Reliability test**

The reliability tests are used to check the internal consistency of the data initially which are checked by Cronbach's Alpha. Cronbach's Alpha shows how closely related a set of items are as a group. The value of Cronbach's Alpha should be greater than 0.7. If the value is between 0.7 and 1 then it indicates that the data is consistent. The value of Cronbach's Alpha is 0.928, which means that the data is reliable (Appendix B2).

**Confirmatory factor analysis**

The Confirmatory Factor Analysis shows the relationship between observed variables and latent variables. The CFA is also known as measurement model. Figure 4 shows that all the relationships between latent variables and observed variables are significant as the values are more than 0.5 except one, PU5 with PU which is 0.43. To get the better result, the measurement model used 3 modification indices between e14 and e15, e7 and e21 and e10 and e12 which indicate that relationship exists between the error terms.

Table 6 of model fit statistics, the CMIN/df also known as Normed Chi-square, shows the minimum discrepancy of the model. In this model the value of minimum

discrepancy is 1.836 which is below 3 and it means that the model is acceptable. GFI is the Goodness of Fit Index. The value of GFI should be greater than 0.90 that means the value is as close to 1 is as good. In this estimation, the value of Goodness of Fit Index is 0.913, which shows a good fit of the model. AGFI is the Adjusted Goodness of Fit Index. In this model the value of AGFI is 0.886, which is less than the value of GFI (0.913). The AGFI also shows significant result.

CFI, TLI, IFI and NFI are the Incremental measures of goodness. CFI is the Comparative Fit Index which compares the fit of the target model to the fit of an independent model. In CFI the variables are assumed to be uncorrelated. The CFI value is 0.957 (Table 7) which is greater than the minimum acceptance level, meaning that it is significant. The TLI value is 0.948 which lies on the acceptance level meaning that it is significant. The IFI and NFI are the Incremental Fit Index and Normed Fit Index respectively. The value of both IFI and NFI should be more than 0.90 and the following shows that the values are 0.957 and 0.910 respectively. Both IFI and NFI are significant.

RMSEA is the Root Mean Square Error of Approximation, which represents the badness of the corresponding model. In this model, the RMSEA value is 0.053 which is less than 0.08 which is significant and meaning that the model is not bad. After analyzing the Fit Indices of CFA, it is clear that all Fit Index of the measurement model have good fit (Appendix B3).

### Composite reliability and validity tests

After conducting CFA, the reliability of the model is rechecked by estimating composite reliability (CR) of the measurement model. Composite reliability shows the internal consistency of the constructs individually. After checking reliability, the validity of the model is also examined by estimating Average Variable Extracted (AVE).

Table 8 shows that the composite reliability values of PE, SE, PEOU, PU and ATU are 0.87193, 0.71876, 0.87447, 0.83796 and 0.85409 respectively. All values are greater than 0.07, clearly indicating that the model is reliable. Also, the value of AVE should be greater than 0.5 for the validity of the model. In case of this model, values of AVE of PE, SE, PEOU, PU and ATU are 0.69449, 0.46939, 0.58259, 0.51864 and 0.5408 respectively. The values are significant except for SE, which is also much closed to the significant level (Appendix B4).

**Table 7** Model fit statistics of the model

Fit index	Values	Acceptance level	Decision
CMIN/df	1.836	Less than 3 (< 3)	Significant
GFI	0.913	Greater than 0.90 (>0.90)	Significant
AGFI	0.886	Less than GFI	Significant
CFI	0.957	Greater than 0.90 (>0.90)	Significant
TLI	0.948	Greater than 0.90 (>0.90)	Significant
NFI	0.910	Greater than 0.90 (>0.90)	Significant
IFI	0.957	Greater than 0.90 (>0.90)	Significant
RMSEA	0.053	Less than 0.08 (<0.08)	Significant

**Table 8** Composite reliability and validity statistics

Constructs	CR	AVE
PE	0.871932	0.694491
SE	0.718764	0.469390
PEOU	0.874470	0.582587
PU	0.837964	0.518636
ATU	0.854089	0.540803

