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Structural Equation Modeling for Acceptance of Cloud Computing

Waqas Ahmed, Sheikh Muhamad Hizam, Ilham Sentosa
UniKL Business School (UBIS), Unversiti Kuala Lumpur
Kuala Lumpur, Malaysia
waqas.ahmed@s.unikl.edu.my
sheikhmhizam@unikl.edu.my
ilham@unikl.edu.my

Jawad Ali
Malaysian Institute of Information Technology (MIIT), Unversiti Kuala Lumpur
Kuala Lumpur, Malaysia
jawad.ali@s.unikl.edu.my

Toqeer Ali
Faculty of Computer & Information Systems, Islamic University of Madinah
Madinah, Saudi Arabia
toqeer@iu.edu.sa

***Abstract*— As the disruptive innovations are being penetrated to each level of society, the acceptance of modern technology is regulating the education activities. Managing the educational usage of computing through cloud applications is a matter of discussion nowadays. The aim of this study is to instigate the assessment of the adoption of cloud computing from end-users perspective. Technology acceptance model is applied to assess the behavioural intention towards the adoption of cloud computing. An online survey was conducted with close-ended questionnaire. Data was collected from 298 respondents. Structural equation modeling (SEM) was conducted to undertake the model fit and path analysis through AMOS software. The analysis demonstrates that perceived usefulness and personal innovativeness are most significant element towards behaviour shaping while the subjective norm is found insignificant towards cloud computing use. The study will help to focus on individual-level innovativeness in academia.**

Keywords—cloud computing, technology acceptance model, user adoption.

I. INTRODUCTION

The technological developments and innovations are transforming civilisation by entering the Web 2.0 and Industry 4.0. This narrative of the digital ecosystem has altered the ways of organisations performance, customers behaviour, businesses growth and society's instincts. As once there was concept of an Internet, solely established for human needs while this is the era of internet of everything. Similarly computing mechanism has been upgraded from physical availability of devices to remote and virtual usage of computer infrastructure. This upheaval in computing is known as cloud computing where resources such as service applications, storage media and hardware can be used from internet instead of physical means. Cloud computing concept was intrigued due to the higher utility of electronic devices such as laptop, personal computers, smart-phones etc. and to counter and replace such usage by virtual resources with high accessibility and common sharing features towards various users [1]. For organisations, there are numerous plusses of cloud computing such as limiting the cost on the purchase of devices by renting the virtual places. These remote resources are fasters and agile in functionality, elastic in meeting users' requirement with low latency [2]. Cloud computing is a significant innovation towards firms to shape up and deliver the novel technology framework to empower for implementing ubiquitous digital tools [3] while for end-users it is cost-efficient and compliant in using the applications [4]. There are various examples of end-users' cloud applications such as Microsoft OneDrive, Google Drive, Amazon Cloud Drive, Apple iCloud etc. [5].

The implication of cloud computing ensures the firm ascendancy by delivering the features of convenience, improved accessibility, cost-saving, mitigating expenses on technological infrastructures, minimal level of training and super-computing power[1] in various sectors such as automotive, retail, manufacturing, education, banking, healthcare and entertainment etc. [6], [7]. The total market value of these sectors' will reach $411bn in 2020 while the worth of cloud computing in education sector is predicted to reach $159bn [8]. The features of education cloud involve collaborative learning, digitalised libraries, interoperability and cyber-storage [9] [10]. It aims to achieve the sustainable development in education sector by incorporating and implementing the Cloud technology for the higher education mechanism, virtual computing labs (VCL), virtual learning environment (VLE) and distance learning application through Software as a Service (SaaS) [11].

In order to the enactment of digital transition, the educational institutions should consider the practices of business organisations where companies are unable to fully optimise and integrate the technology without assessment of end-users ability and ambition towards acceptance of novel system [12]. However, the literature on the acceptance of cloud computing is mainly based on business context with organisational variables [8]. The studies on end-users behaviour and ambition towards technology are less focused in cloud computing literature [13]. Current researches of cloud computing in education sector merely emphasis the business perspectives such as cloud framework, security, strengths, weaknesses and system execution [8], [14]. Adoption of digital tool like cloud computing in organisations depends on end-users' behaviour that influences through numerous personal attributes and factors [12]. In order to study the individual's behaviour in technology adoption mechanism, the technology acceptance model (TAM) is considered as the most validated and significant predictor [15].

