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Investigation of Mobile Cloud Storage Adoption Factors in Higher Education

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***Abstract*— Mobile cloud storage provides benefits for educational institutions. Several researchers have researched cloud computing adoption, but only a few studies related to how users experience using Personal Cloud Storage Services. This research aims to investigate the adoption of the mobile cloud storage factors following the theory, as well as research that has been previously proven related to user interest in using mobile cloud storage among higher education students. This quantitative research uses data analysis techniques using GSCA to prove the theory and achieve the research goals. The research methodology consists of five main stages, namely the stage of model development and research design, the stage of preparing the instrument and its measurement, the stage of testing the instrument, the stage of survey and results, as well as the stages of analysis and discussion as well as conclusions. Five variables are investigated in this research: knowledge sharing, perceived usefulness, attitude toward using a system, trust, and intention to use. The results of hypothesis testing were conducted using GSCA; three proposed hypotheses were accepted, and one was rejected. The variables the research model can explain are 68%, and the remaining 32% are other variables not used in this study. The characteristics of respondents can provide several ways to increase the adoption of mobile cloud computing by linking research results from inferential analysis and descriptive analysis. Future research can focus on extracting these variables through user interviews regarding students' intentions to use mobile cloud computing.**

***Keywords*— Cloud storage; GSCA; higher education.**

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I. INTRODUCTION

New developments emerging in the field of information technology bring improvements and increasingly superior services. This condition can encourage and bring opportunities for improving the quality of life. Cloud computing capabilities can serve user needs better when compared to using infrastructures such as clusters and grid computing. There will be an increase in user effectiveness, time efficiency, and functionality which is supported by the potential for lower costs to be incurred [1]. The difference between the client-server network topology and cloud computing topology is that cloud computing offers robustness and resolves traffic congestion on the network. Then, the management layer can monitor traffic and implement security mechanisms throughout the cloud [2].

According to NIST 2009, the availability of cloud computing can be described by five main characteristics: individual service needs, network access, resource pooling, adjustable speed, and scalable services [1]. From the characteristics that become the advantages of cloud computing, there are several challenges or risks in data recovery, confidentiality, privacy, integrity, availability, reliability, and security [3]–[6]. A similar risk applies to mobile cloud storage accessed from a mobile device. However, new challenges are faced by mobile devices' capabilities, such as limited bandwidth, computing, and storage, that will affect mobile cloud computing services [4], [7].

Mobile cloud computing devices are becoming a significant part of the modern and virtual lifestyle [8]. Mobile cloud computing is more about the infrastructure accessed from different mobile devices (such as laptops, smartphones, and tablets) that can access existing resources anytime and anywhere. Some famous mobile cloud storage examples are Google Drive, Dropbox, and iCloud [9].

Some of the cloud storage benefits in the field of education are related to the ability to provide facilities for learning activities in the form of online applications [10]. Massive open online courses (MOOCs) offer an evolving type of education between traditional online courses and formal

learning[11]. The impact of Covid-19 was that many educational institutions implemented learning online [12]. Mobile cloud computing is rapidly gaining users because of the solutions for the pandemic era.

Learning facilities in the cloud storage can also be used flexibly in the learning environment, supporting mobile learning; support intensive computing for teaching, learning, and evaluating. In addition, shared storage includes extensive system scalability and brings cost reduction in learning applications. However, besides the benefits obtained, there are risks such as reliability, performance, security [13], licensing, and price modeling [7]. Based on these benefits, some phenomena occur among students from higher education. This phenomenon is the formation of student perceptions in sharing knowledge because of the risk of accessing documents without permission when joining a document-sharing service on mobile cloud storage [14]. The other concern was that emerging data-intensive applications pose challenges for mobile cloud computing[15].

Several researchers have researched cloud computing adoption, but only a few studies related to how users experience using Personal Cloud Storage Services [9]. This research gap becomes a new opportunity to investigate the factors of mobile cloud storage adoption. Researchers have developed many models to measure users' acceptance and adoption of information technology. The Technology Acceptance Model (TAM) was developed by Davis and explained by [16]. The model consists of five variables: perceived usefulness, perceived ease of use, attitude towards behavior, behavioral intention, and behavior.

Factors that perceived ubiquity, trust, and subjective norm significantly affected the original conceptual model of TAM [7]. The results of the developed model prove to be better in explaining in more detail the adoption factors using cloud computing model services than the TAM model, which explains more generally. The study states that several variable relationships are of concern in this study. However, these researchers say that further studies are needed to re-examine the analysis of the direct and indirect relationships among the recommended factors. The items with a high modification index have been removed to improve model fit.

