JURNAL SISTEM INFORMASI

JOURNAL OF INFORMATION SYSTEMS

JOURNAL OF INFORMATION SYSTEMS

JURNAL SISTEM INFORMASI

Volume 17, Issue 1, April 2021

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The Acceptance of Government Resource Planning System Using Unified Theory of Acceptance and Use of Technology 2

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Abstract

The Government Resource Planning (GRP) system is a solution for managing all the resources in government, namely people, technology, and business processes. From the GRP evaluation conducted on 616 agencies in Indonesia, only 13% of the agencies fall into excellent and satisfying categories. The biggest problem found is digital data availability, data integration between legacy systems, adjusting old system business processes to the GRP system, and support commitment of regional leaders and heads of offices. One of the GRP systems assessed is Service and Licensing Information System for the Public (SIMPATIK). The province of West Java uses this application for integrated services at the investment department. This study aims to analyze how the acceptance of the SIMPATIK uses the UTAUT 2 model that consists of six independent variables and two dependent variables. The relationship between the independent variable and the dependent variable is moderated by age, gender, and experience variables. The data used are primary data obtained from distributing questionnaires online to 42 DPMPTSP (One Stop Service and Investment/Dinas Penanaman Modal Dan Pelayanan Terpadu Satu Pintu) employees using SIMPATIK. The hypothesis was tested with the SmartPLS and SPSS applications. The results show from a total of 14 hypotheses, three hypotheses that have a significant or acceptable effect, while 11 other hypotheses are not significant or cannot be accepted.

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Introduction

In the digital era, information technology has become an inseparable part of many sectors in Indonesia. In industrial revolution 4.0, the government is trying to increase the digitalization of the bureaucratic process. Therefore, the right approach is needed in developing integrated systems and also good management of company resources. Indonesia has a specific regulation about e-government. The Presidential Instruction No 3 th. 2003 has specific points about the regulation and national strategy in the e-government's development. One of the four points statement is about the use of ICT in government (e-government) will increase the efficiency, effectiveness, transparency and accountability in government (Costa et al. 2016). From the instruction, we can see that the Indonesian government is concerned about the existence and the importance of e-government.

One popular approach to developing integrated systems and enterprise resource planning is the Enterprise Resource Planning (ERP) system (Costa et al. 2016; Almishal & Alsaud 2015). If previously the ERP system was adopted only for manufacturing companies and service companies, now the Government Resource Planning (GRP) concept has been developed to manage all resources in government and automate the bureaucratic process and government services to the public (Costa et al. 2016; Alsheddi, Sharma, and Talukder 2020). GRP is a set of application modules to support internal functions and public services, manage government resources, and integrate government bureaucratic activities from upstream to downstream (from planning, spending, program implementation, to evaluation). GRP is a system used to manage government resources that integrate bureaucratic activities from upstream to downstream (in the context of spending) to support financial management (Costa et al. 2016). The GRP system is used to help achieve government objectives in carrying out government administration and public services.

The popular term in previous studies is e-government. E-Government is a general term that is broadly defined as the government's use of ICT (Wang & Liao 2008). In order to ensure the performance of e-government, which is a good GRP system in this study, it is necessary to assess the effectiveness of the system (Gupta & Jana 2003). Based on the evaluation, the government will take action/decision on how to improve productivity and give more value to the citizens (Gupta & Jana 2003). The existence of the GRP system is used to improve the quality of service (QoS) in the government sector. GRP is characterized as a system that manages all government resources and incorporates all existing bureaucratic processes (Costa et al. 2016). The GRP system's key objective is to improve transparency and accountability in the procurement of goods and services in government, make it easier to access information, and provide facilities related to the accumulation of expenditure or costs for each function in government institutions (Costa et al. 2016). One of the countries that have already adopted GRP is the United Arab Emirates. This country launched GRP in 2015 by providing more than 420 e-services across 44 apps and 30 government departments (Mansoori et al. 2018).

Unified Theory of Acceptance and Use of Technology 2 (UTAUT 2) is a development of the UTAUT model conducted by Venkatesh et al. (2016). The purpose of UTAUT 2 is to study the acceptance and use of technology in the consumer context. In UTAUT 2 there are the addition of three new variables and eliminating one moderator variable, namely voluntariness of use originating from the UTAUT model. The constructs in UTAUT 2 are performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habits. In UTAUT 2, there are only three moderator variables, namely age, gender, and experience, after eliminating one moderator variable in the previous UTAUT. These three variables moderate the effects of construct behavioral intention and use behavior.

The use of the system and its information products will then affect individual users in the conduct of their work, and these individual impacts will collectively result in an organizational impact (DeLone & McLean 2003). The information system is adopted based on the top manager's decision or the holder of the highest structural position in an organization. Still, the success or failure of using the information system is affected by the acceptance and use of individuals who use it. Individual users may respond to new technology in different ways. Individual differences, such as age, gender, tenure, educational background, etc., can affect the individual's assessment and attitude to induced change and technology (Venkatesh & Morris 2000).

Several challenges in the initiation and implementation of GRP in a local government, generally are change management from manual systems and habits to digital systems; availability of digital data; data integration between legacy systems, systems from the central government, and GRP; adjusting old system business processes to the GRP system; support and commitment of regional leaders and heads of offices; and the absence of awareness of periodic audits of the existing GRP. If the government is aware of the factors relevant to the adoption of GRP systems, it is beneficial to become a guideline for improving the GRP system's implementation (Mansoori et al. 2018). Furthermore, this research has been carried out in the West Java Province to be one of the regions that continue to optimize GRP in the West Java Province of DPMPTSP (One Stop Service and Investment/*Dinas Penanaman Modal Dan Pelayanan Terpadu Satu Pintu*). It is also supported by Presidential Regulation Number 1 of 2009 concerning "Electronic Based Government System/*Sistem Pemerintahan Berbasis Elektronik* (SPBE)". One of eight-point of SPBE Management said about change management to increase the service quality. The relationship between service quality and customer satisfaction has been investigated in several studies. Consumer satisfaction is strongly affected by customer expectations of service quality. According to the literature, delivering high-quality service leads to customer satisfaction (Bashir & Machali 2012).

West Java Province DPMPTSP has implemented a Licensing for Public Service Information System (SIMPATIK) which has been replicated in 18 provinces in Indonesia. SIMPATIK makes it easy for people to apply for permits online, find out various information about licensing and its requirements, tracing or tracking the status of permits, doing independent printing of licensing documents, and others. The analysis was carried out to find out what factors influenced the acceptance of SIMPATIK in DPMPTSP West Java Province. By doing this analysis, DPMPTSP is expected to improve the quality of services to the public and realize an optimal GRP System in West Java Province and Indonesia.

Literature Review

The first UTAUT (Unified Theory of Acceptance and Use of Technology) model was invented by Venkatesh et al. (2003) and the extended UTAUT2 was proposed by Venkatesh et al. (2012a). The difference between these models is the addition of variables such as hedonic motivation, price value and habit to the original four constructs namely performance expectancy, effort expectancy, social influence and facilitating conditions at UTAUT2. UTAUT2 contains several recent trends in the adoption of consumer technology and enhanced predictive validity in the sense of technology consumption (Venkateshet al. 2012a). The huge implementation of UTAUT theory in the public sector with various levels of assessment, encouraged researchers to use the UTAUT as a study tool to consider the different aspects of the study about the factors that impact the implementation of e-Government. UTAUT is one of the most comprehensive technology acceptance models, combining eight common acceptance models such as the Theory of Planned Behavior (TPB) (Ajzen 1991a) and the Technology Acceptance Model (TAM) (Venkatesh et al. 2003).

In addition to the UTAUT constructs, UTAUT2 argues that hedonic motivation (i.e., the degree to which the technology is considered to be enjoyable), price value (i.e., the cognitive trade-off between perceived benefits and monetary costs of technology usage), and habit (i.e., the passage of time from the initial technology usage) affect the intention to use the technology (Venkatesh et al. 2012b). UTAUT2 has been effective in understanding behavioral intention in a number of contexts (Syamsudin et al. 2018) and used to classify variables' influence on the implementation of e-government across different networks of information technology (e.g. kiosks, mobile technology, internet). They often used to look at the variety of users of e-Government, the various personal characteristics that typically influence implementation (Wang & Shih 2009; Hung et al. 2006) of e-Government (e.g. consumer age, IT expertise, level of trust and prior knowledge) (Wang & Shih 2009; Hung et al. 2006).

The difference between this study with previous studies (Venkatesh et al. 2012a; Hew et al. 2015; Gupta et al. 2018) is one variable has been removed or adjusted to "privacy concern" from the original UTAUT 2 model, namely is price value (independent variable). Price value means the costs spent by users when using information systems. The reason for eliminating the price value variable is that SIMPATIK is a government facility for the public, where users do not need to pay for operating SIMPATIK. This price

value - behavioral intention path is recorded non-significant values when the users regarded the product/service offering reviewed as free of charge (Tamilmani et al. 2020). Non-significant Price Value-Behavioral Intention path includes research on mobile banking services providing services without special charges over other types of financial networks (Ali et al. 2016).

Methodology

2.1 Problem Identification and Literature Study

The research method is depicted in Figure 1. Problem identification is a starting point for us to understand how we can have a special circumstance competence for certain objects so that we can define what the problem is after that. The goal of the problem of identification is to get to the heart of the problem and then to solve the problem. Problem definition is a gap between expectation and fact, a gap between theory and practice, a gap between law and execution, a gap between goal and consequence, and a gap between past and present time (Sugiyono 2005).
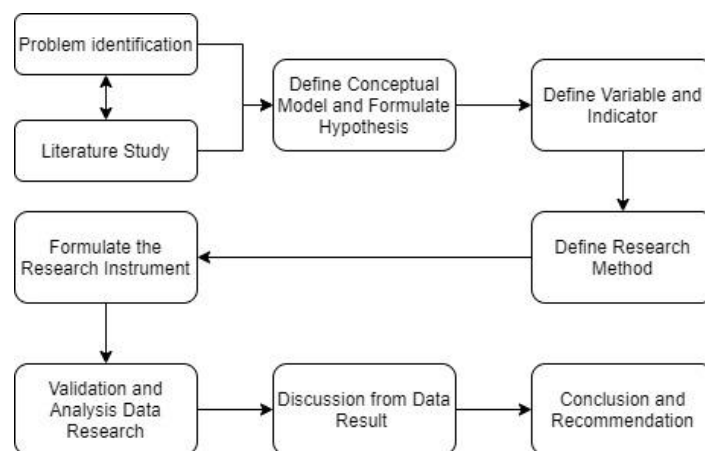
Figure 1. Research Method

Problem identification in this research is about to find out what factors have affected the acceptance of SIMPATIK in DPMPTSP West Java Province. The government will know the effectiveness of the system through this research. Therefore, hopefully, the government has guidance on how to increase efficiency and give more value to the people. Whereas a literature study is an initiative to collect theory, data and a case study that focused on the problem identification that we have defined before. The purpose of the literature review is to reinforce the basic theory that we will use to solve the problem.

2.2 Define Conceptual Model and Formulate the Hypothesis

From conceptual model in Figure 2 can be detailed with following hypothesis:

H1: Performance expectancy has a positive impact on behavioral intention of using SIMPATIK.
H2: Effort expectancy has a positive impact on the behavioral intention of using SIMPATIK.
H3: Social influence has a positive impact on the behavioral intention of using SIMPATIK.
H4a: Facilitating conditions has a positive impact on behavioral intention of using SIMPATIK.
H4b: Age, gender, and experience are moderating on facilitating conditions toward behavioral intention of using SIMPATIK
H5: Facilitating conditions has a positive impact on the behavior of SIMPATIK.
H6a: Hedonic motivation has a positive impact on behavioral intention of using SIMPATIK.
H6b: Age, gender, and experience moderate on hedonic motivation toward behavioral intention of using SIMPATIK
H7a: Habit has a positive impact to behavioral intention of using SIMPATIK
H7b: Age, gender, and experience moderate on habit toward behavioral intention of using SIMPATIK

H8a: Habit has a positive impact on the behavior of SIMPATIK.
H8b: Age, gender, and experience moderate on habit toward use behavior of using SIMPATIK
H9a: Behavioral intention has a positive impact on the behavior of SIMPATIK.
H9b: Experience moderates on behavioral intention towards use behavior of SIMPATIK
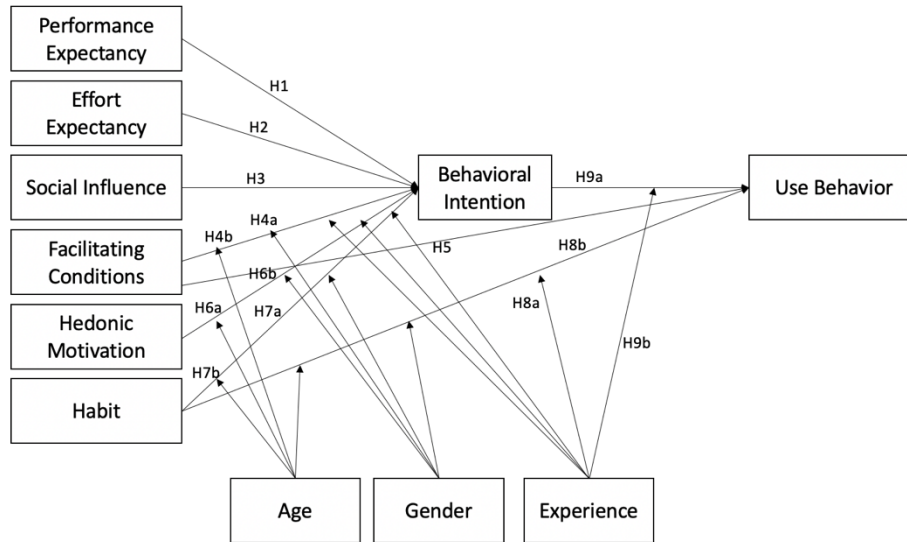
Figure 2. Conceptual model in this study

2.3 Define Variable and Indicator

This study uses variables and indicators in the UTAUT 2 model. The variables used consist of independent variable, dependent variable and moderator variables. The independent variable this study is performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, and habit. For the dependent variable consists of behavioral intention and use behavior. Then, the moderator variables are age, gender, and experience. The variables are detailed with indicators. Total indicator that was used in this study is 21 indicators covering 8 variables. The definition of each variable can be found on Table 1. While a comprehensive statement of each indicator can be found in Table 2.

2.4 Define Research Method

Research is the process of uncovering the relative truth through trials and procedures that follow scientific norms and rules. Scientific research has different approaches and methods depending on the thought event or paradigm used in scientific research (Jogiyanto 2011).The methodology that used in this study is quantitative method. Collecting data in this study is through the distribution of questionnaires, interviews, observate and statistical datasets. This method is often referred to as a confirmatory method since this method is ideal for validation or verification purposes (Sugiyono 2018).

Table 1. Variable Definition

Variable	Description	References
Performance Expectancy	Extant research shows that customers are likely to use technology that is more beneficial and produces favorable results as predicted by users	Venkatesh et al. (2012a), Compeau and Higgins (1995), Alalwan et al. (2016), Izzati (2020)
Effort Expectancy	Consumers tend to use an easy-to-understand application that can offer full benefits	Venkatesh et al. (2012a), Hew et al. (2015), Davis et al. (1989),, Izzati (2020)
Social Influence	If a person feels that the given behavior is approved by his / her peer group, then the person is more likely to have an intention to participate in the given behavior.	Venkatesh et al. (2012a), Ajzen (1991b), Akman and Mishra (2017) , Izzati (2020)
Facilitating Condition	Facilitating conditions reflect the impact of the necessary resources (internet access and mobile memory for download and app) and the knowledge needed to purchase travel via smartphone apps. Extant research indicates a significant association between facilitating condition and behavioral intentions across multiple contexts, including 3 G mobile networks.	Venkatesh et al. (2012a), Wu et al. (2008), Sok Foon and Chan Yin Fah (2011), Izzati (2020)
Hedonic Motivation	As a pleasure resulting from the use of technology. Hedonic motivation (an inherent motivation) has been seen as a significant indicator of technology acceptance and use.	Venkatesh et al. (2012a), Baptista and Oliveira (2015), Alalwan et al. (2017)
Habit	The degree to which people appear to execute behaviors automatically because of learning. Habit as a significant predictor of behavioral intention and actual usage	Venkatesh et al. (2012a), Herrero, et al. (2017)
Behavioral Intention	The willingness of the people (the subjectivity of the person)/how they expect to use them to conduct their actions	Venkatesh et al. (2012a), Venkatesh et al. (2003), Ajzen (1991b), Izzati (2020)
Use Behavior	The actual behavior from the person. Not only an expectation.	Venkatesh et al. (2012a), Venkatesh et al. (2003), Ajzen (1991b)

Table 2. Detail of Variable and Indicator

Variable	ID	Indicator	Statement
Performance Expectancy	PE1	Useful of system	SIMPATIK is very useful for my daily work activity
	PE2	Reliable of System	SIMPATIK helps me to finish my job faster
	PE3	Productivity	SIMPATIK increases my work productivity
Effort Expectancy	EE1	Understandable	SIMPATIK is easy to understand
	EE2	Easy of use	SIMPATIK is easy to use
	EE3	Effectivity and efficiency	SIMPATIK helps me to finish my job more effective and efficient
Social Influence	SI1	Subjective norms	People who important to me is suggest me of using SIMPATIK
	SI2	Social Factor	People who can influence me think that I should use SIMPATIK
Facilitating Condition	FC1	Easy to access	I have an enough resource to access SIMPATIK like smartphone
	FC2	Individual skill	I have an enough knowledge yo access SIMPATIK
	FC3	Comptability	SIMPATIK is compatible with other technology that I used
	FC4	Technical support	I can ask a question to other people if I have a problem of using SIMPATIK
Hedonic Motivation	HM1	Pleasure	Using SIMPATIK is a pleasure for me
	HM2	Entertaining	Using SIMPATIK is entertaining me
	HM3	Convenience	Using SIMPATIK makes me convenience
Habit	HT1	Habit	Using SIMPATIK is my habit
	HT2	Addiction	I should use SIMPATIK to finish my job
Behavioral Intention	BI1	Commitment	In the future, I will always use SIMPATIK
	BI2	Trying to use	I will always try to use SIMPATIK to my daily work

2.5 Formulate the Research Instrument

The main data was obtained from questionnaires distributed to DPMPTSP employees who use SIMPATIK. The questionnaire was distributed online, consisting of 30 questions. The answer to each question is calculated by the Likert scale (1 to 5) with detail in Table 3. Likert scale is a psychometric scale that is popular and most widely used for study using a survey instrument.

Table 3. Option and Weight from Questionnaire

Answer	Option	Weight
Very disagree	STS	1
Disagree	TS	2
Neutral	N	3
Agree	S	4
Very agree	SS	5

2.6 Collect of Questionnaire Data

Population is a generalization field composed of: objects/subjects that have certain attributes and characteristics that the researcher determines to analyze and then to draw conclusions (Sugiyono 2016). Population is not just a number, but also involves all the characteristics/properties of the subject or object under analysis. Although the survey is part of the population's number and characteristics. A correct sampling technique is required to ensure that the sample used is a representative sample (Sugiyono 2016).

The population in this study were all employees of DPMPTSP of West Java Province who used SIMPATIK with 47 people. The criteria taken were that the questionnaire was intended only for employees of DPMPTSP of West Java Province who used SIMPATIK. Krejcie (Krejcie & Morgan 1970) said the population grows. As the population increases, the sample size will also increase at a decreasing rate, and it remains relatively stable in slightly more than 380 cases with a total population of 1,000,000. Krejcie also explains about determining sample size from a given population, which from 45 population size should have a sample of 40 people (Krejcie & Morgan 1970).

Furthermore, in this research for the sample size is 42 respondents that were taken from 47 people who use SIMPATIK. This amount is obtained based on the Slovin formula, which is intended to determine the number of samples with certain error tolerance limits. So, from the total DPMPTSP employees who used SIMPATIK 47 people, a total sample of 42 people. The formula is as written in Equation (1):

$$n = \frac{N}{1+Ne^2} = \frac{47}{1+(47(5\%)^2)} = 42 \qquad \text{Equation (1)}$$

n　　: Number of Samples
N　　: Total Population
e　　: Error Tolerance = 0.05

Respondents in this study were grouped into 6 characteristics, namely based on sex, age, last education, field, work experience, and how long the duration of using SIMPATIK. In terms of sex characteristics, the majority are filled by male employees, with the majority aged 41 to 50 years. The last education of most respondents was a bachelor. Then for the characteristics of the field, most respondents were in the field of Infrastructure and Social Licensing Services and the Licensing Services Economy and Natural Resources. Most respondents answered that they have work experience of more than 24 months or more than two years, and the majority use SIMPATIK 4 to 10 hours per day.

2.7 Validation and Analysis of Data Research

This study is using SmartPLS and SPSS applications for data processing. Both applications are statistical applications used to test the relationships between research variables. The method used in this study is SEM-PLS Structural Equation Modelling – Partial Least Square. PLS is one of the most famous and influential statistical techniques due to its ability to calculate path estimates and model parameters under non-normal conditions (Hulland 1999). There are two types of PLS analysis, namely outer model analysis and inner model analysis.