As there emerged limited empirical data on cloud computing adoption [8] in academia with less focused surveys on end-users' (i.e., students) behaviour [13], the study aims to investigate the acceptance of cloud computing in the education sector by undertaking the TAM model with external constructs towards assessments of students' behaviour. The personal innovativeness [16] and subjective norms [17] are appeared to be the vibrant influencers in decision making towards technology usage. This research will concentrate on end-users personal belief and ambition in cloud computing adoption process that is rarely focused in literature.

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II. Literature Review

A. Technology Acceptance Model

In past 03 decades, the literature on information system (IS) integration involved numerous theories and models to predict the determinants of attitude and behaviour towards technology use where Technology Acceptance Model (TAM) appeared as most generalizable and applied model in various technologies [18]. TAM was proposed by Davis in 1989 to understand and assess the employee's behaviour towards acceptance of management information system. In this model, the behaviour to decide the usage of system is backed by attitude, system convenience and usefulness of technology. TAM has appeared as one of the most practised models with external variables in information system literature [15]. The perceived usefulness and perceived ease of use are main constructs in the model that influence the attitude positively or negatively. Such resulted attitude shapes the behavioural intention of user to decide for actual utility of system as depicted below in Fig. 1.

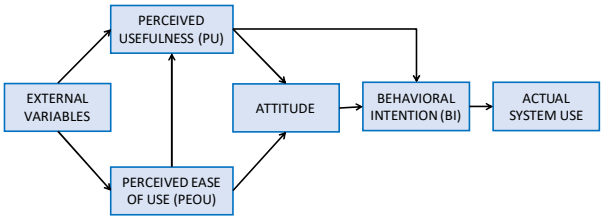

Fig. 1. Technology Acceptance Model

B. Previous Researches

There are various studies available in the literature regarding cloud computing acceptance. Such studies undertook the different IS models like TAM, Theory of planned behaviour (TPB) and Technology-Organization-Environment Model (TOE) in various countries. Mostly the adoption studies are covering the perspective of organisation frameworks. Such as, In Taiwan employees of tech-firms were assessed for acceptance prediction and found that organisational support, trading pressure and comparative benefits of system had positive influence on behavioural intention [19]. In a survey of a USA university, students' behaviour towards cloud computing was derived through perceived usefulness, perceived cost and perceived ease of use[20]. In another education cloud research, relative advantage, government policy, technical complexity and readiness for technology predicted the acceptance perception in higher education institutes [21]. Similarly the studies on cloud adoption in educational sectors encapsulated the aspects of security, privacy and service quality [1], organisation-environment scenario [14], significance and challenges of system [8], enablers and barriers of system [22][23], [24]. While [8] concluded that literature on education cloud needs to fill the gap of less focused section of empirical studies. Research on individual behaviour's aspects can well-explain the potential determinants of digital tools in today's era that can support the organisational strategy of innovation optimisation [12]. To considerate of education cloud implementation in higher education institutes, the students' behavior assessment is crucial and intrigues for thorough investigation and analysis [13].

C. Theoretical Framework and Hypothesis Development

The scalability of the TAM model enables to shape the research framework according to the nature of study. It involves merger of other models with TAM and extension of model with new concepts [25]. TAM can be merged with additional model like TOE to present a better understanding of cloud adoption in organisation risk assessment [26]. To evaluate the individual level adoption the theory of planned behaviour and TAM model combinedly presented the framework for student behaviour [27]. The study proposes the extension of technology acceptance model with personal innovativeness (PI) that refers to personal understanding and ambition of using technology[28] and another variable of subjective norm (SN) which describes the influence of society in acceptance of system. As one variable, i.e., attitude in TAM model acts as a mediator element between the relationship of cognitive constructs, i.e., perceived usefulness (PU) and perceived ease of use (PEOU) towards behavioural intention. However, there discovered the less influence of attitude [29] as the direct effect of both constructs on behaviour is validated and proved through many studies in digital technology acceptance [30]. The study will also eliminate the attitude and will evaluate the impact of four variables (PU, PEOU, PI and SN) on behavioural intention (BI) as delineated in Fig. 2.

