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Users' Intention to Use Mobile Health Applications for Personal Health Tracking

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Abstract

Currently, there are few studies related to the intention to use personal health tracking (PHT) application. This study aimed to analyze factors influencing the intention to use mobile health applications for PHT. The respondents were 516 individuals who had used a PHT application, such as Samsung Health, iOS Health, or MiFit. Data processing was done via using partial least squares–structural equation modeling (PLS-SEM). This study uncovered factors that can affect intention to use PHT applications, including perceived usefulness, social influence, facilitating conditions, hedonic motivation, habits, performance risk, and self-health awareness. It was found that perceived ease of use and self-reported health condition do not affect the intention to use PHT applications. This study can provide guidance on PHT application service providers for ensuring data accuracy, increasing user satisfaction when using the applications, and preventing privacy violation.

Keywords: personal health tracking, telemedicine, health technology, mobile health, Indonesia.

Introduction

The benefits that can arise from modern health technology have a great potential to reduce healthcare costs and prevent health problems that may arise. The Global Observatory for eHealth (GOe) defines m-health as a public health and medical practice supported by mobile devices (World Health Organization 2018). One of the benefits of m-health that can emerge from the presence of m-health in Indonesia is solving the problem of uneven health services. The use of m-health can evenly spread the distribution of health services in Indonesia, because

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problems caused by long distances and poor weather will no longer be salient (Nugraha 2017). At present, with the various potentials and benefits brought by m-health, there are also risks that can arise. One concern that often emerges is information security, especially security in the delivery of information and data storage (World Health Organization 2018). Unfortunately, the policy regarding e-health and m-health in Indonesia is still unclear. In addition, the development and use of e-health and health has not been evenly distributed throughout Indonesia (Nugraha 2017).

m-Health has entered Indonesia in various forms, one of which is applications that are embedded in various types of smartphones that are useful for recording at least one health indicator, such as weight, sports activities, or daily nutritional intake. Based on the World Health Organization (WHO), these applications are categorized as personal health tracking (PHT) (World Health Organization 2018). PHT is the use of cellular applications by clients using telephone-based sensors, health records, and other devices that can be worn by clients to monitor their health statuses.

At present, research on the intention to use smartphone-based PHT applications is not yet available. Further, research related to e-health in Indonesia is difficult to find (Nugraha 2017), and research on the application of m-health to PHT in this country is lacking. Given the number of smartphone users today, the factors that can influence the motivation or intentions of users to adopt the m-health applications for PHT need to be examined more deeply. Knowledge of these factors is expected to be used to serve Indonesian people by supporting their health. It is also hoped that understanding these factors can provide an overview for users and application developers, as well as the government and academics, regarding their strengths, weaknesses, roles, and the influence of PHT applications in Indonesia.

Based on the explanation given above, the present study seeks to address the following research question: What are the factors that influence one's intention to use PHT applications? This research can be useful for m-health application developers, especially in terms of PHT as an illustration of user behavior in Indonesia, and specifically, behavior that influences usage intentions. In addition, this research can provide useful knowledge to consider in developing health-related regulations and policies. In terms of its structure, the remainder of the paper is divided into three parts dedicated to the following topics: methods, results and discussion.

Literature Review

Rubin and Ophoff (2018) conducted research on the factors that influence the adaptation of the use of wearable technology by adapting the second generation Unified Theory of Acceptance and Use of Technology (UTAUT2) model. The Rubin and Ophoff (2018) model has 7 variables that are considered as factors that can influence user intentions, namely performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit. Rubin and Ophoff (2018) found that only facilitating conditions and habits affect users' intentions to use wearable technology for health purposes. Li et al. (2019) has also conducted research on factors that can affect adaptation from the use of wearable technology, but specifically for parents over 60 years of age. Li et al. (2019) using the Smart Wearable Acceptance Model (SWAM). SWAM is a model adapted from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). SWAM includes facilitating conditions, compatibility, social influence, performance risk, perceived social risk, self-reported health conditions, perceived ease of use, and perceived usefulness. Li et al. (2019) found that facilitating conditions, compatibility, self-reported health conditions, and perceived usefulness are factors that can influence the intention to use wearable technology for people aged over 60 years. In addition to the two studies previously mentioned, many other studies have focused on wearable technology and its use as personal health tracking (Clawson et al. 2015). However, until now research on usage intentions in smartphone-based personal health tracking applications has not been available, and has focused more on wearable technology.