The Outer model analysis was carried out to assess the research instruments' validity and reliability, which included convergent validity and discriminant validity by looking at the loading factor value, Average Variance Extracted (AVE) value, AVE square root comparison, and composite reliability. In the analysis of this outer model, the researcher will evaluate the model that links the indicators with their latent variables using the SmartPLS application. The Cronbach Alpha value must be higher than 0.7. However, if the Cronbach alpha is between 0.6 - 0.7, the level of consistency is still acceptable (Hair et al. 2014).

The inner model aims to describe the relationship or strength of estimates between latent or construct variables (Hair et al. 2015). This structural model is made using the SmartPLS application using (R^2), path coefficient (β), and t-statistic test on each path. The inner model analysis consists of Variance Inflation Factor (VIF), Determination Coefficient, Path Coefficient, and Partial Test (T-Test).

The multicollinearity test is a test to prove the presence or absence of multicollinearity symptoms that can be done by calculating VIF (Variance Inflation Factor). Multicollinearity itself is defined as a condition where there is a strong correlation between the independent variables (X) which are included in the formation of a linear regression model. A good model is when there is no multicollinearity between the independent variables because if it occurs, then the variable should be the dependent variable. So that the tolerance value used in VIF is <0.2 and / or> 5 which indicates a problem with collinearity (Hair et al. 2014).

Determination Coefficient Test (R^2) test is used to determine the extent to which all independent variables can explain the dependent variable. The coefficient of determination is between 0 and 1. If the coefficient of determination is closer to 1, the ability to explain the independent variable to the dependent variable is getting stronger, which means that the independent variables provide almost all the information needed to predict the variation of the dependent variable. While the value of the coefficient of determination (adjusted R^2) is small means that it shows the ability of independent variables in explaining the dependent variable is limited (Hair et al. 2014).

Path coefficients are a flexible and comprehensive method based on linear statistics that assume multivariate normality. The strength of the relationship of the hypothesis is seen based on the value of the Path Coefficient (β). The relationship between constructs is said to be strong if the value (β)> 0.100). The t-test statistic is used to determine the presence or absence of the effect of each independent variable individually on the dependent variable tested at the significance or error level of 0.05 (Hair et al. 2014)

2.8 Discussion from Data Result

The next step after validation and analysis data research is a discussion from data results. In this section, all results from the validation test, the relation between the variables, the relation between the case study and the finding will be discussed. The distinction between this section and the previous section is the deeper research, since this section has an approach to a particular case study, while the previous section only has a research of the PLS-SEM results.

2.9 Conclusion and Recommendation

Based research method and all results from this study will give a conclusion and a recommendation. A specified recommendation is aimed at DPMPTSP who has the SIMPATIK system.

Results

3.1 Measurement Model (Outer Model)

Based on the result of the validity and reliability test using the SmartPLS in Table 4, found that all the variables and indicator questions are valid and reliable. The basis for decision making in the validity test is by looking at the value of Average Variance Extracted (AVE). Variables are said to be valid when the AVE value> 0.5 and the loading factor value is greater than 0.5. Meanwhile, the reliability test uses Cronbach's alpha as a reliable determinant of whether a measuring instrument so that the results obtained do not change. A reliable variable if the value of Cronbach's alpha is higher than 0.7. However, if the Cronbach alpha is between 0.6 - 0.7, is still acceptable (Hair et al. 2014).

Table 4. Result of Validity and Reliability Test

Variable	Item	Cross Loading	Cronbach's Alpha	AVE
PE	PE1	0.713	0.783	0.694
	PE2	0.842		
	PE3	0.930		
EE	EE1	0.857	0.722	0.639
	EE2	0.856		
	EE3	0.670		
SI	SI1	0.980	0.948	0.950
	SI2	0.970		
FC	FC1	0.907	0.874	0.725
	FC2	0.865		
	FC3	0.869		
	FC4	0.760		
HM	HM1	0.982	0.938	0.890
	HM2	0.935		
	HM3	0.912		
HT	HT1	0.903	0.746	0.797
	HT2	0.883		
BI	BI1	0.970	0.801	0.814
	BI2	0.830		
UB	UB1	0.925	0.789	0.825
	UB2	0.891		

3.2 Structural Model (Inner Model)

The objective of structural model that shown in Figure 3 is to describe the relationship between laten variable / construct. The measurement of structural model is using (R^2), *path coefficient* (β), and *t-statistic* test with SmartPLS. The range values of R^2 is from 0 to 1. The higher of R^2 score means that endogeneous construct can be explained by exogenous construct. Usually, the more direction arrows to an endogenous construct, then will increase the R^2 score. The rule of thumb that used to classify R^2 score is 0.75 (substansial), 0.50 (moderate) dan 0.25 (weak). Based on result of R^2 test, variable behavioral intention has score 0.433 and variable use behavior has score 0.847. Based on the result in Table 5, exogenous variables like facilitating conditions, habit, behavioral intention, age, gender, dan experience has better explain to endogenous variable use behavior.

Table 5. Result of R^2 Test

Variable	R^2 Score
Behavioral Intention	0.433
Use Behavior	0.847

Path Coefficient (β) is a flexible method and comprehensive based on linear statistics that assumes a multivariate normality. The strength of variable relationship is observed by *Path Coefficient* score. The strong / positive relationship is achieved when the score β > 0,100. The detailed score shown at Table 6.

Table 6. The Result of Path Coefficient and T-Statistic Test

Hypotheses	Path	B (Path-Coefficient)	T-Statistic	Information
H1	*Performance Expectancy → Behavioral Intention*	0.086	0.380	Negative – Not Significant
H2	*Effort Expectancy → Behavioral Intention*	-0.052	0.180	Negative – Not Significant
H3	*Social Influence → Behavioral Intention*	0.093	0.573	Negative – Not Significant
H4a	*Facilitating Conditions → Behavioral Intention*	-0.202	0.499	Negative – Not Significant
H4b	*Moderator Facilitating Conditions -Age, Gender, Experience → Behavioral Intention*	0.188	0.477	Positive – Not Significant
H5	*Facilitating Condition → Use Behavior*	0.217	2.079	Positive – Significant
H6a	*Hedonic Motivation → Behavioral Intention*	0.573	1.933	Positive – Significant
H6b	*Moderator HM-Age, Gender, Experience → Behavioral Intention*	-0.135	0.442	Negative – Not Significant
H7a	*Habit → Behavioral Intention*	0.355	0.818	Positive – Not Significant
H7b	*Moderator HT-Age, Gender, Experience → Behavioral Intention*	-0.070	0.162	Positive – Not Significant
H8a	*Habit → Use Behavior*	0.720	6.724	Positive – Significant
H8b	*Moderator HT-Age, Gender, Experience → Use Behavior*	-0.070	0.568	Negative – Not Significant
H9a	*Behavioral Intention → Use Behavior*	0.033	0.255	Negative – Not Significant
H9b	*Moderator BI-Experience → Use Behavior*	-0.110	1.114	Negative – Not Significant

The results of the partial test (t test) show that the variable Performance Expectancy on Behavioral Intention has a t statistical value of 0.353 which means it is smaller than t table, namely 1.693 with a significance level of 5%. In the Effort Expectancy variable on Behavioral Intention, it is known that the t statistical value is 0.173. This means that t statistic is smaller than t table with a significance of 5%.

In the Social Influence variable on Behavioral Intention, it is known that the t statistical value is 0.461. This means that t statistic is smaller than t table with a significance of 5%. Then for the variable Facilitating Conditions to Behavioral Intention there is a statistical t value of 0.496 which is also still smaller in T-table 1.693. The Hedonic Motivation variable on Behavioral Intention has a t-statistic value of 1.758, which means it is greater than the t table value of 1.693. In the Habit on Behavioral Intention variable, it is 0.827. The variables Age, Gender, Experience towards Behavioral Intention have a t-statistic value of 0.144.

Furthermore, the Experience variable towards use behavior has a statistical value of 1.071 which means its value is smaller than the t table, namely 1.693. Facilitating Condition to Use Behavior has a statistical t value of 2.066, which means it is greater than t table 1.693 at a significant level of 5%. In the Habit variable to Use Behavior, it has a statistical value of 6.291, which means it is greater than t table 1.693 with a significance level of 5%. The variable Behavioral Intention to Use Behavior has a t statistical value of 0.244. Then, the moderator variable Age, Gender, Experience towards Use Behavior has a statistical t value of 0.333, which is still smaller than t table 1.693 with a significance level of 5%. The

moderator variable HM-Age, Gender, Experience towards Behavioral Intention has a t statistical value of 0.442 which is still smaller than t table 1.603. Other moderator variables, namely HT-Age, Gender, Experience with Behavioral Intention have a t-statistic value of 0.365, the moderator variable FC-Age, Gender, Experience with Behavioral Intention has a statistical t value of 0.484, HT-Age moderator variables, Gender, Experience with Use Behavior has a t statistical value of 0.527, the moderator variable BI-Experience on Use Behavior has a statistical t value of 1.109, all of which are still below 1.693 with a significance level of 5%.
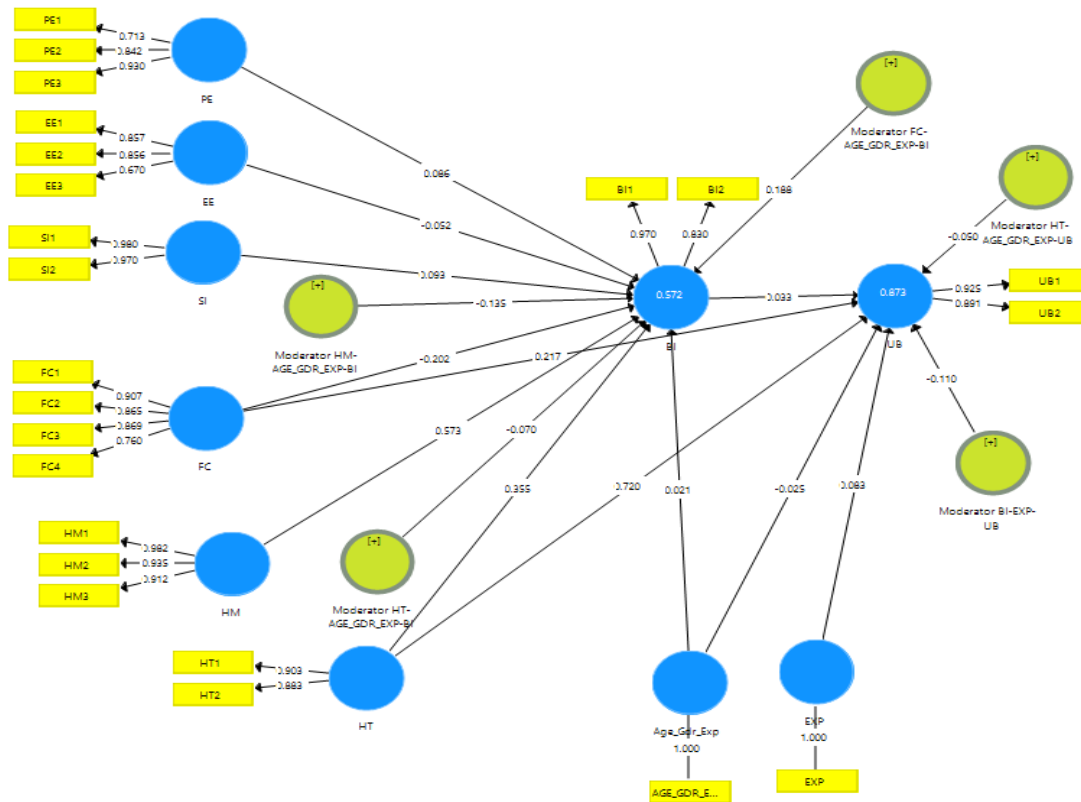

Figure 3. Structural Model Measurement

Discussion

4.1 Impact of Performance Expectation (PE) to Behavioral Intention (BI)

This shows that the independent variable PE (performance expectations) has no significant effect on the dependent variable BI (behavioral intention). This insignificant influence indicates the cause because SIMPATIK users have not really felt the benefits of the Licensing Information System for the Public. Because for its use, SIMPATIK has different access rights for each employee, so that only employees in the licensing service sector really feel the benefits of all SIMPATIK features. This is why other employees outside the licensing service sector feel that SIMPATIK does not have a significant impact on productivity and daily activities in the office. The results of this study have not been able to provide support for the theory of (Venkatesh et al. 2012a), which states that performance expectations have a significant effect on behavioral intention.

4.2 Impact of Effort Expectancy (EE) to Behavioral Intention (BI)

The statistical test of the effort expectancy variable on the behavioral intention variable obtained a statistical T value of 0.173, which means it is smaller than the T table, namely 1.69. This shows that hypothesis 2 is not significant (H2 is rejected). This condition can be caused by several factors related

to the effort expectancy (business expectations). The difference in the education level and a person's ability can be a determinant level of convenience perceived by users.

SIMPATIK is a licensing information system with quite complex features in it, causing users to have adequate knowledge and skills related to information systems. Besides, this rejection was caused by the system, not only by the people. Because the use of SIMPATIK has been limited to certain fields related to licensing services, users from outside these fields feel that SIMPATIK has not really been able to ease their efforts. The study's result has not supported the theory of Venkatesh et al. (2012a), which states that business expectations have a significant effect on the intention to use information systems.

4.3 Impact of Social Influence (SI) to Behavioral Intention (BI)

The analysis results that have been carried out using the SmartPLS application show that the T statistic value for the social influence variable on behavioral intention is 0.461, which means it is smaller than T table 1.69. Based on these data, hypothesis 3 is not significant (H3 is rejected). It shows that the independent variable SI (social influence) has no significant effect on the dependent variable BI (behavioral intention).

This insignificant influence indicated the cause was due to the lack of encouragement from colleagues and leaders in using SIMPATIK. Of course, it is also related to the low level of understanding and use of complex information systems, so that it creates different perceptions of information systems among colleagues. The results of this study have not been able to provide support for the theory of Venkatesh et al. (2012a), which states that social influence has a significant effect on behavioral intention.

4.4 Impact of Facilitating Conditions (FC) to Behavioral Intention (BI)

The statistical test of the facilitating conditions variable on the behavioral intention variable obtained a statistical T value of 0.496, which means it is smaller than the T table, namely 1.69. It shows that the hypothesis is not significant (H4a is rejected). Based on these data, it can be interpreted that more facilitating conditions do not affect behavioral intentions. There are obstacles in implementing SIMPATIK, which are indicated as the cause of the insignificance of H4a.

The extent of West Java's province with its scattered regional apparatus makes it difficult to provide information system facilities for public services, such as the internet. Another factor is because SIMPATIK is not entirely compatible with other technologies used by West Java Province DPMPTSP employees both in terms of electronic devices used and other applications supporting specific fields in the West Java Province DPMPTSP. The rejection of H4a in this study means supporting the theory of Venkatesh et al. (2012b), which states that facilitating conditions do not significantly affect the intention to use information systems.

4.5 Impact of Age, Gender, dan Experience that moderates Facilitating Conditions (FC) to Behavioral Intention (BI)

The statistical test of age, gender, and experience variables moderates the facilitating conditions variable on behavioral intentions to get a T statistic' score of 0.484. It is smaller than the T table, namely 1.69. It shows that hypothesis 4b is not significant (H4b is rejected).

This insignificant moderating effect is due to its mandatory use. Mandatory means that users are required to use the information system by the leader or the highest-ranking official. Hence, users of different ages, genders, and experiences will still try to operate SIMPATIK. For this, the factors of age, gender, and experience are not the things that significantly influence the intention to use SIMPATIK. This study's results do not yet support the theory of Venkatesh et al. (2012a) that the factors of age, gender, and experience can moderate facilitating conditions on behavioral intention.

4.6 Impact of Facilitating Condition (FC) to Use Behavior (UB)

The analysis results using the SmartPLS application show that the T statistical value for the facilitating conditions variable on behavioral intention is 2.066, which means that the T statistic is greater than the T table 1.69. With the data obtained, then hypothesis 5 significance (H5 accepted).

This shows that the independent variable FC (facilitating condition) has a significant effect on User Behavior (UB)'s dependent variable (using behavior). The better the organization's facilitating conditions, the better the behavior of using the information system by DPMPTSP employees. The study results support the theory of Venkatesh et al. (2012b), which states that facilitating conditions have a significant effect on behavioral intention.

4.7 Impact of Hedonic Motivation (HM) to Behavioral Intention (BI)

The statistical test of age, gender, and experience variables moderates the facilitating conditions variable on behavioral intentions having a T statistic value of 1.758. It means that the T statistic is greater than the T table, which is 1.69. It shows that hypothesis 6a is significant (H6a is accepted).

It means that hedonic motivation affects the user's intention to use SIMPATIK. The greater the sense of pleasure obtained by DPMPTSP employees, the more likely it will affect the intention to use SIMPATIK. The results of this study support the theory of Venkatesh et al. (2012b), which states that hedonic motivation has a significant effect on behavioral intention.

4.8 Impact of Age, Gender, dan Experience that moderates Hedonic Motivation (HM) to Behavioral Intention (BI)

The statistical test of age, gender, and experience variables moderated the hedonic motivation variable on behavioral intentions with a T statistic value of 0.365. It is smaller than the T table, which is 1.69. It shows that hypothesis 6b is not significant (H6b is rejected).

From the statistical results obtained, it can be concluded that there is no difference in the pleasure of both men and women at a certain age and with certain experiences in encouraging a user to use SIMPATIK. The reason why DPMPTSP employees intend to use SIMPATIK is because of the demands of their main duties related to licensing services. Hence, the difference in age, type neither gender nor experience affects the intention to use or not use SIMPATIK. This study's results have not supported the theory of Venkatesh et al. (2012b), which states that the factors of age, gender, and experience can moderate hedonic motivation on behavioral intention.

4.9 Impact of Habit (HA) to Behavioral Intention (BI)

The habit variable's statistical test on behavioral intentions obtained a statistical T value of 0.827, which means it is smaller than the T table, which is 1.69. It shows that hypothesis 7a is not significant (H7a is rejected).

This means that habits do not affect the intention to use SIMPATIK. Respondents' habit of using SIMPATIK, compulsory use of SIMPATIK, and dependence on using SIMPATIK in completing work did not affect the respondent's intention to use SIMPATIK. It can be concluded that the respondents stated that frequent or not using SIMPATIK does not affect the strength of the intention to use SIMPATIK. The cause of insignificance is DPMPTSP employees who use SIMPATIK do not entirely utilize all the functionality in the system, so that only some employees or only part of them are accustomed to using SIMPATIK, thus influencing their intention to use it. The results of this study have not been able to provide support for the theory of Venkatesh et al. (2012b), which states that habits have a significant effect on behavioral intention.

4.10 Impact of Age, Gender, dan Experience that moderates Habit (HA) to Behavioral Intention (BI)

The statistical test of age, gender, and experience variables moderated the habit variable to behavioral intentions has a T-statistic value of 0.177. It means that the T statistic was smaller than the T table, namely 1.69. It shows that hypothesis 7b is not significant (H7b is rejected).

From the statistical results obtained, it can be concluded that age, gender, and experience cannot moderate the habit variables. So, it can be said that there is no difference in the pleasure of both men and women at a certain age and with certain experiences in encouraging a user

to use SIMPATIK. The moderator's influence is insignificant because the mandatory government information system has influenced the intention to use it. DPMPTSP employees use SIMPATIK to support the main tasks and functions of licensing services at West Java Province. This mandatory nature also causes differences in age, gender, and experience not to affect the user's behavioral intention to use SIMPATIK. This study's results have not been able to provide support for the theory of Venkatesh et al. (2012b), which states that age, gender, and experience can moderate habits towards behavioral intention.

4.11 Impact of Habit (HA) to Use Behavior (UB)

The statistical test of age, gender, and experience variables moderated the habit variable to behavioral intentions has a T-statistic value of 6.291. It means that it was more significant than the T table, namely 1.69. It shows that hypothesis 8a is significant (H8a is accepted).

It shows that the respondents' habits, dependencies, and compulsions in using SIMPATIK to complete work positively and significantly affect behavior using SIMPATIK. The more often DPMPTSP employees use SIMPATIK, the more frequent use of behavior will be. The results of this study support the theory of Venkatesh et al. (2012b), which states that habit is a strong predictor of information system use behavior.

4.12 Impact of Age, Gender, dan Experience that moderates Habit (HA) to Use Behavior (UB)

The statistical test of age, gender, and experience variables moderate the habit variable towards use behavior has a T statistic value of 0.527. It means that it is small from the T table, namely 1.69. It shows that hypothesis 8b is not significant (H8b is rejected).

From the statistical results obtained, it can be concluded that differences in age, gender, and experience do not moderate the relationship between habit variables and user behavior. So, it can be said that there is no difference in the pleasure of both men and women at a certain age and with certain experiences in encouraging a user to use SIMPATIK. The moderator's influence is not significant because employees carry out their duties as licensing service providers to the public. Also, the use of SIMPATIK is based on the leadership or the head in charge. The assignment of licensing services is carried out based on limited employee resources and the appointed employee's willingness.

Therefore, the factors of education, experience and age, and gender are not becoming a factor influencing assignments related to licensing services so that it does not affect the behavior of using SIMPATIK. This study's results have not provided support for the theory of Venkatesh et al. (2012b), which states that the factors of age, gender, and experience are able to moderate habits towards use behavior.