1) Perceived Usefulness

Perceived usefulness is one of the vital influencers of the TAM model. It describes the user perception about the extent of effectiveness upon using the particular technology. In this scenario, end-users take on the view about the technology as useful that it will enhance the capability and efficacy of performing tasks. Perceived usefulness has positive influence on Behavioral intention to use the technology. In cloud computing, this relationship of PU influencing BI is proved by many studies [13], [19], [20], [26], [27], [31]. Therefore, the study hypothesises that:

H1: Perceived Usefulness (PU) will have a positive impact on Behavioral Intention (BI)

2) Perceived Ease of Use

TAM model presents the main constructs of human behaviour to make the decision. Among these, level of easiness in using the certain system is known as perceived ease of use. According to the concept, technology user perceives that using the system should free of struggle and no extra effort should require to perform the task while using the technology. In other words, end-users accept technology when they think it is easy to use. In education cloud, level of ease has vital impact on decision to use system[8]. It proved the positive relationship towards behavioural intention to use cloud computing [12]. When there is an ease in usability of

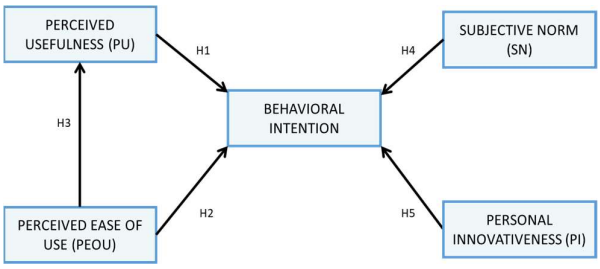

Fig. 2. Theoretical Model

cloud system, the user perceives the technology as useful [20],[21]. Hence, it is hypothesising that:

H2: Perceived Ease of Use (PEOU) will have a positive impact on Behavioral Intention (BI)

H3: Perceived Ease of Use (PEOU) will have a positive impact on Perceived Usefulness (PU)

3) Subjective Norm

Social influence, i.e., the subjective norm has profound impression on individuals' decision support system in technology acceptance[32]. Peer reviews and suggestions shape users' behaviour. In cloud computing acceptance, subjective norm is considered in very few studies [27]. As cloud computing is different from traditional way, an individual seeks the suggestion of peers to utilise the system to make sure the security and trust compliance. In education cloud acceptance, subjective norm impacts the behaviour of user [13], [27]. Hence it is hypothesised that:

H4: Subjective Norms (SN) will have a positive impact on Behavioral Intention (BI) to use Cloud Computing.

4) Personal Innovativeness

Integration of new system relies on innovativeness level of end-users. Personal Innovativeness is the state of an individual's ability to demonstrate positive inclination towards embracing the novelty[28]. The success of digital optimisation in any organisation is ultimately managed by end-users' behaviour, technological ability and ambition [12]. The innovativeness level of students in higher education institution is rarely predicted in cloud computing acceptance behaviour. However, the adoption of various digital tools such as Internet of Things [33], E-Payment [34] and Mobile learning [16] proved the significance of innovativeness on behavioural intention. Therefore, it is hypothesised that:

H5: Personal Innovativeness will have a positive impact on Behavioral Intention to use cloud computing.

III. Methodology

As the nature of the study is causal and finding out the impact of the determinant of technology acceptance on behaviour, the quantitative technique was commenced. A close-ended questionnaire with 05 point-likert scale was used for response compilation. An online survey was conducted to collect the data from students who are the users of cloud computing application such as Microsoft OneDrive, Google Drive etc. The total number of respondents answered the questionnaire were 298. There were 26 questionnaire items consist of the 05 variables. Questionnaire items or research instruments were adopted and compiled from IS literature. As TAM variables, i.e., perceived usefulness, perceived ease of use and behavioural intention were adopted from [35]. The items of personal innovativeness were taken from [28] while subjective norms questions were taken from [36].