This is also supported by Rogers's [17] theory which states that the perception of complexity is one of the characteristics of innovation in studying the use and understanding of a new system or technology. Subsequent studies have proven that convenience significantly affects a person's attitude towards adopting a technology [3], [18]. However, Users will continue to use the system if the system can provide benefits and is helpful. Thus, in this study, the convenience factor is one of the factors of perceived usefulness [16].

Furthermore, in Arpaci [7], the research investigated the trust variable from two aspects, security and privacy. The proposed conceptual model will add control aspects [18]–[20] and indicator items that better represent the perception of trust. Then, the proposed conceptual model also adds an external variable of knowledge sharing [3], a unique benefit of mobile cloud storage services because students can share documents anytime and anywhere to fulfill learning interests. Thus, according to the literature review, the proposed concept will use the original TAM construct variable and refine the conceptual model developed by previous research [21]. So, based on this background, this study investigates the factors of mobile cloud storage adoption following the theory, as well as research that has been proven previously related to user interest in using mobile cloud storage among higher education students. This quantitative research uses data analysis techniques using GSCA to prove the theory and achieve the research goals.

II. Material and Method

A. IT Adoption

A critical element in the implementation of an information system is the acceptance of the information system. An organization's information system can function as a working medium and tool for achieving organizational goals by providing information. Many factors influence the success of an information system. These factors determine how the system can process inputs and produce outputs and information appropriately and how users will accept and use it to achieve organizational goals. Based on the survey results of the research [22], using cloud computing in the Iraq government proposed e-services according to the citizen's perceptions.

User acceptance of the information technology systems implementations can be defined as the intention of the user group to implement the information technology system in their work. If the user does not want to use the new information technology system, then the implementation system will not provide many benefits for the organization/company.

The impact of using ICT is very significant in the world of education. The educational environment will involve big data technology, cloud computing, the Internet of Things (IoT), and artificial intelligence (AI), which will create a new world of educational reform [23]. Based on research by Sayaf et al [24] which surveyed 711 students, proved that students' attitudes towards using ICT can be improved in learning, exchanging knowledge, and solving problems. This study also suggests that educational institutions should be able to encourage students to have experience using various digital media in their learning activities. Cloud computing is an ICT innovation offering many advantages and leads to the digital transformation of private and public organizations [25].

B. Technology Acceptance

The technology acceptance model is developed from various theoretical perspectives. Initially, the theory of diffusion of innovation[17] was the most underlying theory and became the reference for acceptance and various models of technology acceptance. Diffusion of Innovation Theory is the process of spreading or absorbing new ideas that are carried out to change groups or communities, which occurs continuously. In the diffusion theory proposed by Rogers, innovation characteristics determine the speed of an innovation process. There are several characteristics of innovation, namely (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability.

Acceptance of technology in the form of information systems can be measured by several evaluation models that have been developed. Many evaluation models are used to measure the acceptance of an information system used by an

organization or public institution. The following are four examples of evaluation models that are often used to measure the acceptance of a new information system [26]:

1) End-User Computing Satisfaction (EUSC) is a method that uses satisfaction measurement as a form of information system evaluation. EUSC emphasizes the level of end-user satisfaction with the technology aspect. Evaluating satisfaction in the EUSC includes five perspectives: content, accuracy, format, ease of use, and timeliness. This model has been tested and analyzed by researchers to test its reliability. The test results show no significant difference even though this instrument is used in different languages.

2) Task Technology Fit (TTF) analysis is a formal construct. The construct of the TTF is a perception of the suitability of technology capabilities in the needs of tasks at work or includes explicitly the ability of information technology to provide support for work. The TTF model has four key constructs, namely Task Characteristics and Technology Characteristics, which affect the three TTF constructs and the outcome variable, Performance or Utilization. The TTF model posits that information technology will only be used if the functions and benefits generated or available can support user activities.

3) Human-Organization-Technology (HOT) Fit Model is a framework used to analyze and evaluate information systems. The HOT model focuses on essential components in information systems, namely humans, Organizations, and Technology, and the appropriateness of the relationship between them.

4) Technology Acceptance Model (TAM) is how users are willing to accept and use technology. TAM is one of the models for evaluating the success of information systems seen from the use of the system. This model will illustrate that several factors influence user decisions regarding the new system, namely usefulness and convenience. The usefulness shows the user's belief in the contribution of the information system to the performance of the information system user. The convenience aspect provides the level where users believe that using information systems is easy and does not require high effort from new users.