4.13 Impact of Behavioral Intention (BI) to Use Behavior (UB)

The statistical test of age, gender, and experience variables moderated the behavioral intention to use behavior has a T statistical value of 0.244. It means that it is small from the T table, namely 1.69. It shows that hypothesis 9a is not significant (H9a is rejected).

The results showed that the intention to use did not significantly affect the respondent's behavior in using SIMPATIK. The high and low intention of DPMPTSP employees to use SIMPATIK will not affect the high-intensity level of SIMPATIK usage. This study's results do not support the theory of Venkatesh et al. (2012b), which states that behavioral intention has a strong influence on information system use behavior.

4.14 Impact of Experience that moderates Behavioral Intention (BI) to Use Behavior (UB)

The statistical test of the experience variable that moderates the behavioral intention to use behavior has a T-statistic value of 1.109. It means it is smaller than the T table, which is 1.69. It shows that hypothesis 9b is not significant (H9b is rejected).

From the statistical results obtained, it can be concluded that experience does not moderate the relationship between behavioral intention and SIMPATIK use behavior. So, it can be said that there is no difference in the experience of using SIMPATIK in the workplace, which encourages respondents to use SIMPATIK.

The reason for the moderator variable's insignificant influence is that SIMPATIK is an information system that supports the licensing service process for the public. Therefore, all employees who have the main task of serving the community regarding licensing matters will understand and use SIMPATIK regardless of their conditions or experiences. This matter was solely carried out to support the main tasks and functions of licensing services in the West Java Province DPMPTSP. The study results do not yet support the theory of Venkatesh et al. (2012b), which states that an increased experience will automatically affect user behavior and ultimately impact the behavioral intentions of using information systems.

Conclusion

The results of data processing from a total of 42 employee respondents then from a total of 14 hypotheses there are 3 hypotheses that have a significant or acceptable effect, while 11 other hypotheses are not significant or cannot be accepted. Hypotheses that have a significant effect are Facilitating Conditions on Use Behavior, Hedonic Motivation on Behavioral Intention, and Habit on Use Behavior. These variables have a positive effect on the variables they affect. The habit of DPMPTSP employees according to statistical results has the highest significance value in improving SIMPATIK use behavior.

Various outputs related to licensing services make employees who manage matters related to licensing increasingly use SIMPATIK. The feeling of pleasure and comfortable (hedonic motivation) when using SIMPATIK also allows DPMPTSP employees to complete their work effectively, and with minimal error rates. This makes DPMPTSP employees feel more attractive and comfortable when using SIMPATIK in completing their work. Then, the using behavior will increase along with increasing facilitating conditions. The better the provision of adequate organizational and technical infrastructure facilities, will increase the use of SIMPATIK. The existence of a technical team or special staff serving various obstacles related to SIMPATIK will further enhance the behavior of using SIMPATIK in the West Java Province DPMPTSP.

Performance expectancy or someone's belief that using Information Systems can improve their job performance, does not have a significant effect on a user's behavioral intention to use SIMPATIK. The effort expectations that are felt by users also have no significant effect on behavioral intention to use SIMPATIK. Social influence, which in this context means that the influence of colleagues and superiors also does not have a significant effect on behavioral intention to use SIMPATIK. Based on this, the variables of performance expectancy, effort expectancy, and social influence can be a concern in the future by DPMPTSP of West Java Province to increase acceptance and use of SIMPATIK by employees. Researchers can expand the indicators for each variable to a different population and sample. The moderator variables need to be further investigated to find out the effect on behavioral intentions and using behavior.

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Augmented Reality Using Real Objects Tracking Development

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Abstract

Augmented reality applications in tourism usually use images as markers, such as brochures or information boards. However, it is still ineffective because users cannot interact directly with real objects. This study aims to create applications that are more interesting and interactive which can be used by interacting directly with real objects. This research is located in Taman Ayun Temple, one of the tourism objects that are world cultural heritage in Bali. The application is designed with the real objects tracking augmented reality method using the Wikitude Android SDK platform. The application is built in Indonesian and English. The test results show that the percentage of the recognition of 40 objects from various directions is more than 80%, from a distance of 10 to 40 meters is more than 70%, from a good and moderate lighting condition is more than 80% and recognize similar objects as a different object.

Keywords: Augmented reality, object tracking, android, wikitude

Introduction

The existence of temples in Bali apart from the spiritual aspect, has developed into a historical heritage and has become a tourist attraction due to the beautiful architecture of the building (Somantri 2016). One of the temples which is a world cultural heritage in Bali is Taman Ayun Temple. Taman Ayun Temple is a representative temple for the Mengwi people who want to pray to big temples, just come to this Taman Ayun Temple. Apart from being a place of prayer, Taman Ayun Temple is also part of the world cultural heritage (Ardika & Subadra 2018; Widiarta 2016).

Based on observations, the information from the buildings at Taman Ayun Temple is still not fully delivered. Through this problem, technology can be a solution. One of the technologies that is widely used in the tourism sector and has the potential to be a solution to this problem is augmented reality. Augmented reality is a technology that makes it possible to display virtual objects or digital objects in the real world (Zlatanova 2002).

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Several studies that apply augmented reality (AR) technology in the tourism sector are also used as a reference in developing this research. One of them is research on mobile applications that implement augmented reality at Purbalingga District. This study works by detecting images on brochure media as markers and displaying information related to Purbalingga District (Tahyudin et al. 2015). Another research is the augmented reality application in the museum that displays information in text and video using two dimension (2D) images as markers. In addition, the application also uses a location map image as a marker to display location points and can be used via a desktop or smartphone (Yudiantikaet al. 2013). The next research is an augmented reality mobile application for Historic Sites in Tainan. This application uses the AR game as an educational medium as long as visitors are at Chihan Tower by using 3 objects as checkpoints (Hu & Tsai 2016). The three studies previously mentioned use the camera function in displaying augmented reality objects. The constraints experienced in maximizing system performance come from the direction and scanning distance as well as the lighting conditions.

This study aims to provide a different experience in the use of augmented reality technology. This study creates an augmented reality application that can be used when the user is directly at Taman Ayun Temple. The marker used is a real object or building that is inside Taman Ayun Temple. The application is built in two languages, Indonesian and English so that it can be used by both domestic and foreign tourists. It displays information in the form of text as well as audio using text-to-speech technology accompanied by Balinese background music. Through this application, we hope that information about Taman Ayun Temple can be delivered in a more interesting and interactive way. Visitors who come to Taman Ayun Temple can be more comfortable and independent in obtaining information regarding each of the objects in the Taman Ayun Temple.

Literature Review

Augmented Reality

Ronald Azuma, an expert of Augmented Reality in 1997 defined Augmented Reality as a system that has the characteristics of using real and virtual environments, running interactively in real time, and integrating in three dimensions (3D). Furthermore, Azuma wrote that in simple terms AR can be defined as a real environment that is added with virtual objects. Merging of real and virtual objects is possible with suitable display technology, interactivity is possible through certain input devices (Azuma 1997).

Augmented Reality is different from Virtual Reality (VR), where a computer generates an entire virtual living environment, while AR only generates augmented objects to complement the real world for users to interact with (Cawood & Fiala 2008). The resulting object is not limited to graphic objects such as 3D models, but also includes other sensory input, such as sound and text, which can be felt by human senses (Krevelen & Poelman 2010).

- *Marker-Based Augmented Reality*

  Marker based AR is AR which uses markers or object markers that have a pattern that will be read through the camera (Hirzer 2008). The computer will recognize the position and orientation of the marker and create a virtual world at points (0,0,0) and 3 axes X, Y, and Z (Cheng et al. 2017).

- *Marker-less Augmented Reality*

  Marker-less AR is AR which does not use a marker to display digital elements. Marker-less AR takes advantage of device position, direction, and location (Cheng et al. 2017).

Wikitude SDK

Wikitude SDK is an Augmented Reality Software Development Kit (SDK) for mobile devices with android and ios operating systems. Wikitude SDK is a product created by Wikitude GmbH which is located in Salzburg, Austria. Wikitude was founded in 2008 Wikitude GmbH initially focused on developing location-based Augmented Reality with the Wikitude Browser product. However, since 2011 Wikitude GmbH has begun to see a promising market potential in the field of Augmented Reality technology development, thus starting to create technology development with markers, 3D object

rendering, three-dimensional object recognition, two-dimensional and three-dimensional tracking, face recognition, and sensor control. Early 2013, Wikitude released version 1.0.0 of the Software Development Kit (SDK) which is intended for developers to develop augmented reality applications with the help of functions in the library.
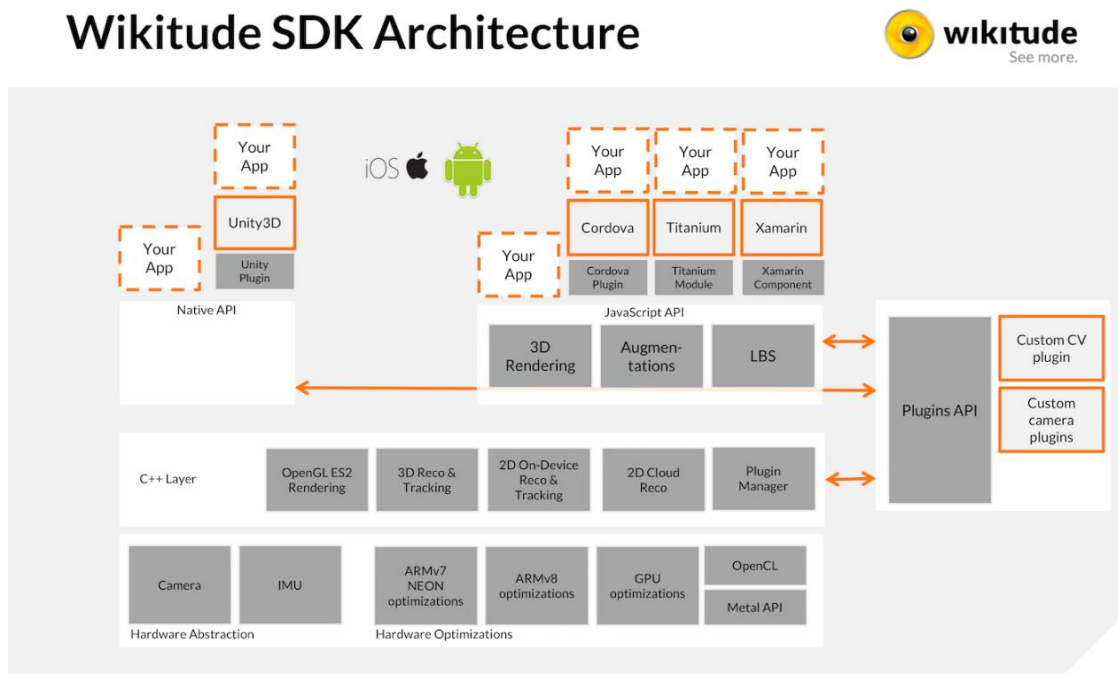

Figure 1. Wikitude SDK Architecture

Figure 1 shows the architecture of the Wikitude SDK. Wikitude SDK is divided into three layers, namely the Computer Vision Engine layer, which is the main engine of the Wikitude SDK, the API layer that connects the main engine with the application or platform you want to build, and the application layer (Wikitude 2020).

Wikitude Studio Editor

Wikitude Studio Editor is designed to optimize Wikitude SDK projects and minimize effort when creating target image collections (.wtc) and target object collections (.wto). Wikitude Studio Editor is a drag & drop tool that allows you to add, delete, edit, and organize target images, objects, and scenes more efficiently (Wikitude 2020).

Wikitude Scene & Object Tracking

This feature is based on the Wikitude SLAM (Simultaneous Localization and Mapping) engine which is used throughout the SDK for any kind of environmental tracking. Scene & Object Tracking makes it possible to detect predefined objects and entire scenes. In order to target that object, it is necessary to create a pre-recorded map of the object which will then be used to trigger the AR experience. The workflow for creating a simple target object is to collect the images of the object or scene, then convert the image into the Wikitude Object Target Collection (.wto) using the Studio Editor, then only need to import the .wto file in the AR application project (Wikitude 2020).

Methodology

Schematic of System Development

Schematic of System Development is the stages in the application development process. The stages are carried out sequentially starting from the data collection stage until the application is ready for use.
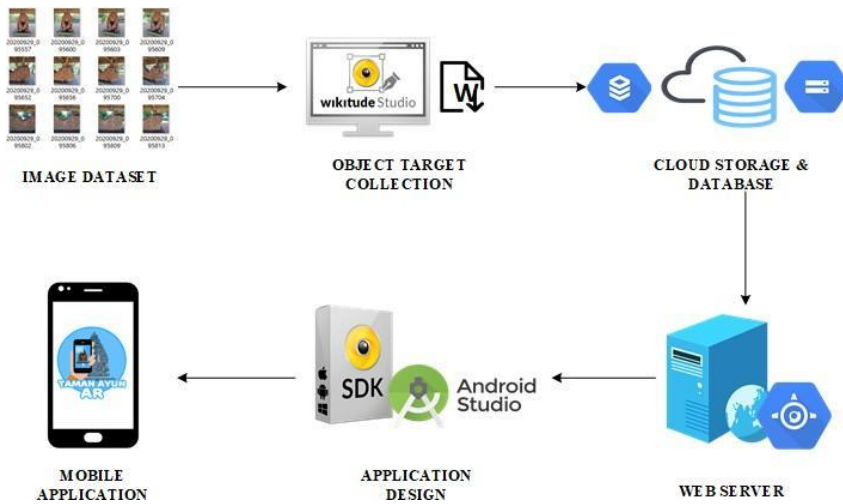
Figure 2. Schematic of System Development

Figure 2 is the System Development Scheme applied in this study. It begins with the process of collecting data on object images dataset, creating WTO files in the Wikitude Studio Editor. Furthermore, the dynamic AR design process is carried out by creating an object database and followed by the development of the server web page. After that, the process of creating an AR application with Android Studio was carried out using the Wikitude SDK platform.

System Overview

System overview is a flow that describes how the system works (see Figure 3). It also describes the function of each component and the relationship between one component and others in this application.
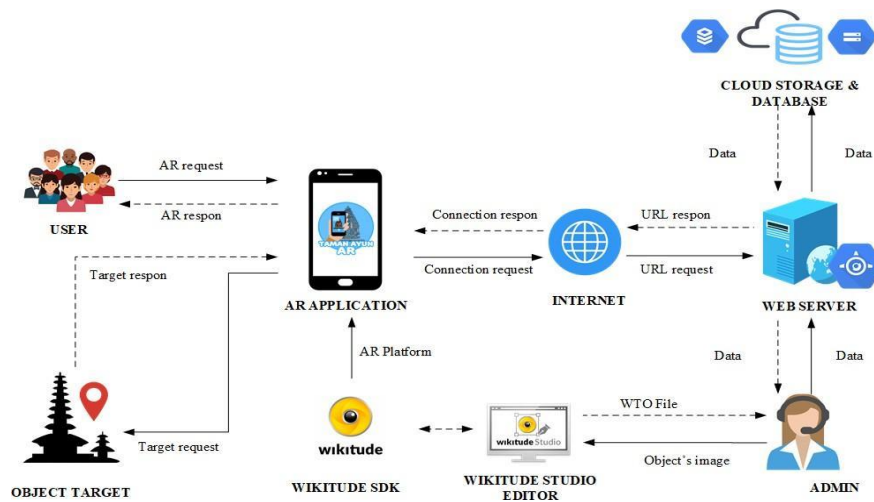

Figure 3. System Overview

First, the smartphone must be installed with the application, then make sure that smartphone was connected to the internet before running the application. The application requests and receives data from the database via web server in JSON format. The administrators can manage data (input, update, delete) and WTO files on the database server. Data that has been stored in the database is used as a trigger in displaying the information.

Application Flow

The Application Flow describes the work steps of the application. It describes the steps from the first time the application is run until it shows the information of the related objects.
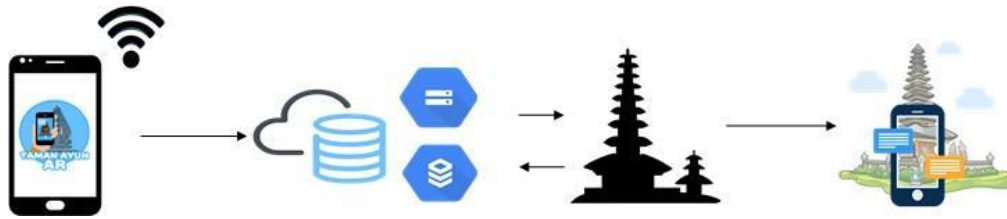

Figure 4. Application Flow

Figure 4 is a schematic explaining the application flow in this study. First of all, smartphones must be installed with the application and connected to the internet. When the application runs, it will display the AR Camera and automatically request data from the server database and storage. The loaded WTO file then matched with the object scanned by the user. If it matches, it will display the information related to the object.

Image Dataset

Each object must be registered in the Object Target Collection (WTO file) before it can be scanned. The object target is created by uploading images of objects which are taken from various points of view to produce a model for recognition. Furthermore, the system is trained to recognize objects based on features or points stored in the WTO file. Uploaded images cannot be more than 50 images and each image cannot be more than 8MP.
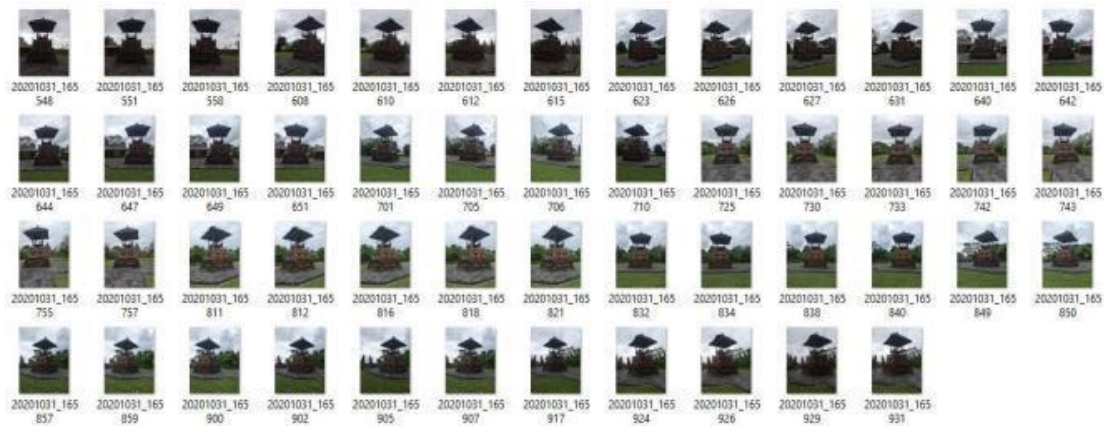

Figure 5. Image Dataset

Figure 5 is an example of an image dataset of one of the objects in Taman Ayun Temple. This research uses a total image dataset of 40 objects and each object consists of a variety of 24 to 50 images. The objects that have been registered in the WTO file must also be listed on the web server to be stored in the database system. The variable used in matching data on the WTO file and on the database is the object's name. When the real object is scanned, the matching object's name in the WTO file will be used to retrieve data from the database to display as object information.

Result

Augmented Reality Testing from Various Directions

Augmented reality testing from various directions aims to find out whether the augmented reality function can run well if the angle of shooting or scanning objects from various directions. Testing was carried out on 40 objects and scanning from 8 directions north, northeast, east, southeast, south, southwest, west, and northwest or in other words surround the object.

Table 1. Various Directions Test Results

Tested Items	Recognized	Percentage
North	33	82.5%
Northeast	32	80%
East	38	95%
Southeast	34	85%
South	40	100%
Southwest	33	82.5%
West	37	92.5%
Northwest	35	87.5%

Table 1 is the test results of scanning objects from various directions against 40 objects at Taman Ayun Temple. The success rate for each direction is more than 80%. Some objects that cannot be scanned from various directions are affected by the object's location, where it is not possible for the user to scan the object from that direction.

Figure 6. Testing from Various Directions

Figure 6 shows testing the object named Bale Pangubengan scanned from various directions. The Augmented Reality technology applied can run well through the direction of scanning objects north, northeast, east, southeast, south, southwest, west, and northwest. It can be concluded that the application is able to recognize objects through scanning objects from various directions or points of view. This test shows that the synchronization between Augmented Reality technology, the model created in the WTO file, and the camera is running well so that the information that can be displayed from the scanned object from various directions.

Augmented Reality Testing from Various Distances

Augmented reality testing from various distances aims to determine whether the augmented reality function can work well if object scanning is carried out from various retrieval distances. Testing was

carried out on 40 objects by scanning the object from 6 scan points as far as 5 meters, 10 meters, 20 meters, 30 meters, 40 meters and 50 meters.

Table 2 is the test results of scanning objects from 6 points distance against 40 objects at Taman Ayun Temple. The success rate for 10 to 40 meters is more than 70%. It can be concluded that the best distance to use when scanning the object is as far as 10 meters to 40 meters depending on the size of the object. Objects that are successfully scanned at 5 meters are small objects or not buildings, such as statues, masks, or other historical objects.