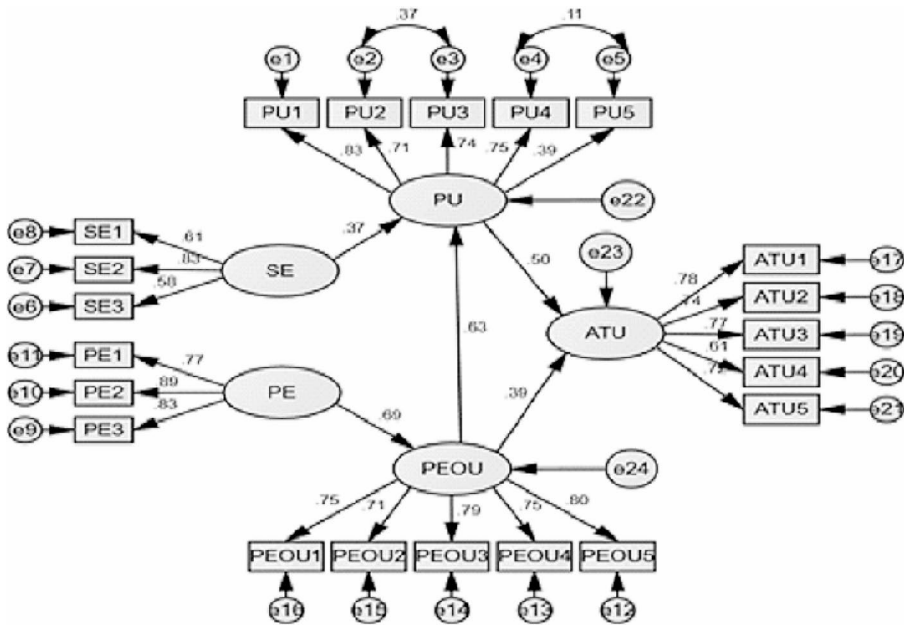


Fig. 5 Structural model

**Structural equation model**

After fulfilling all the above criteria, the structural model is examined. The structural equation model shows the relationship between the constructs.

Figure 5 reveals that there is a direct positive influence of external variable PE on major variable PEOU with path coefficient ( $\beta$ ) 0.69, which means that with 1% increase in PE, PEOU will increase by 69%. Similarly, there is a direct positive influence of external variable SE on major variable PU with path coefficient ( $\beta$ ) 0.37. It means, for an increase of SE by 1% the PU will increase by 37%. The major variable PEOU positively influence another major variable PU with path coefficient ( $\beta$ ) 0.63, meaning that if PEOU is increased by 1%, PU will increase by 63%. There is a direct positive influence of the major variable PEOU on ATU with path coefficient ( $\beta$ ) 0.39, meaning that if PEOU is increased by 1%, the ATU will increase by 39% and another major variable PU also positively influence ATU with path coefficient ( $\beta$ ) 0.50. It indicates that with an 1% increase in PU, the ATU will increase by 50%. To get better results here modification indices between e2 and e3 are used and also

**Table 9** Model fit statistics of the model

Fit Index	Values	Acceptance level	Decision
CMIN/df	2.801	Less than 3 (< 3)	Significant
GFI	0.870	Greater than 0.90 (>0.90)	Close to significance level
AGFI	0.834	Less than GFI	Significant
CFI	0.903	Greater than 0.90 (>0.90)	Significant
TLI	0.888	Greater than 0.90 (>0.90)	Close to significance level
NFI	0.858	Greater than 0.90 (>0.90)	Close to significance level
IFI	0.904	Greater than 0.90 (>0.90)	Significant
RMSEA	0.078	Less than 0.08 (<0.08)	Significant

**Table 10** Standardized regression weights: (final structural model)

Hypothesized path	Estimate	S.E.	C.R.(t-value)	P-value	Remarks
PEOU <— PE	0.686	0.066	10.39394	***	Supported
PU <— SE	0.373	0.096	3.885417	***	Supported
PU <— PEOU	0.631	0.060	10.51667	***	Supported
ATU <— PEOU	0.392	0.075	5.226667	***	Supported
ATU <— PU	0.501	0.083	6.036145	***	Supported

Note \*\*\* refers that the value is significant

e4 and e5; meaning that error term e2 and e3 has a relationship and error term e4 and e5 are also related.