C. Methodology

The methodology used in this research consists of five main stages, namely the stage of model development and research design, the stage of preparing the instrument and its measurement, the stage of testing the instrument, the stage of survey and results, as well as the stages of analysis and discussion as well as conclusions (fig. 1).

The object of this research is Caltex Riau Polytechnic. The conceptual model of the research investigated in this study has been discussed in previous works [21]. The present study validates the model with empirical studies. In making the conceptual model, the search for existing research trends on mobile cloud computing and searching for literature in international journal databases. The next activity is to design a conceptual model and the relationship between variables to form a theoretical construct. To test and analyze the model by the stated objectives, the research designed this time is causative, descriptive, and quantitative. This study will answer four hypotheses, namely:

- The relationship between the knowledge-sharing variable and the perceived usefulness variable
- The relationship between the perceived usefulness variable and the attitude toward variable
- The relationship between the trust variable and the attitude toward variable
- The relationship between the attitude toward using a system and the intention to use.

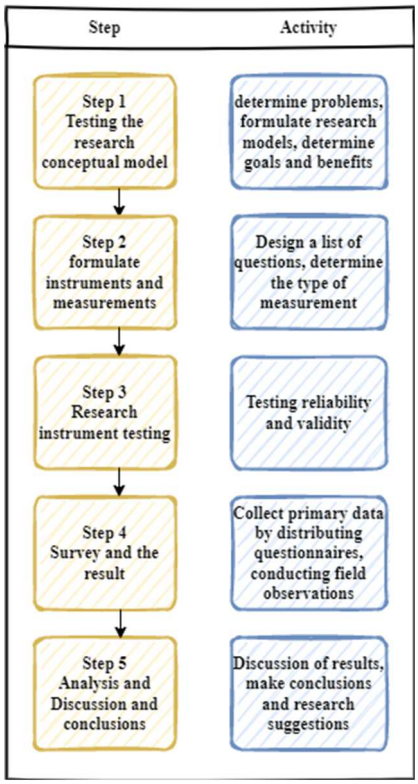

Fig. 1 Research Methodology

The primary data sources in this study came from surveys in the form of questionnaires and interviews. Based on data obtained from Caltex Riau Polytechnic, which became the research object, there were 1982 active students consisting of 11 study programs in June 2022. Based on the Slovin formula, 333 respondents were obtained for this study.

The analytical technique used in this research is descriptive analysis and inferential analysis. Descriptive analysis was performed by describing the data based on respondents' responses to question items related to indicators of research variables. In addition, descriptive analysis is also used to determine the characteristics of respondents. The inferential analysis is used to analyze data using a component-based approach with the Generalized Structured Component Analysis (GSCA) tool.

III. Results and Discussion

A. Descriptive Analysis

It was obtained that information about the number of respondents in semesters 1-3 students was higher (57.4%) compared to semester students >3 (42.6%). Based on their age, respondents were divided into three categories. The

number of ages 17-20 years is 71.5%. The number of ages 21-25 years is 27.3%. The number of people over 25 years old is 1.2%. The number of student respondents who use Google Drive is 85.9%. Student respondents who use iCloud are 9.3%. Student respondents who use OneDrive are 4.2%. Student respondents who use Dropbox are 0.6%. Information obtained that the number of respondents most often use mobile cloud computing services as much as 66.7% daily. Then, 18.3% use mobile cloud computing services with a frequency of 2 times a week. The frequency is once every 2-3 weeks, and the frequency of using once a month is 5.4%.

B. Convergent Validity

Validity describes a measure of the correlation between reflexive indicator scores and latent variable scores. A latent variable is considered to have good convergent validity if the loading factors value is 0.7 and is significant. If the loading value is invalid and insignificant, the indicator can be dropped to get the appropriate model. The following are the results of the convergent validity of each variable calculated using GSCA.

1) Knowledge Sharing: The In-role behavior indicator (X1.2) is the one that best describes the Knowledge Sharing dimension (Table 1). The estimated value of the indicator is the largest, which is 0.888. Based on the critical point value obtained, role behavior helps students describe the dimensions of knowledge sharing in real terms. The critical point value obtained is in the range of 0.853-0.913, which is significant at the 95% confidence level.