Table 2. Various Distances Test Results

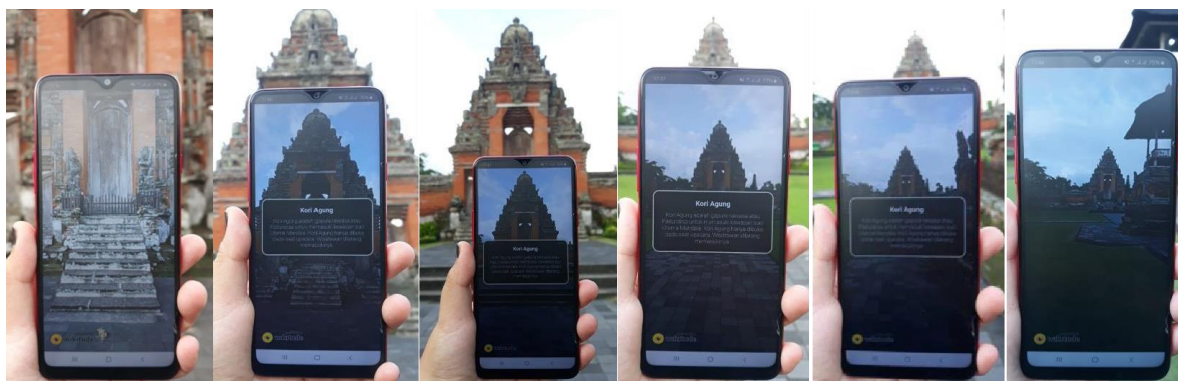| Tested Items	Recognized	Percentage
5 meters	4	10%
10 meters	40	100%
20 meters	38	95%
30 meters	38	95%
40 meters	29	72.5%
50 meters	0	0%

Figure 7. Testing from Various Distances

Figure 7 shows testing the object named Kori Agung scanned from various distances in sequence from the leftmost image to the rightmost image, which are 5 meters, 10 meters, 20 meters, 30 meters, 40 meters, and 50 meters. Based on the results of testing, the Augmented Reality technology applied has accuracy or can detect objects up to less than 50 meters. However, this distance cannot be used as a benchmark for all objects because the size of the objects is different. The size of the object is directly proportional to the distance that can be used in object scanning. The best recommendation for scanning an object is where the entire object appears to fill the smartphone screen, is not cut off and is not too small or scanned with other objects.

Augmented Reality Testing of Various Lighting

Augmented reality testing from various lighting aims to determine whether the augmented reality function can run well when scanning objects in good lighting conditions and less lighting conditions. Testing was carried out on 40 objects by scanning objects in good and less lighting conditions.

The test results on Table 3 shows that the augmented reality technology applied can only detect objects with good and moderate lighting conditions. The success rate for good and moderate lighting conditions is more than 80%. Scanning objects with good lighting causes objects to be captured perfectly and easily recognized. Scanning an object with moderate lighting causes the object to be captured but requires

several attempts at recognition. Scanning objects with less or minimal lighting causes objects to be invisible and unrecognizable so they cannot be recognized. Scanning objects with lighting that is too bright or when the sun is too bright causes the object to appear backward to the light so that the object becomes dark (backlight) and cannot be recognized.

Table 3. Various Lighting Test Results

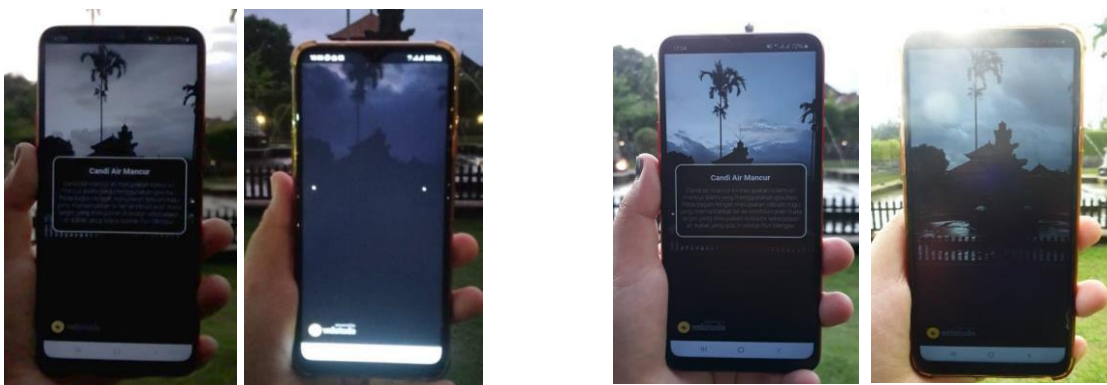| Tested Items	Recognized	Percentage
Good lighting	40	100%
Moderate lighting	33	82.5%
Less lighting	0	0%
Over lighting	0	0%

Figure 8. Testing from Various Lighting

Figure 8 shows testing the object named Candi Air Mancur scanned in the various lighting conditions. This proves that lighting has a very important thing in maximizing application functionality. The recommendation for the right time to use the application is when the object is scanned in the morning when the sun is not too bright, during the day when the sun is not too bright until late in the afternoon, where the lighting is still sufficient to be able to detect objects properly. Meanwhile, not recommended times for application use are when the sun is too bright and at night.

Augmented Reality Testing with Similar Object

Augmented reality testing with similar objects aims to determine whether the augmented reality function can be executed properly by scanning objects on objects that are similar but different. The objects being tested are Meru Tumpang 11 Sakenan and Meru Tumpang 11 Gunung Agung.

Figure 9. Object's Image

Figure 9 shows the original appearance of Meru Tumpang 11 Sakenan and Meru Tumpang 11 Mount Agung. These objects have an 11 overlapping building architecture so they both look the same. These objects scanned to find out whether the system can recognize the two objects as different objects or not.

Figure 10. Recognition Result

The test results in Figure 10 shows that the augmented reality technology applied can detect similar objects as different objects. However, the experiment must be repeated in several scanning positions of the object to obtain appropriate recognition results.

Discussion

This application has several advantages, such as: (1) The application is made based on mobile and can be accessed using the internet network so that processing and delivery of information can be done quickly and easily. (2) The application can be used directly to the real objects so that the user experience is more real, interesting, and interactive. (3) The application does not require other intermediate media as markers, such as brochures, books, or catalogs. (4) The application is equipped with narrative audio and Balinese gamelan background music, so that the sense of hearing is also involved in the user experience. (5) Data manipulation can be done by an admin via a web server. Apart from the advantages that have been mentioned, this application also has several drawbacks. The drawbacks of the application, such as: (1) Users must have good internet access because the augmented reality feature runs through the internet. (2) Users must have a good smartphone camera to maximize the real objects tracking function. (3) The application can only run on the Android platform.

Conclusion

The design of the application based on Android uses the Wikitude platform. Administrators can manage data from a web server so that users must be connected to the internet before starting the application to process data requests. The application is built in two languages, Indonesian and English. The name and description of the recognized object is displayed in text and audio so the user can possibly read and hear the information at the same time.

The system success rate in recognizing 40 objects from various directions reaches more than 80%. The recognition of objects from a distance of 10 to 40 meters achieves a success percentage of more than 70%. While testing of good and moderate lighting conditions has a success percentage of more than 80%. The system can recognize similar objects as different objects.

This application makes it possible for tourists to have a more interesting and interactive travel experience. This research leads to a smart-based tourism industry, where tourists no longer only know the tourism industry through technology but travel directly with the interference of technology in it. This research is still far from perfect, so it is hoped that in the future some developments can be made to perfect it. Developments that can be made include system improvements to allow displaying more than one object at a time, development of an integrated system between tourist attractions and tour and travel services such as information and online booking of hotels, restaurants, transportation rentals, online souvenir shops, etc. It is hoped that in the future this can be a development towards the tourism industry 4.0.

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Information Management and Information System Analysis to Support the Achievement of University Performance Agreements with the Government

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Abstract

The information management process and the use of information systems to support data collection and target achievements monitoring of rector's performance agreement with the Ministry of Education and Culture in Universitas Brawijaya (UB) still have deficiencies. The process involved many stakeholders and covered all areas of business at the university. As a work unit that collects and processes the performance achievement data, the Center for Quality Assurance UB complains that the information gathering takes a long time and is often incomplete. Faculties, study programs, and other work units complained about the unavailability of most of the data or information on the performance indicator targets in the information system used as a reference for implementing business processes. This problem received a general response from the UB ICT Unit that the information system developed and used is under academicians needs. Meanwhile, other academicians such as lecturers, employees, and students have different responses to problems. These problems are unclear and unstructured and have unpredictable goals and solutions. It is necessary to manage information by using reliable Information Systems by all work units to ensure the integration, availability, and validity of data for achieving performance targets. This study analyzed the problem and formulated a transformation step to improve the situation using the Soft Systems Methodology (SSM) with several Root Cause Analysis (RCA) stages. The research's main contribution provides an insight into the overall problem situation covering the various perspectives of stakeholders, the transformation of the state's improvement represented in the conceptual model, and stakeholder assessments of the conceptual model. This research also provides an overview of RCA's application to explore more stakeholder perspectives and identify building conceptual models.

Keywords: Soft Systems Methodology, SSM, Root Cause Analysis, RCA, University Performance Agreement

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Introduction

State Universities have a performance agreement with the Ministry of Education and Culture (MoEc) called a university performance contract or rector's performance contract. It consists of performance indicators in the form of programs and targets to be achieved in a year (Kemenristekdikti 2016). To ensure the integration, availability, and data validity of performance targets achievement, information management by utilizing reliable Information System (IS) by all work units is needed.

Reliable IS is the capability of IS that enables the system to succeed (not fail) in achieving the intended objectives within a certain period and under a particular set of conditions (Zahedi 1987). To increase organizational competitiveness, IS needed to match the needs of business activities that refer to its plans and objectives (Almazán 2017). The use of IS following needs will impact improving the information management process, positively impacting productivity (Almazán 2017).

The process of collecting data and monitoring the performance targets' achievement on the rector's performance contract with the MoEC in Brawijaya University (UB) still has shortcomings. Collecting data of performance indicator targets from faculties throughout UB takes a long time and is often incomplete. Faculties, study programs, and other work units also complain about the unavailability of most of the data or information regarding the performance indicator targets in the operational information system. They have to carry out many steps to find valid information. Besides, many spreading data in several IS developed separately by the faculties, study programs, and work units make gathering information difficult. Many IS are not related to the IS used by many faculties and work units in UB so that the flow of information is not interconnected. That means that critical data needed by the university are not well absorbed in the university's IS. The problem received a general response from the UB ICT Unit that the information system developed and used follows the academicians' needs. In contrast, the information needed on performance targets is the leading information that reflects the university's general conditions and needs regular evaluation.

These problems are unclear, unstructured, have different perspectives from stakeholders, unpredicted goals, and solutions. Therefore, we need a concept of thinking that can accommodate the relationship between stakeholders by looking at problems as a whole and comprehensively, not in pieces, that called systems thinking. However, the case study in this research is not a technical problem with a clear problem definition and purpose that usually resolved by the concept of hard systems thinking, so that it has a different solution, namely using the concept of soft systems thinking.

Soft systems thinking is a way of thinking to accommodate messy problems, unknown objectives, what they want to achieve, and management elements (Checkland 1989). Based on the problem's description, the right approach that can guide researchers to analyze problem situations is the Soft Systems Methodology (SSM). SSM is an approach used to analyze, describe, and interpret problems from various stakeholders' points of view to develop a new conceptual idea needed to transform factual phenomena (Hardjosoekarto 2012).

Mehregan et al. (2012) and Por (2008) carried out the application of SSM in Higher Education to identify the problem in implementing scheduling and learning, where the results were structured and comprehensive conceptual modeling of problems and final solutions. Another form of SSM application is designing an evaluation framework for learning management environment using SSM principles carried out by Hardman and Caceres (2011).

This study aims to analyze and obtain transformation steps to improve the state of information management and use of information systems in achieving the target performance indicators for the rector with the MoEC in UB using SSM, with the addition of several stages of Root Cause Analysis (RCA). RCA is used to explore the root causes of problems and help develop conceptual models' activity in stage 4 of SSM. RCA is a methodology for finding fundamental problems and fixing performance problems, whether related to humans, systems, or equipment (Okes 2019).

Literature Review

Soft Systems Methodology **(SSM)**

SSM consists of 7 stages as can be seen in Figure 1. The SSM model consists of two main activities: real-world activities seen in Stages 1, 2, 5, 6, and 7, and systemic activity thinking (systems thinking) seen in Stages 3 and 4. Not all stages of SSM should be followed when conducting research, depend on needs.
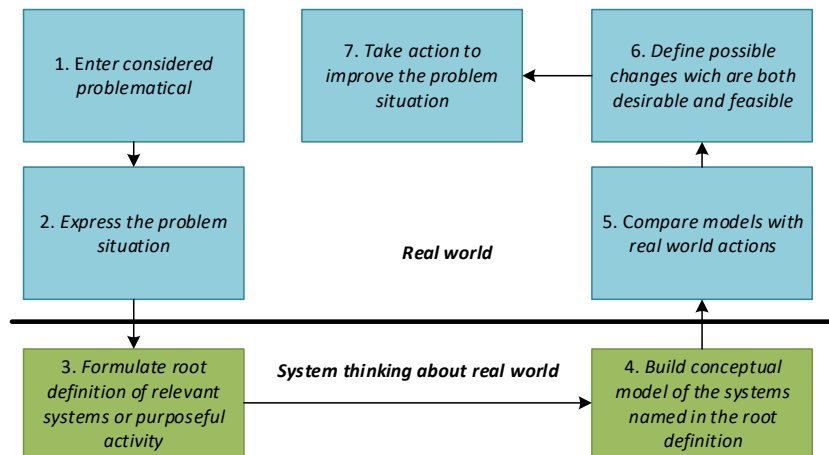

Figure 1. Soft Systems Methodology (Checkland 1989)

Stage (1) is enter considered problematical. This stage examines problems that are unstructured, complex, and have many perspectives (world views). Furthermore, stage (2) expresses the problem situation, namely describing the problem's complexity through a rich picture (s) to capture various perceptions related to the problem. Rich pictures are to be made as complete as possible to show the problem map, relations between actors, and views about the problem.

Stage (3) is formulating root definition of relevant systems or purposeful activity that means defining the root of the problems that includes particular views of the problematic situation by the relevant perspectives. This stage is supported by defining CATWOE (Customers, Actors, Transformation Process, Worldview, Owner, and Environmental Constraints). The customers are the parties who receive the benefits of the transformation process. In comparison, actors are the parties who can transform the situation based on the application of the conceptual model. The transformation process is an activity that shows the process of transformation, improvement, or optimization. Moreover, worldview is a paradigm that justifies the root definition. The owner is the decision-maker who has the responsibility of making the improvement efforts and stopping the transformation. Environmental Constraints are the elements outside the system that can become obstacles in the transformation process.

Stage (4) is building conceptual models of the systems named in the root definitions. The conceptual model is built as a transformation step to improve the situation. The input and output in the transformation process describe building the model. A comparison of the model with real-world conditions conducts in stage 5 by analyzing the possibilities of implementing the conceptual model activities.

Stage (6) is defining possible changes that are both desirable and feasible. This step conducts by assessing the results of interviews with the stakeholders about improvements or transformations to enhance the situation. It can be in the form of structures, procedures, or the attitude of the stakeholders. The next step in stage (7) is followed by improving the problem situation and implementing an action plan to carry out the transformation.

Root Cause Analysis (**RCA**)

RCA is an approach to diagnose and solve problems that can enhance the process of corrective improvement in many organizations by discovering the underlying causes of problems (Okes 2019). The main objectives of RCA include (Rodriguez 2016): 1) identifying the root cause of the problem; 2) building general terminology in the corporate community to facilitate better communication and understanding; 3) learning from problems and failures.

There are many versions of the RCA stages, but, in general, they consist of the following steps: 1) identifying the problem, 2) making a diagnosis, 3) choosing and implementing a solution, and 4) improving and maintaining results. The diagnosis stages must be done logically with deductive analysis using critical thinking (Okes 2019). Figure 2 and Figure 3 show the RCA methodology used as a reference in this study.
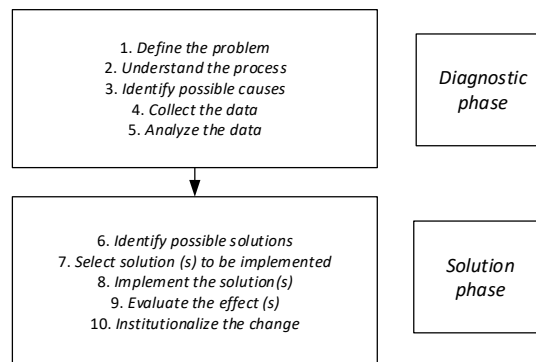

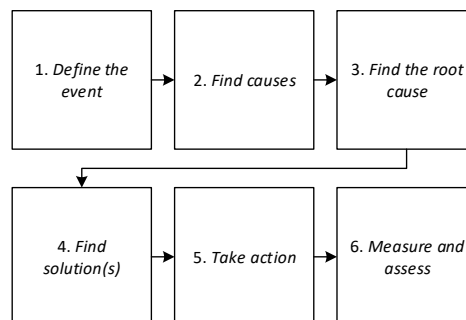**Figure 2. Root Cause Analysis (Okes 2019)**

Figure 3. Root Cause Analysis (Andersen and Fagerhoug 2014)

The methodology proposed by Okes (2019) provides more detailed theoretical stages and explanations, while the methodology proposed by Andersen and Fagerhoug (2014) provides detailed practical guidance for RCA analysis and its tools. The two RCA methodologies will compare to ascertain, which of them was necessary, and several steps are selected to assist the analysis in SSM.

Research Methodology

The approach of this study is SSM, with the addition of several RCA stages. The RCA stages were analyzed by evaluating each stage's objectives and adding the stages to the results and objectives which were not in the SSM. However, the addition of the RCA stages to the SSM is not the main focus of this study. The research methodology is shown in Figure 4. The added RCA phases became parts of Stage 2 and 3, namely 2.1, 2.2., 2.3, and 3.1.

Since the early 2000s, there have been many SSM studies with several methods or techniques. These additions have varying complexity, ranging from the addition of specific techniques at the SSM stage

to the development of new methodologies from the combination of SSM with other methodologies, such as the merging of SSM with System Dynamics (SD) by Ulloa and Careces (2005).

Ulloa and Careces (2005) and Hanafizadeh and Aliehyaei (2011) assume that the combination of SSM with other methodologies caused by the weakness of SSM. There are including 1) SSM does not have accurate tools to change the root definition at stage 3 to be the conceptual model in stage 4; 2) The proposed conceptual model is considered based on certain viewpoints (not based on expert knowledge).
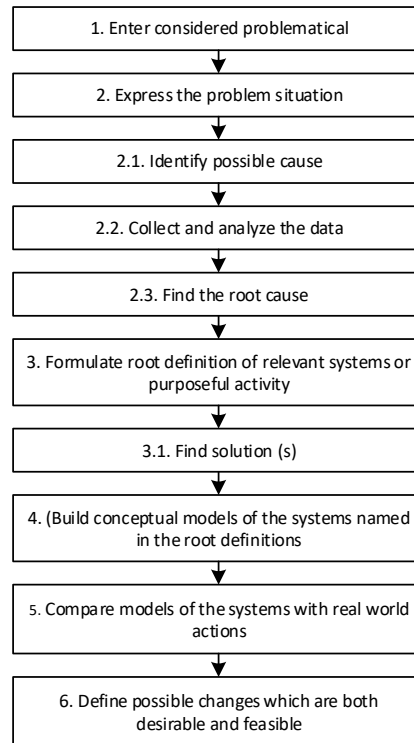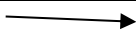

Figure 4. Research Methodology

Wheeler (2000) states that if SSM is a flexible methodology and not a fixed methodology. So it can be applied according to the user's motivation by not always following the seven stages. That statement comes from the constitutive rules of SSM developed by Checkland (1989) in the late 1980s. The rules for using SSM provide additional proof of SSM flexibility. The scope and flexibility of the application of SSM in various industrial fields, the ease of adding methods and other techniques to its stages, and the flexibility of combining with other methodologies show that SSM is developed with these objectives. Thus, using SSM with the added techniques or methodologies can be done flexibly depending on the needs and researchers or practitioners' creativity. Various techniques outside of SSM can overcome the presumption that SSM's deficiencies are related to the implementation process difficulties.

Findings

1. Stage 1 and 2

The rich picture in Figure 5 illustrates the problem situation described in the study's background. The description of the rich picture symbol is shown in Table 1.

Table 1. Description of the symbols in Rich Picture

Symbol	Description
→	Describe the direction of regulation and information.
→	Describe the direction of information flow, information systems, and regulations.
💬	Describe state or stakeholders' task.
☁	Stakeholder complaints.