Structural Equation Modeling (SEM) was used to evaluate the strength of the relationship between variables towards acceptance behaviour. SEM is based on two analysis models, i.e., measurement model and structural model. The measurement model represents the relationship between research instruments and the research variable by reliability and validity analysis followed by factor analysis where the model fit indices of the variable are measured. In structural model, the path analysis and hypothesis testing are performed [37]. The SEM analysis was conducted through AMOS 24.

IV. Results

1) Demographic Results:

Table I shows most respondents are male (63%), while respondents from 18 to 34 years of age are high in number (74%). As per the education level, the Master students are prevalent in number with 49%. According to the field of study, business students are higher with 36%. While 45% students spend 5 hours per day on internet.

TABLE I –DEMOGRAPHIC RESULTS

Gender	**%**	**Field of Study**	**%**
Male	63	Business	36
Female	37	I.T	33
Age	**%**	Engineering	11
18-25	39	Education	13
26-34	36	Medical	5
35-44	18	Others	2
>45	7	**Avg. Time spent on Internet daily**	**%**
		<05 Hours	45
Education Level	**%**	6-10 Hours	36
Bachelors	40	>11 hours	19
Masters	49		
Doctorate and Higher	11		

2) Reliability analysis

Reliability technique is applied to establish the level of the uniformity of the questionnaire items. The questionnaire is viewed as reliable when individual responses steadily to all research instruments. Reliability test is performed by using the program SPSS 25, as depicted below in Table II:

TABLE II – RELIABILITY RESULTS

Variable	**Recommended Value**	**Cronbach Alpha**	**Conclusion**
Perceived Usefulness	> 0.7	0.891	Approved
Perceived Ease of Use	> 0.7	0.910	Approved
Subjective Norm	> 0.7	0.908	Approved
Personal Innovativeness	> 0.7	0.909	Approved
Behavioral Intention	> 0.7	0.900	Approved

Cronbach's alpha reliability ranges from 0 to 1. The minimum level of internal reliability should be higher than 0.70. The higher value of reliability implies strong internal consistency between the items [38]. In Table II, all variables are fulfilling the recommended criteria of reliability analysis; therefore, these variables are feasible to use for analysis.

3) Structural equation Model Analysis

SEM analysis is used to explore the strength of the relationship between the model, present the goodness of model indices and path analysis of impacts on endogen variables. Confirmatory factor analysis (CFA) the basic step in this process to confirm the unidimensionality in the mode. In this process, factor loading with less 0.5 value are eliminated; however, in this study model factor loadings of all items are above 0.5 as portrayed in Fig .3. The variables have shown the unidimensionality to fulfil the requirement of CFA.

The SEM Analysis as portrayed in Fig 3 shows the relationship between the variables towards the cloud usage,