In this model the value of minimum discrepancy is 2.801 (Table 9) which is below 3 showing that the model is acceptable. In this estimation the value of Goodness of Fit Index is 0.870 which is very close to the significance level, indicating that the model is good fit. Here, the value of AGFI is 0.834, which is less than the value of GFI (0.870). Thus, AGFI shows a significant result.

CFI is the Comparative Fit Index which compares the fit of the target model to the fit of an independent model. In CFI, the variables are assumed to be uncorrelated. The CFI value is 0.903 (Table 9) which is greater than minimum acceptance level, meaning that it is significant. The value of TLI should be greater than 0.90 for a good fit. The TLI value is 0.888 which is very much closed to the significance level and the model is almost good fit. The value of both IFI and NFI should be more than 0.90 and the result shows that the values are 0.904 and 0.858 respectively. The value of IFI is significant but NFI is closed to significance level which yields almost a good fit.

In this model, the RMSEA value is 0.078 which is less than 0.08 and thus significant, meaning that the model is not bad. After analyzing the Fit Indices of SEM, it is clear that all Fit Indices of the structural model are good fit (Appendix B5).

### Significance tests of the hypotheses

Table 10 shows the Estimate, the Standard Error and the Critical Ratio (C.R.). All the path coefficients are significant at 1% level. Thus, Perceived Enjoyment has positively and significantly affected Perceived Ease of Use, the hypothesis H<sub>1</sub> has been supported. Self-efficacy has a positive and significant impact on Perceived Usefulness, the hypothesis H<sub>2</sub> is also supported. Perceived Ease of Use has positively and

significantly affected Perceived Usefulness, thus supporting hypothesis H<sub>3</sub>. Perceived Ease of Use has a positive and significant impact on Attitude toward Use, proving hypothesis H<sub>4</sub>. Perceived Usefulness has a positive and significant impact on Attitude toward Use, which supports the hypothesis H<sub>5</sub>.

The study on students' attitudes towards using ICT as a learning tool reveals that perceived enjoyment, ease of use, self-efficacy, and usefulness play significant roles in shaping their attitudes towards using ICT tools. Students' opinions of ICT tools' ease of use considerably improve as they grow to enjoy using them more. Self-efficacy also positively influences students' perception of usefulness, suggesting that fostering confidence in their abilities to effectively utilize ICT tools for educational purposes is crucial.

The study also highlights the importance of designing user-friendly ICT interfaces and providing adequate training to ensure students feel comfortable and confident in using these tools. As students perceive ICT tools as easier to use, their overall attitude towards using them for learning becomes more positive, suggesting that efforts to enhance the ease of use can lead to more favorable attitudes towards their adoption and utilization. The study emphasizes the importance of considering these factors when designing and implementing ICT-based educational interventions to enhance students' learning experiences and outcomes.

The study on students' attitudes towards ICT as a tool of learning highlights the importance of designing engaging learning experiences that incorporate elements of enjoyment or gamification. Building student confidence is crucial, and educators should provide ample opportunities for students to practice using ICT tools and offer support. Emphasizing usability and utility is also essential, with user-friendly interfaces and clear instructions being crucial. Promoting positive attitudes towards technology is essential, and educators should provide opportunities for students to explore and experiment with different ICT tools in a supportive environment. Ultimately, fostering positive attitudes towards technology adoption can lead to increased engagement, motivation, and improved learning outcomes. The findings emphasize the need for educators to consider students' perceptions and attitudes towards ICT tools in designing effective teaching and learning experiences. By addressing factors such as enjoyment, ease of use, self-efficacy, and usefulness, educators can create more engaging and supportive learning environments that leverage technology's potential to enhance student learning outcomes.