TABLE I
CONVERGENT VALIDITY OF KNOWLEDGE SHARING

Variable	Loading			
Knowledge Sharing	Estimate	SE	95% CI	
	Alpha =0.684			
X1.1	0.812	0.025	0.762	0.858
X1.2	**0.888**	0.014	0.853	0.913
X1.3	0.635	0.047	0.536	0.724

2) Perceived of Usefulness: Convergent validity for the perceived usefulness variable (Table 2) is good because all indicators have a loading factor value of more than 0.7 and are significant. The Efficiency Indicator (X2.2) has an estimated value of 0.902, which is the indicator that can best describe the dimensions of perceived usefulness. Based on the critical point value obtained, efficiency helps students describe the dimensions of perceived usefulness significantly because the critical point value obtained is in the range of 0.874-0.922, which is significant at the 95% confidence level.

TABLE II
CONVERGENT VALIDITY OF PERCEIVED USEFULNESS

Variable	Loading			
Perceived of usefulness	Estimate	SE	95% CI	
	Alpha =0.924			
X2.1	0.836	0.027	0.778	0.882
X2.2	**0.902**	0.013	0.874	0.922
X2.3	0.835	0.02	0.79	0.871
X2.4	0.845	0.023	0.794	0.88
X2.5	0.862	0.018	0.823	0.893
X2.6	0.825	0.025	0.773	0.873

3) Trust: Convergent validity for the Trust variable (Table 3) is good because all indicators have a loading factor value of more than 0.7 and are significant. The Security Indicator (X3.3) is the one that best describes the Trust dimension. The estimated value of the indicator is the largest among the other three indicators, which is 0.908. Based on the critical point value obtained, the safety factor helps students describe the dimension of confidence significantly because the critical point value obtained is in the range of 0.881-0.931, which is significant at the 95% confidence level.

TABLE III
CONVERGENT VALIDITY OF TRUST

Variable	Loading			
Trust	Estimate	SE	95% CI	
	Alpha =0.844			
X3.1	0.858	0.018	0.821	0.896
X3.2	0.852	0.023	0.806	0.895
X3.3	**0.908**	0.012	0.881	0.931

4) Attitude Toward Using a System: Convergent validity for the Attitude Toward using a system (Table 4) is good because all indicators have a loading factor value of more than 0.7 and are significant. Indicators of Perception of Brilliant Idea (Y1.2) and Perception of Enjoyment (Y1.3) are the ablest to describe the dimension of Trust. The estimated value of the indicator is the largest among the other three indicators, which is 0.935. Based on the critical point value obtained, the perception factor for bright ideas and perceptions of enjoyment helps students describe the Attitude Towards variable significantly because the critical point value obtained is in the range of 0.916-0.954, which is significant at the 95% confidence level.

TABLE IV
CONVERGENT VALIDITY OF ATTITUDE TOWARD USING A SYSTEM

Variable	Loading			
Attitude Toward using a system	Estimate	SE	95% CI	
	Alpha =0.924			
Y1.1	0.925	0.01	0.907	0.944
Y1.2	**0.935**	0.01	0.916	0.953
Y1.3	**0.935**	0.011	0.916	0.954

5) Intention to use: Convergent validity for the Intention to Use variable (Table 5) is good because all indicators have a loading factor value of more than 0.7, and all are significant. Based on the critical point value obtained, all indicators help students significantly describe the dimensions of User Behavior at a 95% confidence level.

TABLE V
CONVERGENT VALIDITY OF INTENTION TO USE

Variable	Loading			
Intention to use	Estimate	SE	95% CI	
	Alpha =0.893			
Z1.1	0.91	0.014	0.881	0.935
Z1.2	0.912	0.013	0.883	0.934
Z1.3	0.9	0.014	0.872	0.928

C. The Overall Goodness of FIT

At this stage, the goodness of the fit structural model and the R^2 value is identified from the data processing results using the GSCA application. The following are the results of the analysis (Table 6).

TABLE VI
CONVERGENT VALIDITY OF KNOWLEDGE SHARING

Model Fit		Cut off	Descriptions
FIT	0.68	0-1	Good
AFIT	0.678	0-1	Good
FITs	0.418	0-1	Passable
FITm	0.753	0-1	Good

The FIT value measures how large the model can explain the data variance. The model that is formed can explain all the existing variables of 0.68. The model can explain all variables by 68%. The other variables that are not in the model are 32%.

The AFIT value can indicate the possible variations of the model movement. The AFIT value is 0.678. The model can explain 67.8% that knowledge sharing, perceived usefulness, trust, and attitude toward using a system can influence the intention to use mobile cloud computing.