2. *Stage 2.1*

This stage identifies the possible causes of the problem by brainstorming the possible causes of the problem using a Cause and Effect Diagram (CED) or Fish-Bone Diagram, or the Ishikawa Diagram. The analysis begins by identifying the problems in stages 1 and 2, then brainstorming the problems. Based on the initial analysis, the problem consists of three things, namely: 1) the lack of media availability to find information, 2) obstacles in gathering information, 3) obstacles in achieving performance targets. Figure 5 show the CED analysis of the lack of media availability to find information problem. At this stage, the causes of the problems were produced and would be explored more by using questionnaires and interviews at stage 2.2, namely data collection and analysis.
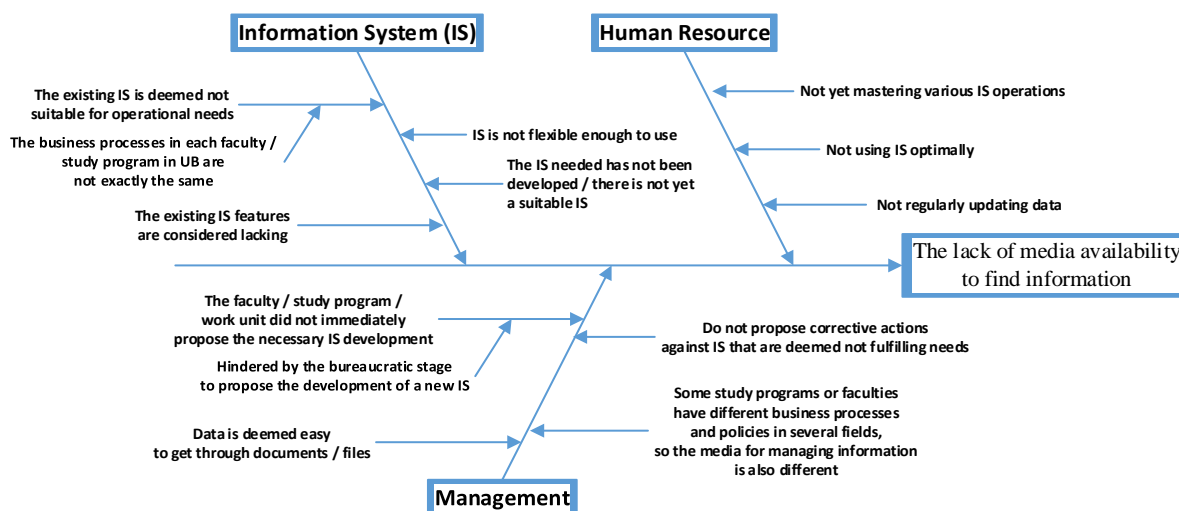

Figure 5. Cause and effect diagram analysis of the lack of media availability to find information

3. *Stage 2.2*

This stage gathers information, explore the causes of the problems, and confirm whether the brainstorming was already correct. Questions on the questionnaire and interview were following the brainstorming results by using CED. There are the media find information, obstacles in gathering information, and obstacles in achieving performance indicators. Identified the cause of the problems became the answer options in the questionnaire. Interview questions had the same question structure and choice of answers compared to the questionnaire, but they were used to gain more causes of the process's problems.

The questionnaire was carried out in Academic, Student Affairs, Staffing, Cooperation, Facilities, Infrastructure, and Research and Service units at each university faculty while interviews were conducted in 5 faculties. After obtaining the questionnaire results and interview on the faculty, an interview was conducted on the ICT unit to determine the ICT unit's perspective about the problem situation.

4. *Stage 2.3*

Analysis in this stage is using the why-why diagram to find the root cause of the problem. The analysis is carried out following the categories of the causes of CED problems, for example, in the media's problems for information gathering. The causes of the problem are information systems, human resources, and management, where one why-why diagram analyses one category. From the complete analysis of why-why diagrams on each problem and each category, 26 root causes were found and categorized into four groups: the root causes of information system problems, human resources, management, and infrastructure (Figure 6). These root causes are shown in Table 2.
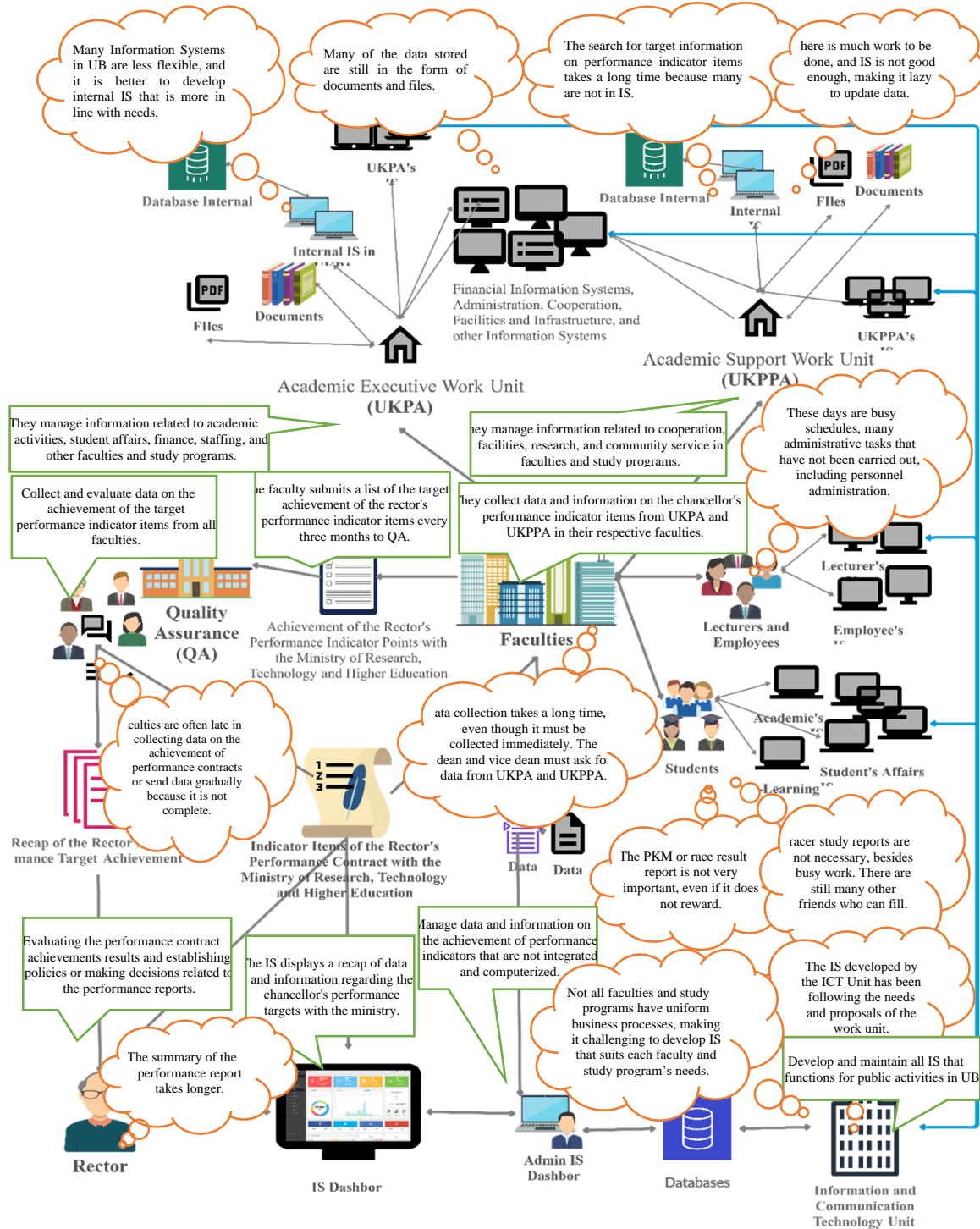

Figure 6. Rich picture

Table 2. Root Cause

No	Root Cause	Category
1	Time constraints when developing information systems	Information system
2	Deficiencies or errors in the development of information systems at the design /coding stage	
3	Deficiencies at the requirements analysis stage of information system development	
4	Number information systems, there are several overlapping information system functions.	
5	Shortages/errors when testing the information system.	
6	Lack of information system development team.	Human resource
7	Lack of human resources to help manage information.	
8	Employees need assistance and training in operational information systems.	
9	Employees have many workloads.	
10	Each faculty has a type of educational program with various curricula so that the business processes are different / not the same as other faculties.	Management
11	The influence of internal campus policies and the development of government regulations on business processes in each faculty.	
12	The administrative process long and complicated to propose improvements and development of new information systems.	
13	Many information system developments internally to avoid the bureaucratic process.	
14	Management of information (availability, regularity, and unity of information) has not been a priority of the faculty.	
15	Lack of faculty commitment to managing information well,	
16	The government aims to unite data and information nationally	
17	The development of the university (its effect on increasing the workload of employees to manage information)	
18	Differences in policies and regulations in each faculty (influence on business processes and information management)	
19	Lack of commitment from the leadership to provide an understanding of the achievements of university performance (to employees)	
20	Lack of leaders' commitment to understanding the importance of information management (to all university stakeholders).	
21	Influence of university and government regulations and policies related to educational staff competencies (related to performance indicators of educational staff competencies)	
22	Faculty priorities do not include some performance indicators.	
23	The collaboration program is not a top priority for the faculty.	
24	The influence of faculty/university leadership policies on funding	
25	There is no information system to manage uncomputerized data.	Facility
26	UB has many data connected to many information systems.	

5. *Stage 3*

The formulation of the root definition in this study is carried out based on the perspective of the problem situation in general from the CED analysis results, questionnaires, interviews, and finding the root of the problem. The root definition in this study is as follows:

"Supports for the availability, quality, and unity of the performance indicators achievement data of the rector and the Ministry of Education and Culture can be improved by having good information management using information systems according to the needs. It is possible to achieve this with the leader's commitment to improve information management and develop information systems, followed by stakeholder understanding of the importance of achieving performance indicators of the rectors with the Ministry of Education and Culture to represent university performance. "

Based on the root definition above, the CATWOE analysis is shown in Table 3.

Table 3. CATWOE analysis

CATWOE	Descriptions
Customers (C)	Leaders (rector, vice-rector, dean, and other leaders), QA, UKPA (faculties and study programs), UKPPA
Actors (A)	All academicians at the university (lecturers, employees, students)
Transformation process (T)	● Improve information management processes and information systems to ensure the availability and integrity of data ● Improve university management, both resources, and leadership policies ● Increase the fulfillment of the necessary facilities and infrastructure
Worldview (W)	The achievement of the rector's performance indicator targets with the Ministry of Education and Culture supports the improvement of university quality, which must be achieved and improved
Owner (O)	Rector, QA, ICT unit
Environmental constraints (E)	Government policies or regulations, university resources
3E Criteria	
Efficacy	The commitment of the top leaders and the entire academic community to carry out the transformation
Efficiency	The collaboration of the transformation process with various work units according to the problem domain
Effectiveness	Improve the process of managing information on the performance indicators of the chancellor and the Ministry of Education and Culture by improving information systems, business processes, information architecture, and data integration

6. *Stage 3.1*

At this stage, identifying a possible solution of 26 root causes of the problem was identified. Writing down corrective and anticipatory actions from each root cause of the problem conduct to identify the solutions. Corrective and anticipatory actions at this stage helped define the elements of activities in developing conceptual models.

7. *Stage 7*

At stage 7, a conceptual model is built, contains nine activities as a state transformation step, shown in Figure 7. The first activity in the conceptual model is the initiation of FGDs and forming an evaluation team. This activity needs to conduct first because the problem is broad in scope, occurs in various fields,

and involves many stakeholders. The second activity is to evaluate the information management process. Evaluating information management included all activities either they used the information systems or not. At this activity, an evaluation report is generated along with the preparation for starting the next steps.

The difference in information management business in several faculties was a significant problem that needed an immediate solution. Therefore, the third activity needed to be carried out immediately after the evaluation study. FGDs are conducted to find solutions to the differences in business processes and Standard Operational Procedures (SOP) for information management in each faculty. This activity produces the uniformity of information management business processes, agreements, and solutions.

After the FGD study results on business process uniformity, the next steps are Stages 5, 6, and 7, namely the integration of the university's data warehouse with external databases and improvement and development of information systems. These stages involve the Information and Communication Technology (ICT) unit's role at both the university and faculty levels.
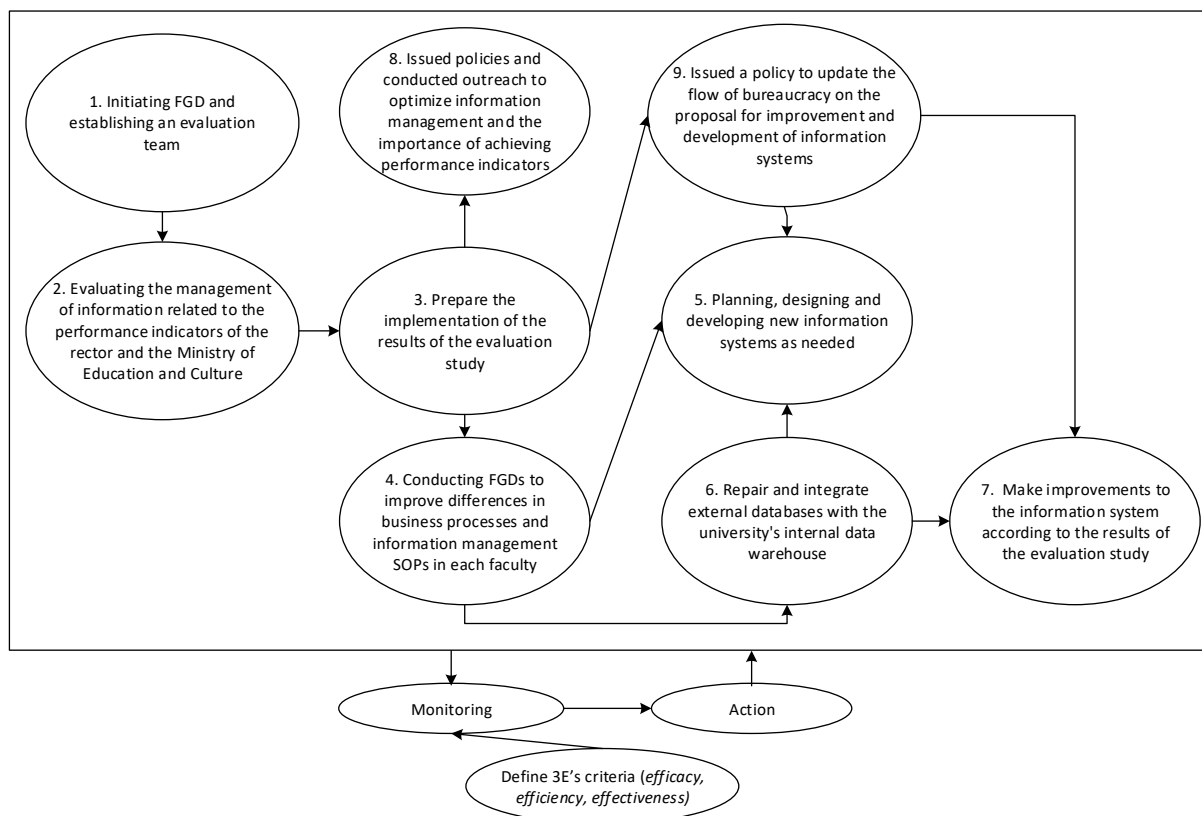

Figure 7. Conceptual Model

The next step is to optimize information management and achieve performance contracts. Optimization of information management arranges through several policies requiring lecturers and students to report various data, update routine employee data on facilities and infrastructure. Meanwhile, optimizing performance contracts' achievement includes enhancing faculty policies to prioritize the performance indicators achievement. This policy needs following by the stakeholders (employees, lecturers, and students).

8. Stage 5 and 6

At stage 5, the conceptual model is compared with real-world conditions to determine whether the conceptual model's activities can apply. The conceptual model is compared with the assumptions if the activities are implemented. Based on the comparisons at this stage, the results show that all conceptual models' activities can be applied.

At stage 6, an evaluation arranges using a questionnaire to assess whether the proposed conceptual model's activities are appropriate and possible to be applied. The questionnaire is distributed to nine respondents, lecturers, employees, and leaders in the UB Quality Assurance Center. Each respondent's answer to the questionnaire was assessed qualitatively, where the respondent answered by choosing one of the five answers for each question. The quantitative answer scores substitute for qualitative by giving points to the selected answers in the data tabulation. The interval criteria are as follows: 1) Very Good = 4.21 - 5; 2) Good = 3.41 - 4.20; 3) Enough = 2.61 - 3.40; 4) Bad = 1.81 - 2.60; and 5) Very Bad = 1.00 - 1.80.

The provisions of the evaluation variables in the SSM conceptual model refer to Checkland's (1989) statement; that determines the possibility of organizational change based on logical and acceptable criteria from organizational culture. Referring to Checkland's (1989) statement, the evaluation variables consist of accuracy, resources, time, culture or habits, and motivation.

Based on the index method calculation, most of the conceptual model activities have a "Very Good" value, with an index value above 4.20. Others had a "Good" result with a score above 3.41. It shows that respondents approve and judge most activities in the conceptual model can be implemented. The graph of each activity's evaluation results based on the questionnaire results shown in Figure 8.
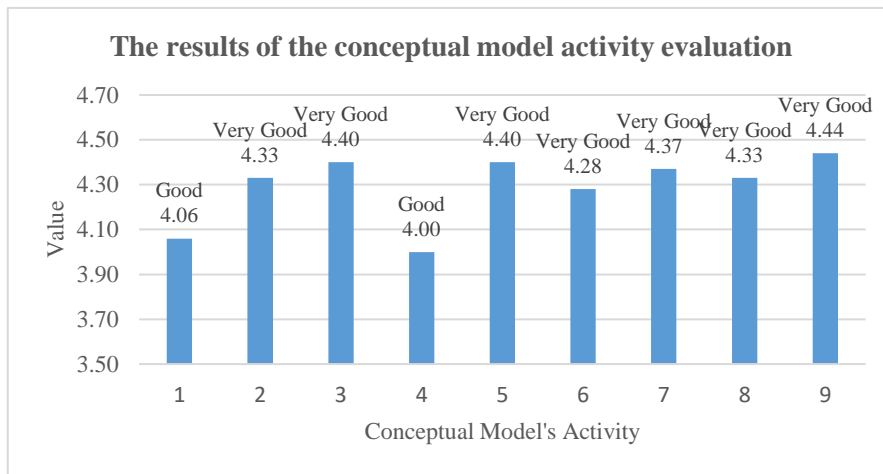

Figure 8. The evaluation result of each activity in the conceptual model

The activities assessment results in the conceptual model based on evaluation variables were mostly rated "Very Good." The graph of the index calculation results shown in Figure 9.
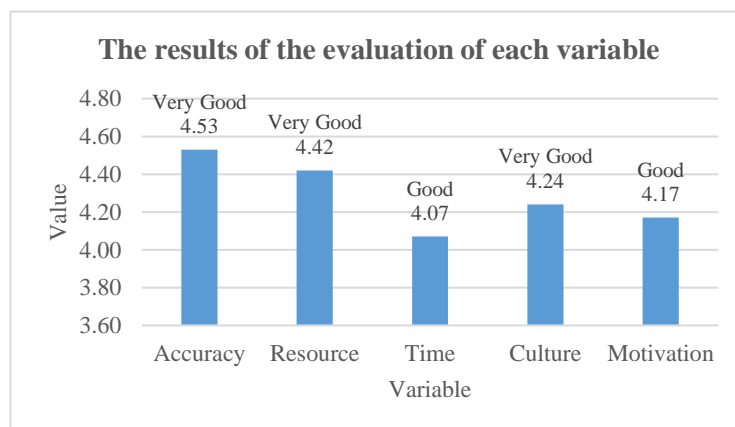

Figure 9. Result of the activities assessment based on evaluation variables

The assessment of activities in the conceptual model in Figure 8 shows that the respondents assess all conceptual model activities as relatively appropriate and can be applied well. Figure 9 also shows that the conceptual model can be implemented because it fulfills the available resources, such as time, cost, culture, and motivation.

Discussion

The 12 problem perspectives were found from the rich picture in Figure 6 in the cloud-shaped dialog box. Apart from that, two other perspectives are implicitly seen in the picture, and there are problems with the policies and the influence of human resources on the information management process.

The 26 root causes of the problem are also another perspective of the problem. The RCA stage added to the SSM stage 2 successfully helps analyze the problem situation to get more perspectives than what is seen through the rich picture. With more perspectives that have been obtained, the broader the researcher will understand the problem situation.

The RCA stage added in stage 3 of SSM, namely identifying possible solutions to root causes, succeeded in helping researchers as a reference tool other than root definition in defining the activity elements in the conceptual model. Identifying corrective and anticipatory actions as possible solutions can also minimize differences in interpretation between different analysts in developing a conceptual model. However, the root cause analysis stage using the Why-why diagram in stage 2 can produce different root causes of problems depending on the researcher's ability and insight. Therefore, various parties that are considered to have ideas and knowledge to solve problems are essential.

The transformational steps for improving the situation are represented in a conceptual model consisting of 9 activities. These activities transform the overall state, including issues of information systems, human resources, management, facilities, and infrastructure. Each activity in the conceptual model can be developed by building subactivity to become more detailed, and technical steps for its application are determined to guide the university in improving the situation.

In stage 4, Checkland (1989) states that different researchers or analysts can develop different conceptual models from the same root definition because words give different connotations to each person. Checkland (1989) adds that the built model is not a model that is considered 'correct' but a coherent model and can be maintained. The suitability of the conceptual model built is assessed based on the evaluation by stakeholders. In Figure 8 and Figure 9, the conceptual model generally scores "good" and allows it to be applied.