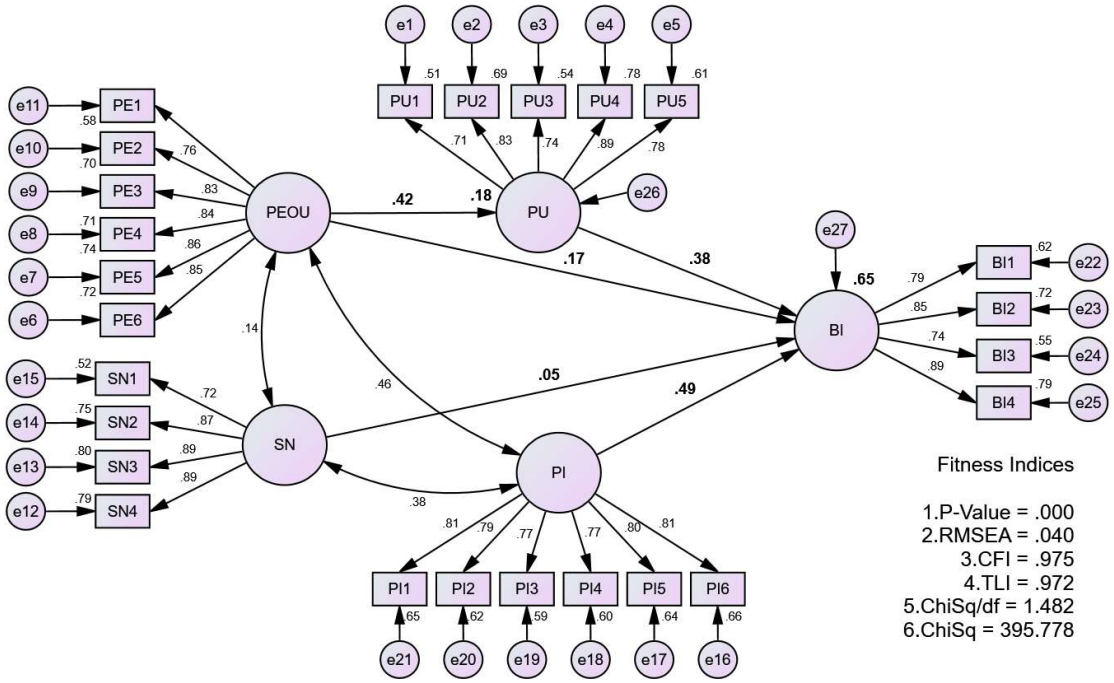

Fig. 3. Structural Equation Modeling Analysis

i.e., the relationship between personal innovativeness, subjective norms, perceived ease of use and perceived usefulness towards the behavioural intention. Personal innovativeness has strongest relationship towards the behavioural intention (0.49). It shows the higher level of innovativeness can lead to positive behaviour to use cloud computing. Similarly, perceived ease of use of cloud system enhances the perceived usefulness of end-users (0.42) and then perceived usefulness has good relationship towards the behavioural intention (0.38). However, social influence and peer suggestions in cloud computing are not found effective as there is negligible impact of subjective norms on behavioural intention (0.05) to use cloud computing. Overall variable impact on behavioural intention is 0.65, and perceived usefulness is impacted by perceived ease of use with 0.12. The above model also represents the correlation between the personal innovativeness and subjective norm as 0.38, personal innovativeness and perceived ease of use as 0.46 and subjective norm is corelated to perceived ease of use at 0.14. The correlation between the variables must not exceed the 0.80 [37] therefore the model variables are not highly correlated. As correlation level higher than 0.80 between two variables terms them identical variables.

4) Goodness Model fit indices:

Structural equation modeling consists of numerous model fit indices to indicate the strength of the model towards data analysis as mentioned in Table III. But there is no peculiar fit index for generalised way. It is then decided by researchers [37], [39] that one index from each category of model fit (i.e., absolute fit, incremental fit and parsimonious fit) can be used to achieve the level of goodness model of fit indices.

In this study, each index from three categories of model fit is evaluated, and the result is indicated in Table IV. Here all indices have appeared as fit. The P-value or Chisq can be subtle when sample size exceeds 200 because being the nonparametric statistics, it is very sensitive to large sample size [37]. This study has undertaken 298 samples for analysis; therefore, P-value is below the recommended level. However, according to [37], it is considered as fit in absolute fit model while another index of this category, RMSEA, is also appeared as good fit. The incremental fit model has 02 indices (i.e., CFI and TLI); these are also good fit in this study. Similarly, the parsimonious fit model contains the Chisq/df index that appears to be fit with 1.482 value against the threshold level of <5.0. In SEM, this study has shown the unidimensionality, strength of relationship between the variables, and goodness of model fit indices. The final step in SEM is to test hypothesis through certain factors and confirm the path assessment.

TABLE III – GOODNESS OF MODEL FIT INDICES

Model	Index	Recommended Value	Description
Absolute Fit	Chisq P	> 0.05	Subtle at sample size more than200
	RMSEA	RMSEA < 0.08	< 0.06 is good fit
Incremental Fit	CFI	CFI > 0.90	CFI = 0.95 is a good fit
	TLI	TLI > 0.90	TLI = 0.95 is a good fit
Parsimonious Fit	Chisq/df	Chi-square/df< 5.0	The value should be less than 5.0.