The FITs value indicates the total variation of all components described by the structure of the model specification. FITs value is 0.418. Thus, 41.8% of the model explains the variance in knowledge sharing, perceived usefulness, trust, and attitude influencing intentions to use mobile cloud computing.

The FITm shows the total variance of all indicators described by a particular measurement model specification. The FITm value is 0.753. The model is good at noting the variance in the indicators. Thus, 75.3% of the model explains the variance in the indicators of knowledge sharing, perceived usefulness, trust, and attitude toward influencing intentions to use mobile cloud computing.

D. R Square Identifications

The value of R2 on the perceived usefulness variable is 0.663, which means that the knowledge-sharing variable of 66.3% can explain the variability of perceived usefulness (Table 7). The value of R2 on the attitude toward using a system is 0.734. The perceived usefulness and trust variables of 73.4% can explain the attitude variability. The variable of intention to use has an R2 value of 0.693. The variability of intention to use can be explained by attitude toward using a system variable, knowledge sharing, trust, and 69.3%.

TABLE VII
R SQUARE OF LATENT VARIABLE

R square of Latent Variable	
Knowledge sharing	0
Perceive of Usefulness	0.663
Trust	0
Attitude Toward Using a System	0.734
Intention to Use	0.693

E. The Overall Model

The overall model in GSCA involves integrated structural and measurement models (Table 8). The GFI (Goodness of Fit Index) value is 0.987. The model is very suitable because it is close to a value of 1. For the SRMR (Standardized Root Mean Square Residual) value in this study, the number is 0.068 from > 100 respondents, and it can be interpreted that the SRMR model is suitable (acceptable fit).

TABLE VIII
OVERALL MODEL

Model Fit		Cut off	Descriptions
GFI	0.987	> 0.90	Acceptable fit
SRMR	0.068	≤ 0.08	Acceptable fit

F. Hypothesis Testing Results

The hypothesis test in this study is to look at the path coefficient value in the structural model. Of the four hypotheses proposed, one was rejected, and the other three were accepted, so the relationship between the variables is described as follows (fig. 2).

It is known that the estimated value of Hypothesis 1 is 0.814, the SE value is 0.019, and the CI value is 0.778-0.853. Based on observations of the path coefficient value. There is a positive influence between Knowledge Sharing and perceived Usefulness seen from the estimated value and 95% confidence level in the range of 0.778 to 0.853. Therefore, hypothesis 1 states that Knowledge Sharing has a positive and significant relationship to Perceive usefulness is **accepted**.

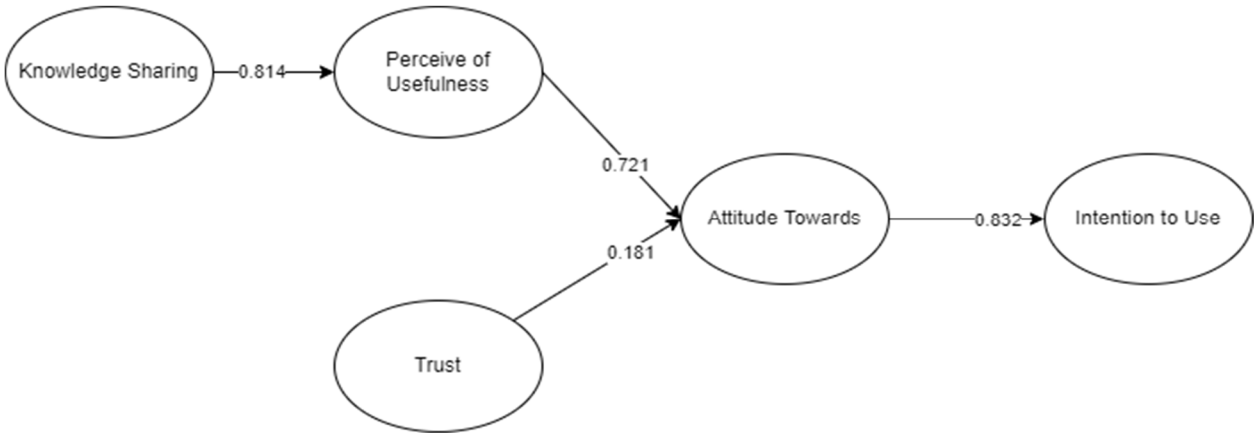

Fig. 2 Hypothesis Testing Results

It is known that the estimated value of Hypothesis 2 is 0.721, the SE value is 0.049, and the CI value is 0.632-0.815. Based on observations of the path coefficient value. There is a positive influence between Perception of Usefulness and attitude toward using a system seen from the estimated value and 95% confidence level. Therefore, hypothesis 2, which states that perceived usefulness has a positive and significant relationship to attitude toward using a system, is **accepted**.