Although SSM provides knowledge and produces conceptual models that are judged appropriate to problem situations, the discussion of the success of SSM has become a debate among researchers and SSM practitioners (Connel 2001). Several researchers have debated the measurement of the success of SSM, such as Mingers and Taylor (1992), Ledington and Donaldson (1997), and Kreher (1994). Connell (2001) proposed criteria for measuring the success of SSM, based on the aspects of the methodological contribution and evaluation of research results. The SSM success criteria divided into four quadrants as follows: 1) Q1 when SSM can be considered successful if it succeeds in providing insight; 2) Q2 when SSM can be considered successful if it helps manage/change management; 3) Q3 when the problem situation can be resolved through a clear understanding through understanding the use of SSM; 4) Q4 the problem situation has been successfully resolved, and changes can be managed through the use of SSM.

This research succeeded in providing insight into the structure of the problem, stakeholders' various perspectives, the transformation of the expected state, and the stakeholders' assessment of steps in the conceptual models. This understanding shows that the SSM approach succeeds in providing insight and includes success in the Q1 criteria. Simultaneously, the criteria for the contribution of the study's final results show that the activities in the conceptual model are acceptable and can be applied by stakeholders. In this case, the success of the research results is in Q3.

Conclusion

This study analyzes information management's problem situation and information systems in achieving performance indicators for the rector and the Ministry of Education and Culture. The addition of three stages of RCA to SSM succeeded in finding 38 problem perspectives, namely 12 from the rich picture in stage 2 of SSM, and 26 from the RCA analysis. The root causes of the problems found are used for analysis by formulating the root definition and anticipatory and corrective actions. This analysis facilitates developing a conceptual model to determine what activities are required to transform problematic states. The conceptual model must also be tested to determine whether it is possible to apply it in the real world. The stakeholders' evaluation results indicate that the conceptual model in this study is acceptable and possible to apply. The results of the analysis of all stages provide insight and understanding of problem situations.

The contributions of this study include: 1) providing an overview of the application of RCA to explore problem perspectives that cannot be captured from the rich picture, 2) providing an overview of the use of the RCA approach to help develop conceptual models by defining corrective and anticipatory actions from the root causes of problems, 3) The research results can be used as input for initial research to evaluate the problems of information management and the use of information systems in Universitas Brawijaya.

This study's main limitation is the stakeholders' lack of involvement, especially in Stages 3, 4, and 5, due to the researchers' limited opportunities and time. Moreover, the RCA methodology's addition does not become one of the main discussions in the study because it focuses on exploring and understanding the problem situation.

Further research opportunities, this research can be developed on a broader research object, namely at many higher education institutions. The research results can be used as evaluation and learning materials regarding information management and reliable information systems to support higher education institutions' achievement in a performance agreement with the Ministry of Education and Culture.

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Correlations between Online Learning Media Types, First Access Time, Access Frequency, and Students' Achievement in a Flipped Classroom Implementation

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Abstract

Since the 1960s, the world has seen how information technology (IT) influences education. In the present era, with the massive development of the Internet, various kinds of IT-assisted learning are popping up like mushrooms in the rainy season. However, no matter how advanced IT-assisted learning has been grown, learning media is still an inseparable part of education. Former studies already covered students' preferences toward various types of media, yet none discussed the achievements. In this study, we specifically present how the use of certain types of learning media correlated with students' access behaviors and, more importantly, students' achievement. The data were collected from the Learning Management System (LMS) activity logs of 44 students from the undergraduate program in Informatics, with former experience of using e-learning. The result shows that these factors have a positive correlation. In terms of media type influence towards students' achievement, the media that has the appearance of the lecturer gives better achievement, compared to the media that only has audio, and the media that only consists of text and images.

Keywords: blended learning, flipped classroom, learning media, students' access behaviors, students' achievement.

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Introduction

Since the decade of the 1960s, the world has been presented with various types of Information Technology (IT) assisted learning (Aparicio et al. 2016). The scenario span from computer-assisted, up to the contents that available for massive access via the Internet. The IT adoption in the education realm has triggered learning with the help of electronic means, which known as e-Learning, such as the use of compact disc with educational contents; classrooms with geographically separated participants (distance learning); and online learning, where the contents are stored in a server which is accessible from the Internet (Moore et al. 2011). The adoption of technology is considered beneficial due to the nature of the present target audiences from the learning contents, which are the millennials, where most of them are digital natives (Okaz 2015). According to an evaluation by Hubackova and Semradova (2016), blended learning is a favored learning style for students.

To deliver the topics to the learners, the use of suitable media can be considered as an inseparable thing from learning. Despite the abundance of resources available online, the main source of information and guidance is still one provided by the lecturer (Gutmann et al. 2015). However, when discussing media, one could not deviate away from communication science. It is found that video-based communication imitates the bonding of in-person communication better than text-based communication (Sherman et al. 2013). On the other hand, in a business-communication study, it is found that the use of multimedia advertising is beneficial to the corporation. Therefore, as also found by Putri and Solfema (2019), the use of various types of learning media affects learning activities positively.

In 2018, a study about student's preference toward learning media in a flipped classroom blended learning setup was conducted by Gozali et al. (2018). The study compared three types of learning media: the first one came in the form of webpages with text-and-images, and the second type was recorded slide show with audio narration from the lecturer; the last media type studied was recorded slide show, now with the lecturer actively explaining the lecture materials. The findings show a relatively similar preference for all three, with a slight difference in achievement. An extended study, with a focus on the access styles, was reported by Sengkey, Paturusi, et al. (2019). The term "access styles" is referring to did the student access to the media? Did one make repetitive access or only once? Was there any part skipped? It was found that the students tend to access the third type of learning media repeatedly. The same authors also reported another study, where they asked the students to assess the same media types. The study reported that the slide-based media commonly have higher scores compared to ones with only text-and-images (Sengkey, Sambul, et al. 2019).

Even though the media comparisons seem already studied thoroughly, there niches and gaps that are not filled yet, and questions that still need an answer. The previous studies already made comparisons between these media, yet they have not addressed the results achieved by students. On the other hand, how strong the correlation between media types, access frequency, the first access made by students, and the students' achievements are not found in those studies. Therefore, in this study, we try to answer how these things are inter-correlated one and another. The next sections are organized as follows: Literature Review presents the state-of-the-art of this study, next in Methodology, we present the detailed information regarding how the study took place; next in Results and Discussion we present the findings as well as results of statistical comparisons between the parameters under study. Last, in Conclusion, this paper is concluded.

Literature Review

Learning Media

The word "media", which is the plural form of "medium" (Lister et al. 2009). Medium means an intermediary or a mean, which is used to convey something. As described earlier, in a study about the implementation of rich media (multimedia) in a commercial web, it is found that the use of such media yields higher trust from the visitor (Appiah 2006). Respondents in research about communication means (Sherman et al. 2013), testified that video chats have a higher impact on their bonding, and compared with audio chat and text-based chat (instant messaging).

In education, learning media is a means to convey messages, which are the educational contents or learning materials, where the goal is the learning process to happen (Nurseto 2012; Susilana and Riyana 2009). According to Kosasih and Angkowo (2007), optimal learning media will stimulate students to learn. In a study of the participants of the *Paket B* program, the variation in learning media used may lead to the more active involvement of the students (Putri and Solfema 2019). To the extent of an interesting learning media, the systematic planning of the learning media use must implement the VISUALS (Visible, Interesting, Simple, Useful, Accurate, Legitimate, Structured).

With the development of IT, then come a higher chance of developing more varying and interesting learning media. Within the last decade, multimedia-based learning media have become something that is commonly developed and adopted. The experience of Hadibin et al. (2013) in implementing interactive multimedia-based learning media for a vocational high school proves that the use of such media increases the learning interest of the students so that they were not easily getting bored. On the other hand, from the perspective of the educator, the availability of the media is considered helpful. In another study, where the researchers used Adobe Flash to develop an interactive learning media, the findings are also positive, as indicated by the students' ability to think more critically (Gayatri et al. 2018).

IT-Assisted Learning

IT-assisted learning has been existing since the 1960s, started with Computer Assisted Instruction (CAI) until the present development such as Massive Open Online Course (MOOC), Small Private Online Course (SPOC), Little Open Online Course (LOOC), and Distributed Open Collaborative Course (DOCC) (Aparicio et al. 2016). Even only from the terminologies, it can be inferred that the utilization of computers and the Internet to support learnings are coming to a point where the learning path becomes adaptive (self-paced), open online, distributed, and collaborative. According to a study that involved Indonesian and Mongolian higher education institutions, IT-assisted learning has a huge potential, especially when implemented in undergraduate and postgraduate course-based programs (Usagawa and Ogata 2015). Now, with the availability of the Learning Management System (LMS), such as MOODLE (Dougiamas and Taylor 2003), the technical obstacle in implementing this type of learning is reduced. Even with the availability of the well-known LMS MOODLE, still, some studies try to develop LMS by using PHP frameworks, such as CodeIgniter, as reported by Putri (2018). These potentials are proofed to a very beneficial during a global pandemic. For example, Sengkey et al. (2020) utilized mixed platforms, LMS and Google Colab to deliver an activity-based of Probability and Statistics course during Study from Home (SFH) time. However, the implementation itself is not free from challenges. A literature study by Aini et al. (2020) found that either students and instructors have barriers to develop and access an online course, especially in terms of connectivity and ICT skills.

The evaluation of a blended-learning course that was designed with instructional model Analysis, Design, Development, Implementation, and Evaluation (ADDIE), that was implemented in a public university in Indonesia shows a positive impact on learning motivation and achievement, due to the possibility of self-paced learning (Paturusi et al. 2012). The extent of the study found that blended-learning brought enhancements to students' performance and learning achievements, and on the other hand, the students had more satisfaction with it (Paturusi et al. 2016). In another study by Setyaningrum (2018), blended learning helps students to have deeper conceptual knowledge, due to the possibility to access the learning contents repeatedly, especially ones that presumably difficult. The same author also studied the educator's perspective on blended learning implementation. The result shows that the educators, especially ones that younger and/or hold a higher degree, have a positive perception toward it (Setyaningrum 2016). A study on the user acceptance of e-Learning suggests that the e-Learning characteristics as a major factor that influences adoption by the lecturer (Suarta and Suwintana 2015).

Learning media cannot be separated from the learning process itself, even so in IT-assisted learning environments. Technological advancements had made learning media in digital format available as demonstrated in previous studies (Gayatri et al. 2018; Hadibin et al. 2013). A study by Abuloum et al. (Abuloum et al. 2019) even found that the students have a higher preference for digital textbooks than the conventional ones. It is even better for students with prior engagement to online learning, due to the higher level of motivation in online courses (Wang et al. 2013). In regards to performance, the findings

of Hart et al. (2019) shows that students tend to perform better in online courses. Aligned with Wang et al. (2013), Hart et al. (2019) also found that prior experience is a benefit.

Former studies, (Gozali et al. 2018; Sengkey, Paturusi, Sambul, et al. 2019; Sengkey, Sambul, et al. 2019) were done by using questionnaires to collect responses from students. Another work by the same authors made use of the activity log available from the LMS to evaluate pre-classroom students' behavior, in terms of media access, in the same class setup as the earlier papers. The study concluded that the students mostly access the text-and-images first rather than the other two (Sengkey, Paturusi, and Sambul 2019). In a later study, where the authors involved more students and courses, they found that text-and-images media were the most frequently accessed yet the slide show with recorded narration mostly gained the earliest accesses with statistically significant differences than the other two (Sengkey, Paturusi, et al. 2020).

Methodology

Locus and Respondents

The research reported in this article adopted the same method as used by studies in this particular field (Gozali et al. 2018; Sengkey, Paturusi, and Sambul 2019; Sengkey, Paturusi, et al. 2020; Sengkey, Paturusi, Sambul, et al. 2019; Sengkey, Sambul, et al. 2019). Moreover, parts of the data discussed in this article were discussed in the last study (Sengkey, Paturusi, et al. 2020). The data came from a course with code IFN304, Network Communications that was held in the fall semester of 2019. This is a 5 credits course, held in the 3rd semester on the Undergraduate Program in Informatics, Universitas Sam Ratulangi. Due to its credit, then this course is scheduled twice a week, on Tuesday and Thursday. There were 44 students enrolled in this course when the data were taken. These students have former experience with e-learning environments and the LMS used in this research. Besides that, since they are IT students, they are also considered to possess the skills required to use e-learning fluently.

Media Types and Codes

As described earlier, there were 3 types of media used, as adapted from the previous studies (Gozali et al. 2018; Sengkey, Paturusi, and Sambul 2019; Sengkey, Paturusi, et al. 2020; Sengkey, Paturusi, Sambul, et al. 2019; Sengkey, Sambul, et al. 2019). Therefore, we also adopted the same codes/abbreviations, which are: TIM for learning media that consists of text-and-images only; SAD for a recorded slideshow with the audio narration from the lecturer, explaining the contents; and VID, which is similar to SAD, but this one with the lecturer appear in-frame, explaining the contents.
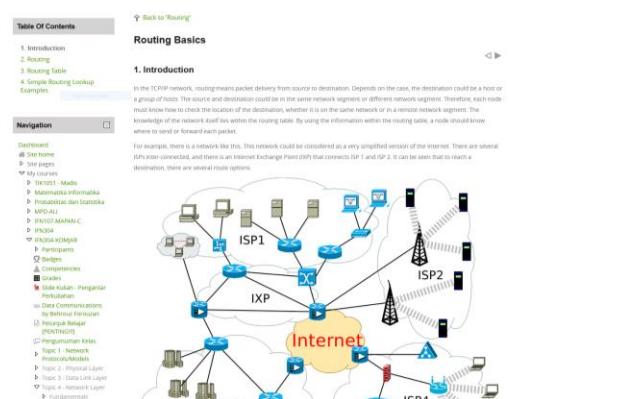

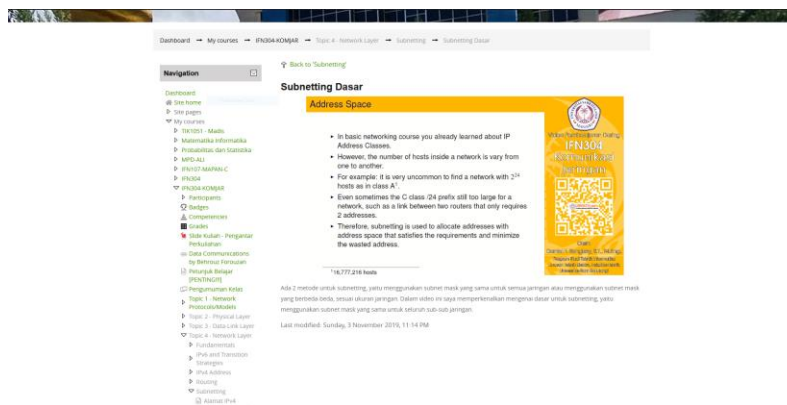**Figure 1. An example of text-and-image (TIM) learning media, as shown in the LMS**

Figure 2. An example of the recorded slide with audio narration (SAD) learning media

Figure 3. An example of the learning media of the recorded slide that has the lecturer appears inside the frame (VID)

TIM media came in the form of webpages, accessible from the LMS. Since video-based media are taking a lot of space, the SAD and VID media were uploaded to a third-party video sharing site and then embedded inside the LMS. The examples of TIM, SAD, and VID are shown in Figure 1, Figure 2, and Figure 3, respectively.

Lectures, Sessions, and Media

To achieve justifiable results, and avoid bias, the study was applied to six lecture sessions, wherein each session all media types were used in a different order. It means, in each session, the topic was broke-down into three parts (modules), where each part will be exclusively delivered by using one of the media studied. Another measure that was taken to avoid student's bias, is randomizing the permutation of the media sequence for each session. We even went further by using a script in R language to free the randomization from human intervention. The schedule is shown in Table 1.

Parameters, Boundaries, and Data Sources

As described earlier, four parameters studied in this research: 1). media types; 2). access frequency; 3). the number of hours the first access was made toward a particular learning media, relative to the scheduled lecture; 4). Students' achievements. The media were provided by the lectures and made available in the LMS. The access frequency and the time of the first access are obtained from the activity log, available from the LMS. This log contains all activities made by all participants, lecturers, students, or even guests, including the timestamp for each activity. Therefore, several additional steps were done to clean this dataset from unneeded data, and transform it into a tidied format. The cleaning steps are filtering out activities that were not done by students, transforming the timestamps to "%d/%m/%y

%H:%M" format, and then extracting the log lines for each module. After that, in each module, the difference between the scheduled lecture and the first access made by each student was extracted by subtracting the former with the later numbers.

Table 1. The lecture sessions, modules, and media type used for each sub-topic

Session (Lectures)	Modules	Media Types			Session (Lectures)	Modules	Media Types		
		TIM	SAD	VID			TIM	SAD	VID
1	1.1	▓			4	4.1	▓		
	1.2		▓			4.2			▓
	1.3			▓		4.3		▓	
2	2.1		▓		5	5.1			▓
	2.2			▓		5.2		▓	
	2.3	▓				5.3	▓		
3	3.1		▓		6	6.1			▓
	3.2	▓				6.2	▓		
	3.3			▓		6.3		▓	

To obtain the students' achievements, for each lecture there was an offline test held in the class as shown in Figure 4, during the first 30 minutes of the lecture. Each test had 15 multiple-choice questions, five for each module (that was delivered by a certain media). The questions were designed at C1 or C2 levels of Bloom Taxonomy. Later, the number of correct answers or later known as scores were tabulated and merged with the tidied log, into a table as shown in Figure 5.

Figure 4. Students working on the test in one of the scheduled lectures

Figure 5. Screenshot of tidied data synthesized from the course log and the number of correct answers for the respective session and media, shown in the RStudio window.

As previously done by Sengkey et al. (2020), this study also adopts the limitation for the first access time. As this course was scheduled twice a week, hence if a student accessed the media long after the scheduled lecture, it should be considered as an improper act. Therefore, for this study, we limit the first access time to no later than 72 hours (three days) after the scheduled lecture. Late access is still accommodated up to 72 hours due to the consideration of the load from other courses, the possibility of connectivity issues, and some other obstacles that might happen. Regarding the representation of the number, since we concern with the number of hours before the scheduled lecture, then late access (after schedule) is represented with a negative number, and vice versa, the number of hours before the scheduled lecture is represented with a positive number. Later, for all statistical tests, we use 90% confidence level ($\alpha = 0.1$).