## Conclusions and recommendations

This study assesses the students' attitude towards use of ICT as tool of learning through TAM analysis. To measure the relationship between TAM constructs, the study used SEM. It is found that TAM is a useful model to help the researcher to assess the attitudes of students towards use of ICT as tool of learning. From the KMO and Bartlett's test and the Cronbach's Alpha value reveal that the sampling is adequate and the data is reliable. From the Confirmatory Factor Analysis, it is noticed that the entire observed variable has significant relationship with the



concerned latent variables except the indicators PU5 with the related construct PU, which is also closed to the significant level. So, it can be concluded that the observed variables explain the latent variables significantly. In CFA the model fit indices also shows that the model is a good fit. After analyzing the CFA model this study rechecks the reliability by estimating composite reliability and test the validity by calculating average variable extracted. The findings show that all the variables are reliable and have the validity. Thereafter, structural model is conducted and the findings of the structural model show that the Perceived Enjoyment positively and significantly influences the Perceived Ease of Use, the Self-efficacy positively and significantly influences the Perceived Usefulness, the Perceived Ease of Use positively and significantly influences the Perceived Usefulness, the Perceived Ease of Use positively and significantly influences the Attitude towards Use and the Perceived Usefulness positively and significantly influences the Attitude towards Use. In other words, if PE increases then PEOU increases, if SE is improved then PU is increased, if PEOU increase PU and ATU both increases and if PU is increased then ATU is increased (Table 11).

It can be concluded that the two major variables PEOU and PU has direct positive impact on Students Attitude towards Use of ICT as tool of learning and the external variables influences indirectly through the major variables. The use of ICT is easy to use and useful to the students, which indicates that the students have positive attitude towards use of ICT as tool of learning.

The findings provide some recommendations which may be helpful for the policymakers and future researchers. The most important recommendation is, as the students have positive attitude towards use of ICT, steps should be taken to improve the facilities of using ICT and ICT based education should be promoted. Government and private investment sector should increase investment on the ICT based education. Evolution of technology-based education and planning for monitoring projects should be undertaken. As the extensive use of ICT in education can help the students to reduce knowledge gap, the extensive use of ICT should be promoted.

This study however suffers from some limitations. We have collected data only from six universities. The study uses only two external variables due to easy assessment of the model. But in reality, there are some other variables that influ-

**Table 11** Summary of the hypotheses results

Hypothesis	Results
H <sub>1</sub> : Perceived Enjoyment has a positive impact on Perceived Ease of Use	Direct, positive and significant
H <sub>2</sub> : Self-efficacy has a positive impact on Perceived Usefulness	Direct, positive and significant
H <sub>3</sub> : Perceived Ease of Use has a positive impact on Perceived Usefulness	Direct, positive and significant
H <sub>4</sub> : Perceived Ease of Use has a positive impact on Attitude towards Use	Direct, positive and significant
H <sub>5</sub> : Perceived Usefulness has a positive impact on Attitude towards Use	Direct, positive and significant

ence the TAM. Future researchers may include other external variables to extend the TAM and should consider more data for generalization.

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**Data availability** Data may be available on reasonable request.

**Code availability** Not Applicable.

## Declarations

**Ethics approval and consent to participate** Not applicable for this article. However, a consent form of the following was filled by the respondents to permit the publication on the information collected from them.

**Questionnaire Consent Form** I (respondent) hereby give my permission to Tasfia Zahan Ria, Dr. M. Zakir Saadullah Khan and Dr Utpal Kumar De [researchers] to allow me to respond the questionnaire and use my responses exclusively for research purposes. I understand that the research title is Students' Attitude towards Use of ICT as Tool of Learning: A Structural Equation Modeling (SEM) Approach. I believe that hereby named Tasfia Zahan Ria, Dr. M. Zakir Saadullah Khan and Dr Utpal Kumar De will maintain my anonymity with regard to my responses to the questionnaire items. I hereby give my permission in the form with my signature below: Signature \_\_\_\_\_ Date \_\_\_\_\_ Contact of Researchers: Tasfia Zahan Ria [tasfiazria68@gmail.com] Dr. M. Zakir Saadullah Khan [zskbd@yahoo.com] Dr Utpal Kumar De [utpalkde@gmail.com]

**Conflicts of interest** The authors declare that there is no conflict of interest at all. Additionally, the authors declare that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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