It is known that the estimated value of Hypothesis 3 is 0.181, the SE value is 0.056, and the CI value is 0.047-0.272. Based on observations of the path coefficient value. There is no positive influence between Trust and attitude toward using a system seen from the estimated value and 95% confidence level. Therefore, hypothesis 3, which states that Trust has a positive and significant relationship to attitude toward using a system, is **rejected.**

It is known that the estimated value of Hypothesis 4 is 0.832, the SE value is 0.026, and the CI value is 0.782-0.877. Based on observations of the path coefficient value, it can be concluded that there is a positive influence between User Behavior and Intention to be seen from the estimated value and a significant 95% confidence level. Therefore, hypothesis 4, which states that attitude toward using a system has a positive and significant relationship with Intention to Use, is **accepted**.

G. Discussion

The research investigating factors of adoption of mobile cloud computing in university was already studied from previous research [27]. Based on the results study in Saudi Arabia public universities, the most influential factors of the adoption were quality of service, perceived usefulness, perceived ease of use, relative advantage, and trust. The research by [28] investigated significant factors for adopting mobile cloud computing in Ethiopian Higher Education using the TOE-DOI framework. This study proved significant and positive influences of technology, organizational, environmental, and sociocultural factors on the intention to use mobile cloud computing.

This study proves that the knowledge-sharing variable positively and significantly affects perceived usefulness. This hypothesis test results follow previous studies' results [3],[29]. Students believe in and accept the benefits of sharing knowledge using mobile cloud computing services. Mobile cloud computing is a media that has become a wealth of channels for sharing knowledge, doing assignments to fulfill student roles and the influence of friends/lecturers/seniors who also use the application. By sharing knowledge, the benefits of mobile cloud computing can be felt by students.

This study proves that the perceived usefulness variable positively and significantly affects students' attitudes to mobile cloud computing services. The results of this hypothesis test follow the results of previous research and the theory of Davis [16], which states that if a system is beneficial to someone, the system will have an impact on the positive or negative attitude of someone who will use the system. Users believe and accept the benefits generated by mobile cloud computing because the system can complete tasks quickly, improve performance, improve performance, increase effectiveness, make work easier, be accessible anywhere and anytime, and find convenience from the system. Thus, the educational process can be completed correctly, increasing the user's intention to use mobile cloud computing.

This study proves that the Trust variable has no positive and significant effect on attitude toward using a system. The results of this hypothesis test are different from the results of previous studies [7], [19], [30]. The risks in mobile cloud computing services, such as security, privacy, and control, are not a concern and affect attitudes toward using mobile cloud computing services.

This study proves that the attitude toward using a system variable positively and significantly affects students' intentions to use mobile cloud computing services. The results of this hypothesis test follow the results of previous studies and the theory of Davis[16], [23]. The students have a positive attitude about using mobile cloud computing services because using application services is a bright, fun idea, and students like to use them. So, positive behavior is shown by these students. It makes students intend, plan, and predict that they will always use mobile cloud computing services.

The student environment is familiar with the need for knowledge-sharing media such as services provided by Google Drive, OneDrive, Dropbox, and iCloud. The characteristics of these respondents can provide several ways to improve the adoption of mobile cloud computing. By linking research results from inferential analysis and descriptive analysis. Such as making mobile cloud computing a traditional medium of education, conducting training, socializing the use of mobile cloud computing, and providing fast internet network services so that access to services can be increased and the benefits felt.

IV. CONCLUSION

The results of hypothesis testing were conducted using GSCA; three proposed hypotheses were accepted, and one was rejected. The variables the research model can explain are 68% based on the results of the GSCA calculation. The remaining 32% are other variables not used in this study. The student environment is familiar with the need for a knowledge-sharing medium such as services provided by Google Drive, OneDrive, Dropbox, and iCloud. The characteristics of respondents can provide several ways to increase the adoption of mobile cloud computing by linking research results from inferential analysis and descriptive analysis. Such as making mobile cloud computing applications used as a traditional medium of education, conducting training, socializing the use of mobile cloud computing, and providing fast internet network services. Access to services can be increased, and their usefulness is felt. Future research can focus on extracting these variables through user interviews regarding students' intentions to use mobile cloud computing.

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