Results and Discussion

Access Frequency

Figure 6 shows the boxplots for the access frequency of each media, grouped by scores. One thing that is clearly shown in the distribution of access frequency tends to shift to the right side when the score grows higher. Another thing that visible is the presence of outliers. In some cases at the higher scores, there are outliers at the right side of the boxplots, marking extremely frequent access, compared to the common distribution. The general trend for each score group is similar to one discussed in the previous publication, where TIM came as the significantly most frequently accessed media, while the other two, despite the higher access tendency for SAD, the difference is not significant, compared with VID (Sengkey, Paturusi, et al. 2020).
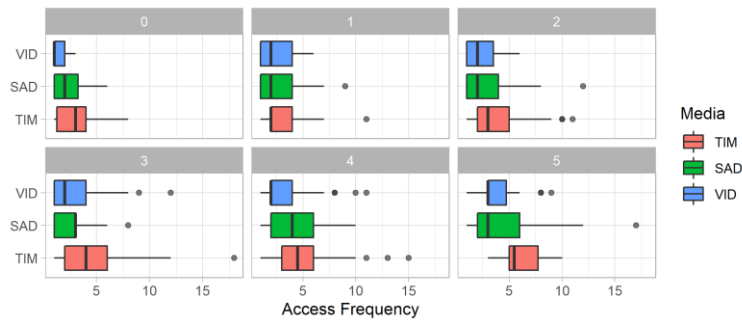
Figure 6. Boxplots of access frequency for each media type, grouped by scores

First Access Time, Relative to the Scheduled Lecture

The first access time as subtracted from the scheduled time for a particular lecture, where the respective media are used shows the media that accessed earlier. This parameter, grouped by the score is shown in the boxplots in Figure 7. The trend of early access gained by SAD in each box of the score is also similar to the general comparison done in the previous publication (Sengkey, Paturusi, et al. 2020). The runner-up is TIM, although the difference is not statistically different from VID.
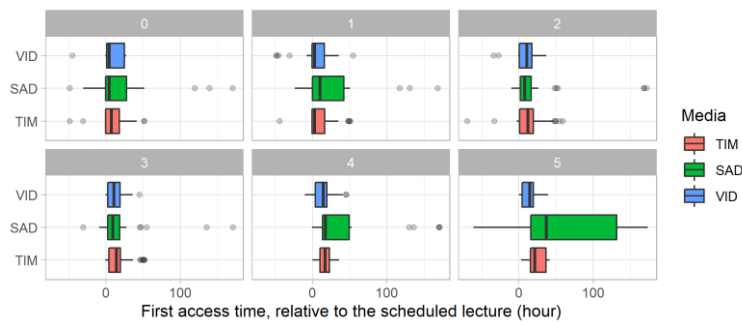

Figure 7. Boxplots of the number of hours the first access was made toward a particular learning media

Correlation

Even though there were comparisons of some of the parameters discussed in the previous publication (Sengkey, Paturusi, and Sambul 2019; Sengkey, Paturusi, et al. 2020), and the score-grouping done in previous subsections already give some insights about the correlation, however without a proper method of comparison, the inference could not be precise. Hence, to appropriately calculate the correlation between each parameter, a heterogeneous correlation calculation was done by using the polycor software package (Fox 2019), in GNU R version 4.0.2 (R Core Team 2020). In this calculation, the media is assumed as an ordinal variable, where VID is the highest and TIM is the lowest. The correlation is calculated with Maximum-Likelihood Estimates with complete observation, which means all non-complete observations were not included in the calculation. The results are plotted as a correlogram, as shown in Figure 8.
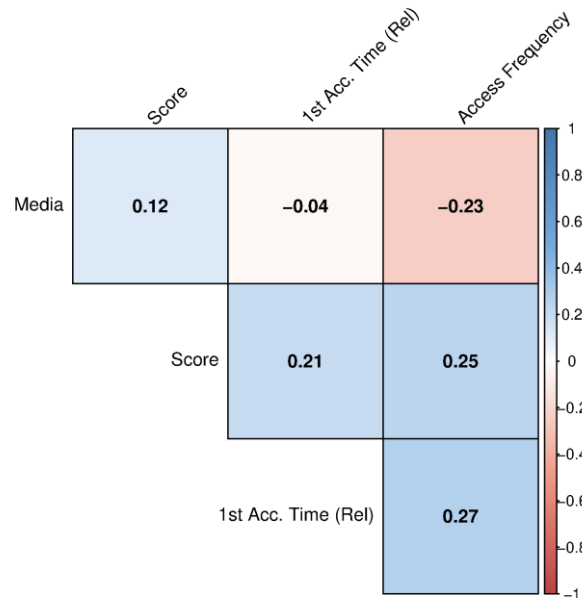
Figure 8. A polychoric correlogram, showing the polychoric correlation coefficients between parameters studied in this research (n = 594)

Table 2. Type, Standard errors, and p-value of bivariate normality of the correlation

	1st Acc. Time (Rel)	Media	Access Frequency	Score
Media	Polyserial 0.043 < 0.001***			
Access Frequency	Pearson 0.038 < 0.001***	Polyserial 0.044 < 0.001		
Score	Pearson 0.039 < 0.001***	Polyserial 0.045 0.023*	Pearson 0.039 < 0.001***	

From Figure 8, it can be inferred that generally, the parameters are positively yet weakly correlated, except for Media and the student-access variables where the correlations are negative. It means the complexity of the media used is inversely proportional to the access. Yet in terms of achievement, it shows a slightly positive influence.

The access parameters, whether the earlier the access or the frequency, both show a stronger correlation with the achievement. The directly proportional relation between the earlier access and the frequency is self-explainable. Regarding these access variables and the achievement, the correlations can be inferred as the more time before the lecture gained access toward the media, the higher the achievement. This finding is aligned with the general conclusion from another study that reviewed the effect of time on students' achievement (Yeşil Dağlı 2019).

Media and Students' Achievement

Students' achievement is one thing that is commonly used as an indicator of a successful education. Therefore, despite the weak positive correlation between the media types and students' achievement,

this subsection provides a further discussion regarding these two parameters. Figure 9 shows boxplots of the number of correct answers (score), which denotes the students' achievement, in each media type. As can be seen, the distribution of the scores in each media types almost similar, especially the medians of the SAD and VID. Yet, these boxplots also show that the score from the SAD media has a higher variance, as can be compared by the length of the boxes.
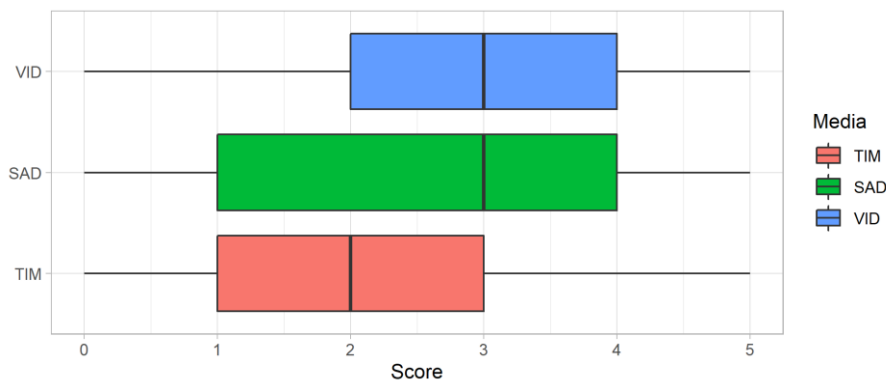

Figure 9. Boxplots of the score (students' achievement) for each type of media

The statistical summary in Table 3 shows the quantitative trend of what is illustrated in Figure 3. According to these numbers, there is a tendency for better achievement by the VID media, as can be compared from the Q_1, mean, and median values. On the other hand, as described earlier, the achievement of SAD is more varied than the other two, as can be seen from the standard deviation.

Table 3. Statistical summary of the score for each media type

Media	Min.	Q1	Mean	Median	Q3	Max.	Std. Dev.
TIM	0.00	1.00	2.37	2.00	3.00	5.00	1.40
SAD	0.00	1.00	2.73	3.00	4.00	5.00	1.60
VID	0.00	2.00	2.78	3.00	4.00	5.00	1.48

We extend the study by applying inference statistics tests to gain a more robust understanding and conclusion toward the phenomenon. Since there are three media types, hence to compare the students' achievements, a multivariate test must be done. Hence, to decide the proper method, we started with the distribution normality test for the scores in each media type. The test used is the Shapiro-Wilk test and the result is presented in Table 4. The null hypothesis for this test is the data is normally distributed, therefore, as can be seen from Table 4, the p-value for each media is far below the defined alpha, and it can be concluded that the data are not normally distributed. Since the data are not normally distributed, further tests must be done with non-parametric methods. For the multivariate test, we used the Kruskal-Wallis test. The result is shown in Table 5. With the p-value equals 0.0155, then it can be inferred that at least one group has a different distribution, therefore a post-hoc test was carried out by using Dunn's test with Bonferroni adjustment. The result is shown in Table 6. The first line in each cell shows the mean difference between compared groups, which is calculated from the mean of the group in the row subtracted by the mean of the group in the column. This result strengthens the assumption that the use of VID yields better achievement. Based on the p-values, it can be seen that the differences between these three groups are statistically significant at a 90% confidence interval. The mean differences suggest that VID yields the highest achievement, and TIM is the lowest one.

Table 4. Results of the Shapiro-Wilk test for distribution normality of score in each media type

Media	*W*	p-value
TIM	0.936	< 0.001***
SAD	0.917	< 0.001***
VID	0.928	< 0.001***

Table 5. Result of the Kruskal-Wallis test on the score

Variable	*H*	Degree of Freedom	p-value
Score	8.34	2	0.0155*

Table 6. Results of the post-hoc test using Dunn's method with Bonferroni adjustment for the score comparison between each media type

Row Mean-Col Mean/ p-value	SAD	TIM
TIM	-2.314003 0.0620*	-
VID	0.426171 1.0000	2.638141 0.0250*

The findings in this study may bring insights to practical aspects, mainly for higher education institutions and/or instructors who seek to develop online courses. Since earlier access brings better achievement, and the choice of the media type is influencing the achievement, instructors are suggested to use video-based learning media upon preparing an online course. However, since video-based media requires more network bandwidth, the instructor must take into account the available and affordable resources of the students.

Conclusion

The study on learning media is an important matter in education as thoroughly discussed by literature. In the age of Information Technology, the advent of various methods of IT-assisted learning bring forth more options and types of media that can be used. In this study, we evaluated three types of learning media and the correlation with student access behaviors (the first time accessed made and the access frequency), and students' achievement. We found that these parameters are positively correlated, except for the media and the access behaviors. Regarding access frequency and the early access (the first time a student accessed a certain media), as expected, with more frequent access and the sooner the media accessed, the student tends to have better achievement on the evaluation.

In terms of the influence of certain media types on students' achievement, an important matter that we found is the learning media with the appearance of the lecturer yields better achievement, followed by the recorded slide show with audio narration. Learning media that only consists of text and images yields the lowest achievement. Therefore, in the future, this factor should have a major intention when an educator designing a blended learning implementation.

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Evaluating User Experience of a Mobile Health Application Halodoc using User Experience Questionnaire and Usability Testing

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Abstract

This paper aims to evaluate the user experience of a mobile health application called Halodoc to keep the user using the application and keep from losing a potential source of revenue for Halodoc. Halodoc is one of the companies that use the internet to provide health services for its users. Halodoc has services such as features for consultation with doctors, online medicine purchases, and hospital appointments. Halodoc's vision is to simplifying healthcare, but there are still many complaints and negative reviews about Halodoc on Google play store and Apple store about the usability. This paper uses a mixed-method approach using User Experience Questionnaire (UEQ) and Usability Testing. The results of the analysis were used as a reference for making the improvement designs. The results of the UEQ evaluation showed accordingly to the UEQ benchmark already a good level of UX. However, the usability test uncovered some concrete areas for improvement.

Keywords: Mobile Health (mHealth), Usability Testing, User Experience Questionnaire, User Interface, User Experience.

Introduction

Computer and internet technology are solutions to many problems and needs related to the effectiveness and efficiency of a procedure or activity. Companies in the health sector started to implement computer and internet technology in their operations, they changed their activities from an offline concept to an online concept (Yani 2018). Halodoc is one of the companies that use the internet to provide health services and medicines for its users, this application operates in Indonesia with a valuation of more than US $ 65 million (Crunchbase 2020). Halodoc has complete services such as features for consultation with doctors, online medicine purchases, online laboratories, health articles, making hospital appointments, and an assessment feature for COVID-19. Halodoc is available for Android and iOS, it

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has a website that can be used to run its features and have two language can be used, English and Indonesian, depends on the language setting on the users' phone. Halodoc also collaborates with pharmacies, hospitals, medicine distributors, specialist doctors, nurses, and medical equipment suppliers to support the 'Health Store (*Toko Kesehatan*)' feature. This service helps users to buy medicines or medical devices or household health supplies (Halodoc 2021).

Halodoc offers simplified healthcare to millions of people in Indonesia via the internet. Halodoc's main service is to provide easy access to health through an online application and simplifying healthcare, especially in Indonesia. Halodoc already partnership with more than 20 thousand doctors and more than 4 thousand pharmacies in Indonesia. Meanwhile, in terms of users, Halodoc claims that there are around 18 million active users using their platform, but it is still not enough to achieve their goals to simplified healthcare to millions of people in Indonesia via the internet, they have intention to fix things that make health services have a long waiting time; such as documentations, administrative costs, and matters relating to other medical services (Isna 2020). The number of users, growth of the user base, and number of transactions in the application are the main factor for Halodoc to keep their business. Without users and transaction activities in the application, the company will be hampered to do their activities and will lose potential sources of income. Initial observations were made on user reviews on Google Playstore and Apple Store, there are still many users who give a one-star rating with negative reviews. Incomplete pharmaceutical information, pharmacy supply that is too far from the user's location causing long delivery times, and unclear price information are the negative reviews on Halodoc application that can make the application not being able to meet user expectations to provide health services from Halodoc.

The World Health Organization (WHO) explains that health facilities in the form of technology (mHealth) need to carry out continuous evaluations to increase their effectiveness, efficiency, and user satisfaction (World Health Organization 2011). The term "health technologies" refers to the application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures, and systems developed to solve a health problem and improve quality of life (World Health Organization 2011). Perception of ease of use of applications can influence a person to use health applications (Zhao et al. 2018).

The ISO standard ISO 9241-11: 2018 refers to usability testing as a method to improve the quality of a product concerning effectiveness, efficiency, and user satisfaction. Research by Hinchliffe and Mummery in 2014 examined usability techniques for improving a health promotion website (Hinchliffe and Mummery 2014). The results showed that usability tests can identify improvements from the user's point of view and can be used for the redesign of the site. Meanwhile, to measure the experience felt by users can use the quantitative method of the User Experience Questionnaire (UEQ). UEQ is a method that is easy to apply, valid, and reliable to complement data from other evaluations with a subjective quality assessment (Laugwitz et al. 2008). From the research conducted by Arefe Heshmati et all, the UEQ questionnaire is free and possible to use in all medical informatics applications (Heshmati et al. 2021), it means UEQ can be applied on mHealth to measure the UX score. Based on the previous research, this research can contribute by combining the two methods used to solve problems of effectiveness, efficiency, and user satisfaction, UEQ is used for quantitative methods and usability testing for qualitative methods, so that the results of these two methods are expected to enrich the results of this research.

Based on user complaints through reviews on the Google Playstore and Apple Store regarding the Halodoc application, evaluation of the application and user experience needs to be done regularly so that Halodoc does not lose users and their potential source of income, and can meet Halodoc's goals to facilitate access to health for the Indonesian people. This study involved Halodoc users as respondents, especially users of the health store feature to buy health products in Halodoc. The purpose of this study is to analyze and evaluate the user experience of the Halodoc application based on UEQ and usability factors. This study also seeks to provide recommendations and suggestions for improving the appearance of the Halodoc application based on the results of the UEQ evaluation and Usability Testing.

Literature Review

Mobile Health (mHealth) Technology

mHealth is a broad label for a variety of services, and technologies supported by mobile devices, such as smartphones, patient monitoring devices, personal digital assistants, and other wireless devices to improve behavior, health quality, and individual well-being (Lucivero and Jongsma 2018).There are many wearable devices available in the market with apps that can record body movements, generate charts of daily calorie consumption or exercise, and provide health advice and self-management tools for chronic patients, as well as healthcare providers (Lucivero and Jongsma 2018).The use of mobile health information and sensing technology (mHealth) has the potential to reduce health care costs and improve health data logging. These technologies can support ongoing health monitoring at both the individual and population level, encourage healthy behaviors to prevent or reduce health problems, support the self-management of chronic disease patients, increase provider knowledge, reduce the number of health service visits, and provide personalized services. mHealth also accommodates localization of health services and on-demand interventions in ways previously unimaginable (Krishna et al. 2009).

Halodoc

Halodoc is an application and website from Indonesia that offers medical services and equipment. Halodoc application already have 5,000,000+ installs in Google Play Store with almost 300,000 reviews and 131,200 reviews on the App Store in April 2021, with that much of downloads, Halodoc has 18 million monthly active users (Silviana 2020). With the aim of facilitating the needs of a healthcare platform in Indonesia by connecting patients with licensed doctors, insurance companies, laboratories, and pharmaceutical installations into an application (Halodoc 2021). Halodoc has several features and services that accommodate user needs:

1. *Consultation with a doctor*; facilitating Halodoc partner doctors to interact with users via video calls and chat which can be accessed via applications and websites.
2. *Buying medicines*; connected to the GOJEK (ride-hailing application) as a third party that delivers orders for medicines with doctor's prescription, vitamins, and non-medicated medical devices, healthy food and non-medicinal drinks to users.
3. *Hospital features*; helps to search for the hospital according to user requirements.
4. *Lab inspection features*; facilitate laboratory examinations for users who are unable to come directly to the laboratory where phlebotomists (patient blood specimen collectors) work in the laboratory (Halodoc 2021).
5. *Health Shop Features*; provide medical equipment and other needs related to health.

Usability

The international norm International Organization for Standardization (ISO) namely ISO 9241-110: 2006 defines the usability of a product as *the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.*

According to the ISO 9241-110: 2006, *effectiveness* means that users can achieve their goals with the product accurately and completely, *efficiency* means that achieving the goals is possible with reasonable effort, and *satisfaction* describes the feeling that using the product is comfortable and pleasant. To specify these concepts in more detail, the norm defines in addition seven dialog principles. These dialog principles specify properties of a user's interaction with a system that is beneficial to complete tasks, for example, error tolerance or suitability for learning.

Usability accordingly to this definition sets a strong focus on solving tasks or reaching goals with the help of a product or system. Usability on a system is very important so that the system can continue to be used by users. Users will experience the best when using a system that has high usability (Nielsen 2019).

User Experience

In our modern competitive environment, offering good usability is no longer sufficient to be successful. For most activities, there are several products available that have similar functionality and similar levels of usability. Thus, to be better than the competition, other interaction qualities must be considered as well. A well-known statement of Don Norman, an academic in cognitive science, design and usability engineering and a former vice president of Apple Inc. who is also the initiator of user-centered design, is "*If it doesn't feel right, who cares if it works?*" (Norman 2003).

This statement covers the idea that it is important to care also for interaction qualities that go beyond pure usability, i.e., to consider aspects of the interaction with a product that does not relate to the pure tasks or goals of a user. This idea is also covered in ISO 9241-210: 2019 which defines user experience (short UX) as a *person's perceptions and responses that result from the use or anticipated use of a product, system, or service.*

Thus, *s*imilar to the definition of usability, the user experience depends on user group and context of use. But there are several important differences to the definition of usability. User experience is a completely subjective quality. In the center of the definition is the impression of the user. Thus, the researchers must ask the user about his or her subjective impression concerning his or her interactions with the product to measure UX. Another important difference is that user experience is not only influenced by the actual use of the system. The concept also covers the time before the user uses the product (anticipated use) (Hornbæk and Hertzum 2017).

For a UX designer who wants to know what to do to create a good UX for a product or for a researcher who asks how to measure UX the ISO 9241-210: 2019 definition is not very concrete. Therefore, alternative approaches to specifying user experience have been formulated. For example, Sharp et al. (2019) distinguish between two types of product qualities related to user experience:

- *Usability goals:* Qualities of an interaction that are related to the tasks that users need to complete to reach their goals. They correspond to the classical definition of usability. Examples are efficiency, learnability, dependability, or adaptability to name just a few.
- *User Experience Goals:* These are qualities of an interaction that are related to the subjective impression concerning the overall interaction with the product, for example, stimulation (fun of use), novelty, or aesthetic appeal of the user interface. They are not related to working on tasks (Sharp et al. 2019).

User Experience Questionnaire

The User Experience Questionnaire (UEQ) is based on the idea that UX can be measured by considering usability goals and user experience goals. The questionnaire was constructed empirically and 6 scales that represent the most important UX aspects for a larger set of products resulted from the construction (Laugwitz et al. 2008).

The items of the UEQ are semantic differentials with a 7-point answer scale. They consist of a pair of terms with opposite meanings that span a sematic dimension. An example for an item representing the scale stimulation is:

<div align="center">boring o o o o o o o exciting</div>

The 6 scales and the corresponding items are:

1. *Attractiveness*: User's general impression of the product, do they like it or not. Items: annoying/enjoyable, good/bad, unlikable/pleasing, unpleasant/pleasant, attractive/unattractive, friendly/unfriendly.
2. *Efficiency*: User's impression that reaching goals using the product is quick and efficient, the organization of the interface is clear. Items: fast/slow, inefficient/efficient, impractical/practical, organized/cluttered.
3. *Perspicuity*: User's impression concerning ease of understanding how to use the product. Items: not understandable/understandable, easy to learn/difficult to learn, complicated/easy, clear/confusing.

4. *Dependability*: User's feelings about safety and controllability of the interaction with the product. Items: unpredictable/predictable, obstructive/supportive, secure/not secure, meets expectations/does not meet expectations.
5. *Stimulation*: User's impression that it is interesting and fun to use the product. Items: valuable/inferior, boring/exiting, not interesting/interesting, motivating/demotivating.
6. *Novelty*: User's impression that product design is innovative, creative, and catches user's attention. Items: creative/dull, inventive/conventional, usual/leading edge, conservative/innovative.

Efficiency, *Perspicuity*, and *Dependability* are task-related UX aspects (usability goals). *Stimulation* and *Novelty* are non-task-related UX aspects (user experience goals). *Attractiveness* is a pure valence dimension, and it is assumed that the rating concerning this aspect is influenced by the task-related and non-task-related aspects.

The questionnaire format supports participants to immediately express feelings, impressions, and attitudes that appear when using a product. Filling out the questionnaire does not require too much effort from the participants, so the UEQ can be used as an online questionnaire. The reliability and validity of the UEQ was investigated in several studies; see Lauwitz et al. (2008) for details.

Additional information concerning the UEQ can be seen at www.ueq-online.org. This site allows also to download of the handbook, a data analysis tool, and various translations of the questionnaire.

Methodology

Research Design

This study uses a mixed-method approach, where the research uses quantitative and qualitative analysis simultaneously. Referring to Creswell in Ishtiaq research, the quantitative approach is a technique of analyzing and collecting data through predetermined standardized research tools and producing empirical data in the form of a certain number of scale scores (Ishtiaq 2019). In our study, we use the User Experience Questionnaire to collect empirical data concerning Halodoc. Meanwhile, in a qualitative approach to analyzing non-numerical data, the analysis is carried out on the results of usability testing on design alternatives. Such a qualitative method can produce more detailed suggestions for improvements and usability tests and questionnaires are a good method combination because the strengths of both methods complement each other well.