TABLE IV. MODEL FIT INDICES RESULT

Index	Results	Comment
P-Value	0.000	Poor Fit
RMSEA	0.040	Good Fit
CFI	0.975	Good Fit
TLI	0.972	Good Fit
Chisq/df	1.482	Fit

5) Hypothesis Testing

Hypothesis testing is performed by set parameters such as critical ratio score with higher than 1.96 and probability value with less than 0.05. Estimate value shows the percentage impact of on endogen variable from exogen. The significance level in hypothesis testing was set at 95 %, which depicts the value $\alpha = 0.05$. Therefore, CR and probability values in data analysis results will decide for acceptance and rejection of the hypothesis. The results of hypothesis testing are shown in Table V. The study has tested 05 hypotheses; the results are discussed as follows:

1) Hypothesis 1

Hypothesis 1 explains the relationship between perceived usefulness and behavioural intention to use cloud computing. The hypothesis analysis shows probability value is less than 0.05 and critical ratio is higher than 1.96, i.e., 6.484. Therefore, the H1 is a good fit and hence accepted.

2) Hypothesis 2

Hypothesis 2 depicts the relationship between perceived ease of use and behavioural intention to accept cloud computing. The value of CR for this hypothesis is greater than threshold value, i.e., 6.869. The probability value is also less than 0.05, that shows a significant impact of PEOU on BI. Therefore, hypothesis 2 is a good fit and accepted.

3) Hypothesis 3

Hypothesis 3 portrays the relationship between perceived ease of use and perceived usefulness to use cloud computing. The value of CR for this hypothesis is greater than the threshold value, i.e., 3.142 and the probability value is also less than 0.05, that shows the significant impact of PEOU on PU. Therefore, hypothesis 3 is a good fit and accepted.

4) Hypothesis 4

Hypothesis 4 represents the relationship between subjective norm and behavioural intention to accept cloud computing. The value of CR for this hypothesis is less than the threshold value, i.e., 1.099 while probability value is higher than 0.05, that shows an insignificant impact of SN on BI. All parameters towards significance of this relationship appear void. Therefore, hypothesis 4 is rejected.

5) Hypothesis 5

Hypothesis 5 illustrates the relationship between personal innovativeness and behavioural intention to use cloud computing. The value of CR for this hypothesis is greater than the threshold value, i.e., 8.018. The probability value is also less than 0.05 that shows significant impact of PI on BI. Therefore, hypothesis 5 is good fit and accepted.

TABLE V. HYPOTHESIS TESTING

Hyp.	Path		Est	S.E.	C.R.	P	Result
	From	To					
H1	PU	BI	0.235	0.036	6.484	***	Accepted
H2	PEOU	BI	0.468	0.068	6.869	***	Accepted
H3	PEOU	PU	0.118	0.038	3.142	0.002	Accepted
H4	SN	BI	0.035	0.032	1.099	0.272	Rejected
H5	PI	BI	0.385	0.048	8.018	***	Accepted

V. CONCLUSION

The study aims to investigate the vital stimuli of the digital tool such as cloud computing, usability from end-users point of view. This study focuses the personal understanding and motivation towards technology usage that is less focused in cloud computing studies. Personal innovativeness, perceived usefulness and perceived ease of use are resulted significant towards cloud computing use by confirming the hypothesis. While the subjective norm is found unable to influence behaviour. This result is different from the previous IS studies [15], [32] due to the nature of technology and its understanding. It proves that an innovative mindset does not need social influence and peer reviews in decision making for technology use. The study proposes the vitality of personal ability and understanding of technology among students for smooth integration of innovation in academia. The study also proved the robustness of the TAM model in understanding the behavioural constructs towards digitalisation in education sector. However, extending the TAM with more specific variable such as personality traits would support the literature in this regard. The research is limited to the only component of academics, i.e., student, however considering the other stackholders like teachers and admirations, can enhance the understanding in this field.

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