Data Collection Procedures, Population and Sample

Respondents in this study were users of the Halodoc application who had already used and transacted at Halodoc at least once so that it was in line with the initial objectives of the study, namely evaluating the user experience of the Halodoc application. In accordance with the UEQ handbook, there should be at least 20-30 respondents in order to get reliable results (Schrepp et al. 2014). The UEQ questionnaire was given to selected respondents using a purposive sampling method. Data collection was disseminated through social media Instagram, Twitter, and LinkedIn by making announcements regarding the link to filling out the research questionnaire that was linked to the UEQ questionnaire link. We obtained 202 responses, after the data was cleaned by remove duplicates and remove the data that does not match the criteria, we got 96 respondents. Data collection was carried out from November 14, 2020 to November 18, 2020.

To get the best result to know the usability problems, usability testing needs to conduct with 3-5 respondents (Nielsen 2019). Three respondents are recruited in this usability testing that focused on the Halodoc users who ever use Halodoc to buy health products before. The respondents are recruited from the UEQ respondents who are willing to participate in usability testing and eligible for the requirements. Usability testing in this study will be carried out remotely, the findings to be captured in this study are the extent to which the respondent succeeded in working on each task, the problems faced by the respondent, application operation errors, comments, and suggestions for improvement designs. Remote usability testing uses the Zoom application, and the scenarios that will be used in this usability testing are:

> *"You are doing an activity and feel a sudden headache. You are planning to buy one strip of Panadol headache relievers. Please use Halodoc to buy the medicine."*

In this testing, the researcher waiting until the session is complete and then asking questions about the participant's thoughts and actions. The researcher takes notes and follows up with additional questions about their task and asking about suggestions at the end of the session to not interfere with usability metrics. After that, the answer will be coded to clean the data and differentiate every answer or give the same code if the answer are similar. "KUT" words is used to a code name that can can be seen on the Table 1.

For data collection purposes, task scenarios will be needed to guide users in running the application, as well as an instrument to measure the level of effectiveness and efficiency of using the application. Task scenarios are a collection of tasks that must be completed by respondents when using the application (Nurhadryani et al. 2013).

Data Analysis

User research is conducted to find information based on the real situation of Halodoc users, identify needs, the context of use, and specific user needs. Determination of problems and objectives is carried out by observing problems around them, such as user complaints regarding applications used on the application store platform, conducting interviews with Halodoc, and conducting small talk with users of the Halodoc application regarding the difficulties faced. The UX assessment of the Halodoc application in version 8.0 is to find out the UX value of the Halodoc application, especially the Health Shop feature to buy medicines, then analyze what factors can make the UX value in the Halodoc application increase, the results of this questionnaire will become a reference for making usability testing scenarios that will be done at a later stage.

The instrument of quantitative research is a questionnaire that refers to the UEQ guidebook, using a semantic differential questionnaire 1 to 7 with Indonesian language items (Santoso et al. 2016). The application of this questionnaire uses google form and is distributed to respondents. In this questionnaire, apart from the UEQ items, the researcher also added a validation question to validate that respondents were actually Halodoc users, besides that, they also added personal data questions to see the distribution of the questionnaire and demographics can be made from respondents' answers.

Usability testing tries to find an application usage flow or application interface that does not match a good user experience. Participants in the implementation of usability testing are users of the '*Toko Kesehatan*' feature. The ' *Toko Kesehatan*' feature on the Halodoc application enables to buy health products. Then to determine the usability problems, the best result is to experiment with 3-5 respondents (Nielsen 2019). Usability testing was chosen because it would be useful when combined with a survey or quantitative questionnaire, to increase the validity of the data because it clarified the specifics raised in the survey or questionnaire (Zaphiris et al. 2018).

Initial data processing was carried out regarding UEQ data, at this stage, processing was carried out by following the tools provided by the previous UEQ researchers in the form of excel sheets. In this process, the results obtained from the UEQ questionnaire are used, then the data processing of usability testing results is carried out which is also done in parallel with data processing from the UEQ questionnaire. The process of designing an alternative prototype of the Halodoc interaction design is based on the analysis of usability findings. The prototype produced in this research is made with the collaborative design tool called Figma to make it high-fidelity. In the final section, conclusions are made after the results of the initial and final UX values are compared. After that, it can be seen if the design needs improvement and enters the evaluation stage again, or it can immediately enter the stage of achieving satisfaction.

Results

Evaluation Results using the User Experience Questionnaire

Measurement of user experience in the Halodoc application design with UEQ has carried out 96 respondents who entered the criteria with the demographics of 32 male respondents and 64 female respondents, the majority were 20-29 years old as many as 88 respondents, 6 respondents from 30-39 years old, 1 respondent from 40-49 years old, and 1 respondent from 50-59 years old. Meanwhile, from the domicile, there were 84 respondents from Jabodetabek, 2 respondents from outside the Java island, and 10 respondents from the Java island other than the following cities: Jakarta, Bogor, Depok, Tangerang, and Bekasi (Greater Jakarta).

The overall results of the Halodoc UEQ scale are depicted in Figure 1 and 2. The value of each UEQ item can be seen in Figure 1, where the average on the Attractiveness scale is 1,778; Perspicuity 1,810; Efficiency 1.818; Dependability 1,622; Stimulation 1,570; and Novelty 1,211.
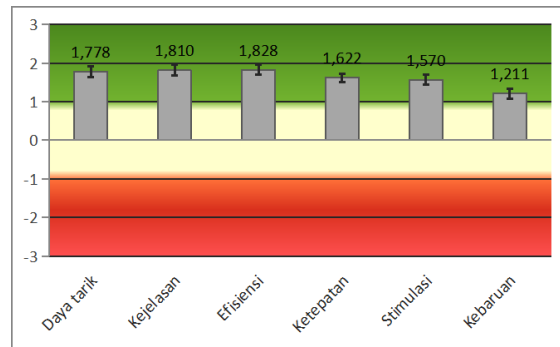
Figure 1. Average UEQ scale values of the Halodoc application design
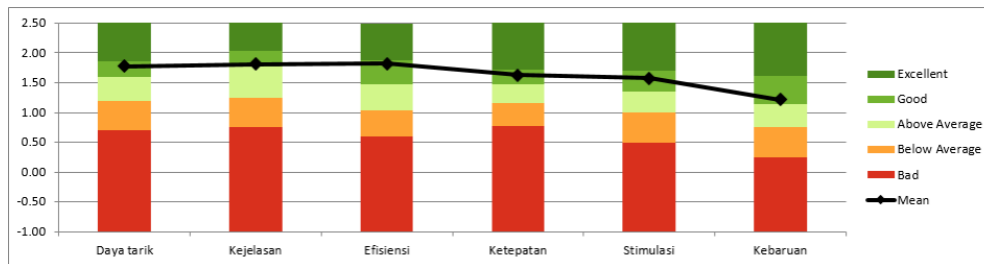
Figure 2. **UEQ benchmark diagram on the Halodoc application**

Figure 1 shows the results of the questionnaire responses on the Halodoc application are all positive user experience (according to the handbook a value falls into the positive range if it is >0.8). This section will be evaluated for the part that will increase the value of the user experience in the next design improvement.

Based on the UEQ benchmark results diagram, the Halodoc application is included in the "good" category. The benchmark contains data from more than 400 different evaluations of products with the UEQ. A value is in the Good category if it is amongst the 25% best results from this benchmark data set. Thus, according to the UEQ, the overall quality of the Halodoc application is already high. However, none of the scale values falls into the Excellent category that corresponds to the 10% best results, thus there is still room for improvement. Therefore, to find out the focus of improvements caused by these deficiencies, an additional usability testing method was carried out.

Evaluation Results using Usability Testing

Based on the evaluation results, the main obstacle of the Halodoc application for purchasing health products is the lack of certainty or clarity regarding medicine purchases, such as information on selected pharmacies, medicine availability, uncertain medicine price information, and a lack of flexible search features. This is supported by the results of the evaluation which state that most respondents expect to

develop a search feature that initially can only take the product name as input, to be developed into several input options such as medicine type, disease name, medicine type filter feature, pharmacy distance, and price. The search button, that is too small, should be enlarged. The results of the conclusions of this usability testing analysis can be seen in Table 1.

Table 1. Conclusion of Usability Testing Analysis

Code	Usability Testing Analysis Conclusion
KUT1	Medicine prices are uncertain, can be expensive or cheap
KUT2	Search feature that is not visible on the home and on the medicine list
KUT3	Not knowing which pharmacy to buy, worried about the delivery time
KUT4	Searching for medicines manually without a search feature makes it difficult for users because there is no sort or filter feature like in e-commerce
KUT5	There are no alternative solutions when medicines are not available
KUT6	The writing on the button goes to pay which creates a misperception

Discussion

Previous Design of Halodoc Mobile Application

The initial view of the Halodoc application, the home display of the Halodoc application can be seen in Figure 3. On the home screen, there is information about the username that is logged in, current location, features found on Halodoc (Chat with Doctors, Health Stores, and Make Hospital Appointments), other services, and health articles.
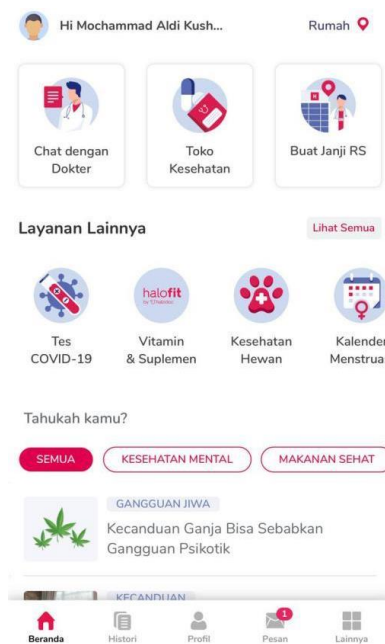

Figure 3. Halodoc Home Display

After clicking the '*Toko Kesehatan*' feature, the initial health shop feature menu will appear which can be seen in Figure 4. In the display, there is the current location, a transaction history symbol, a search feature to upload prescription medicines, a choice of disease categories, and a choice of pharmacies that work with Halodoc. To order your medicine from this screen, you can click on the choice of health products or selected pharmacies, then the screen will display medicine options selected according to the selected product category, as shown in Figure 5. On this screen, there are products with sponsor labels and products that are not sponsored products, there is also a back button on the top left of the screen, and a search button on the top right of the screen.

After selecting a medicine that is on the product category menu display or the selected medicine, the system will automatically display the search for the nearest pharmacy. After successfully getting the

pharmacy of choice automatically, the user will be immediately directed to the cart menu display as shown in Figure 6, the user will get information on the medicine image, medicine label, medicine name, price and quantity ordered, upload prescription feature, delivery address, notes, total price, the next button, and the estimated time of delivery until the medicine is received by the user.

Users can also change the shipping address by clicking the red "change" button, and after clicking the display will immediately appear selecting the address that is on. In the display of the payment options menu that can be accessed when the user clicks the "next" button on the basket view, there is a medicine purchase option for whom, details of prices from medicine prices to Halodoc delivery service prices, there is a section for filling in promo codes, and of course there is a choice of the available payment methods as shown in Figure 7. If the user has selected the desired payment method, the pay & message button will turn red, and when the button is clicked, the user will immediately be directed to the successful payment display if the payment is successful.
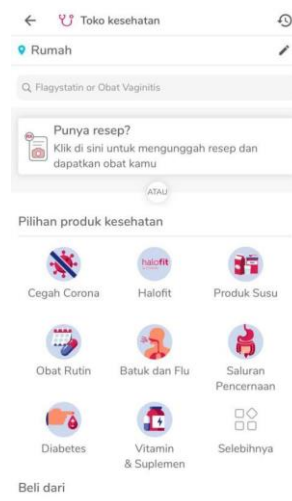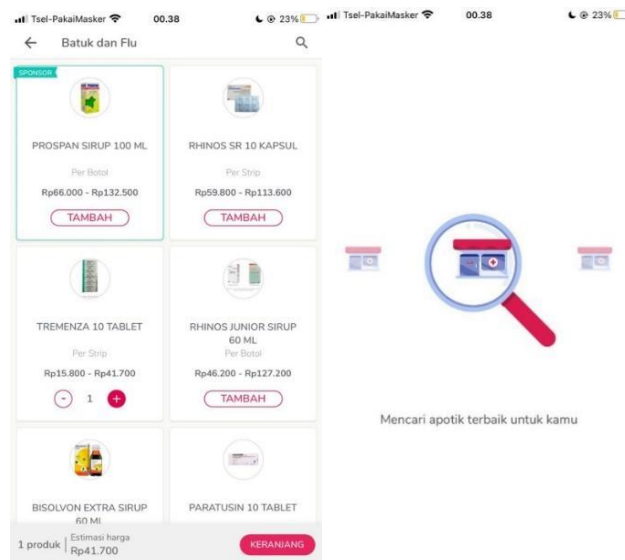

Figure 4. Halodoc '*Toko Kesehatan*' Feature Menu

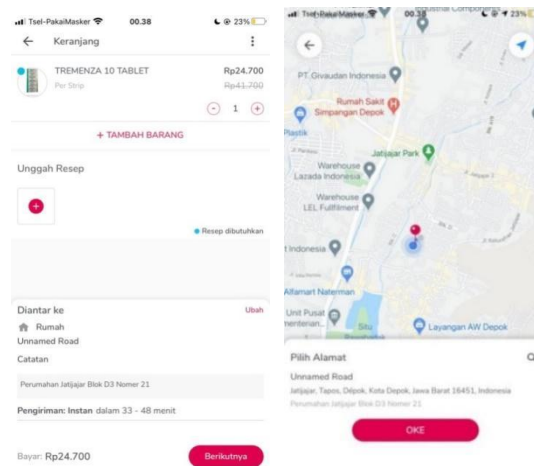**Figure 5. Display of Medicine Category Menu and Pharmacy Search**

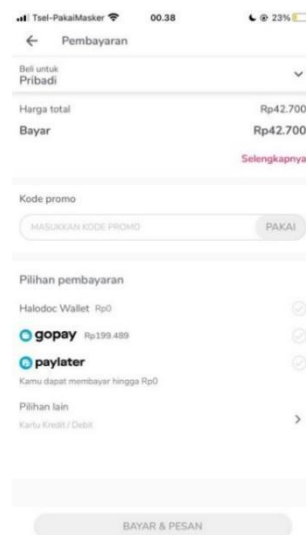**Figure 6. Basket Menu Display and Address Selection**

Figure 7. Payment Options Menu Display

Design Improvement

The improvement in this study is in accordance with the results of the UEQ and usability testing, which can be seen in the previous section. The design improvements will focus on certainty or clarity regarding the transaction, whether it is clarity in delivery, delivery method, and delivery time. There are four display screens that are design improvements. Several displays are intentionally blurred because currently the displays are being considered by Halodoc to be implemented.

1. Home Display improvements: the first recommendation focuses on the home display regarding changes to the search feature that is exchanged for a position with the upload recipe button, this is related to the results of usability testing analysis with the KUT2 code regarding the less visible search feature, while this feature is very useful for users to select the product they need as shown in Figure 8.

2. Location improvement design, further improvements are made by setting the user's location at the beginning of the phase, when on the home screen, this is intended to encourage users to fill in the shipping address first to avoid address delivery errors, and to help the Halodoc system to determine the exact price of medicines available at the closest location to the user, as well as seeing the availability of the product you are looking for, this is related to the results of usability testing analysis with the KUT1 code as shown in Figure 9.

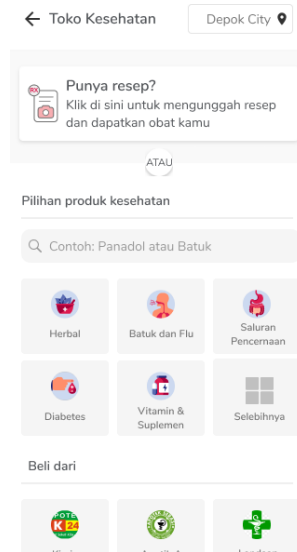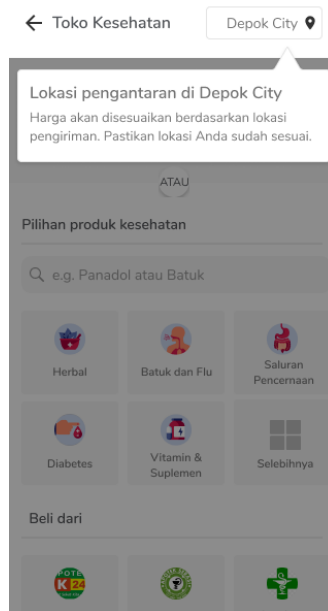**Figure 8. Home display improvements**

Figure 9. Improvements to the Display of Delivery Location Options

3. Health Product List improvement, further improvements to the display of health product lists, in this case in the form of medicines. Improvements are made to the price display, which if it has been set at the nearest pharmacy, the price will be adjusted and can display the appropriate price because it has filled in the shipping address at this stage, as seen in Figure 10. In the upper right corner of the display also remains the address option. Then according to the KUT4 code, the sort and filter features were added to help make it easier for users to use the application to search for health products.

4. The addition of a *Toko Kesehatan* selection feature, further improvements to the addition of a choice of delivery selection features that are more displayed so that users are more aware of adjustable delivery times, it is hoped that users will no longer feel worried about uncertain delivery times and confusion when not available, also it can be an alternative solution when the medicine cannot be purchased. This is related to the results of usability testing analysis with the KUT3 and KUT5 codes and can be seen in Figure 11.
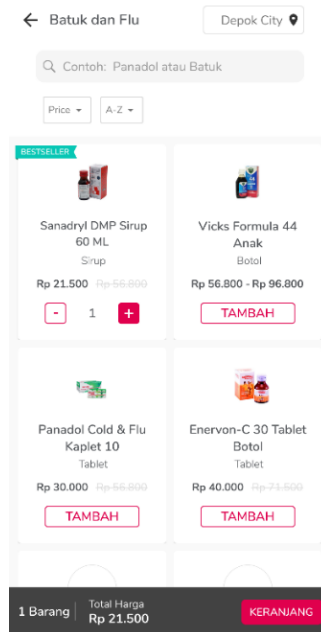
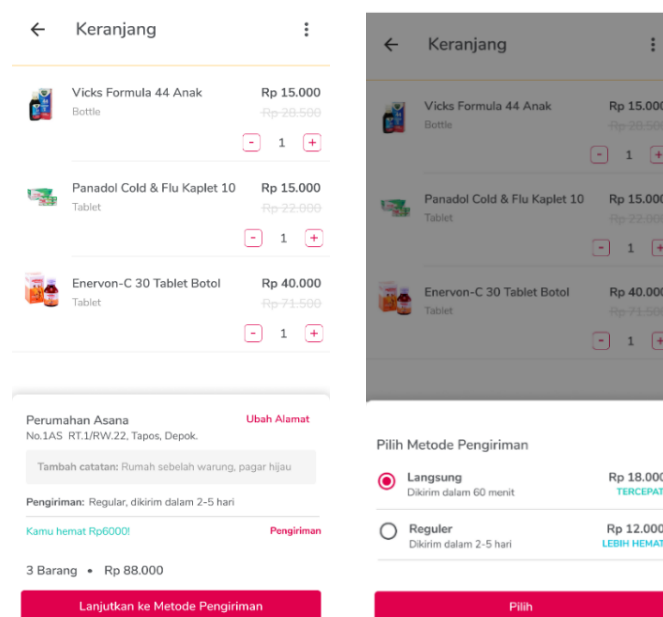**Figure 10**. **Improvements to the Health Product List Display**

Figure 11. Improved Shopping Cart & Shipping Method Selection Display Design

Conclusion

The results of the analysis using the UEQ method obtained an average scale of Attractiveness of 1.778; Perspicuity 1.810; Efficiency 1.818; Dependability 1.622; Stimulation 1.570; and Novelty 1.211. These results explain that the Halodoc application according to the UEQ scale has a positive user experience value because all scales show an average value greater than 0.8. The comparison to the benchmark showed that all scale values fall into the category Good (best 25%), but not into the category Excellent (best 10%). Meanwhile, another finding stated that there were complaints in the questionnaire related to pharmacies that were obtained far from the delivery location, causing delivery to take more time. Based on the results of the evaluation analysis using the usability testing method, the main obstacle of the Halodoc application for purchasing health products is the lack of certainty or clarity regarding medicine purchases, such as information on selected pharmacies, availability of medicines, uncertain medicine price information, and less flexible search features. This is supported by the results of the

evaluation which state that most respondents expect to develop a search feature that initially can only take product names as input, to be developed into several input options such as types of medicines, prices, names of diseases, and requires additional features of pharmacy distance and options delivery. On the other hand, improvements to the button size need to be done, some button display sizes are too small.

This study shows the importance of involving end-users in the observation. UEQ and usability testing will get the recommendation of the solution based on the observation. As a result, it is recommended to use the design alternatives to help Halodoc to achieve their goals of simplifying healthcare for Indonesia and can increase the Halodoc application's user experience score by implementing the suggestion design based on this research.

We acknowledge this research has limitations. Only three participants were involved during the UT. This causes the research findings can be more improved in the number of participants to enrich the data and suggestions. Moreover, this study relies on the survey and user testing as data collection methods. For future research, expected to get more participants for data collections and add UEQ data collection for the new improved design suggestions to get the UX score, so it can be compared to the current design UX score and enrich the results.

Acknowledgement

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