The design of the research model and factors in this study are based on several previous studies, namely, the research conducted in (Rubin and Ophoff 2018; Mangkunegara et al. 2018; Li et al. 2019). The factors that have been chosen are due to the results of previous studies and their suitability for the current research. Perceived ease of use and perceived usefulness are chosen because these two factors have often been considered for their influence on technological adaptation based on Technology Acceptance Model (TAM) (Davis 1985). Factors based on Unified Theory of Acceptance and Use Technology (UTAUT2) were chosen for the same reason. However, not all factors from UTAUT2 were included: The factors of performance and effort expectancy were not used because of their similarity with the perceived ease of use and perceived usefulness variables, which are indeed adaptations of these factors (Venkatesh et al. 2012). Other factors, such as price value, are also excluded because there are no costs incurred for the use of the application, which is the object of research. Health-related factors, such as those describing the state of health or user health concerns—referred to as self-health and self-health awareness—are used to enrich the views of this study based on previous research (Mangkunegara et al 2018; Li et al. 2019). From these considerations, a research model is formed, as illustrated in Figure 1.

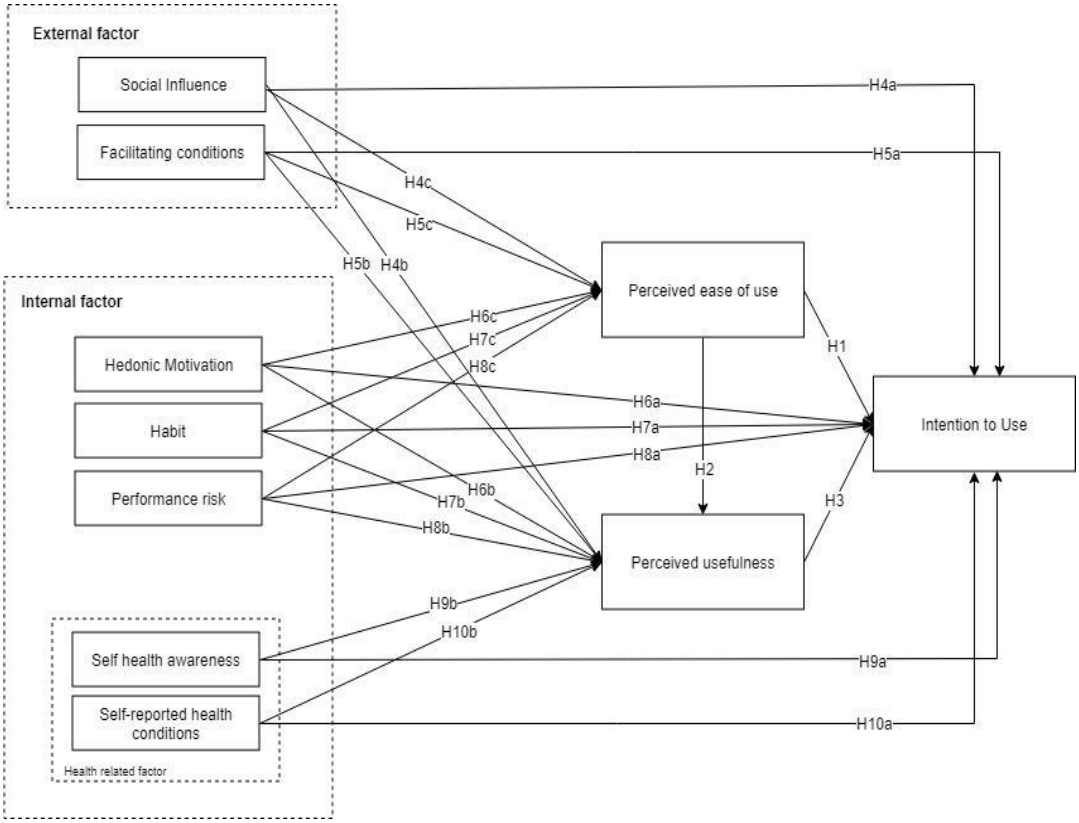

Figure 1. Proposed conceptual model

In TAM, it is said that an application that is easy to use can be easily accepted by the user. In addition, perceived ease of use influences how users perceive the usefulness of the application, because when applications are easy to use, their usability will be easier for the users to understand (Davis 1985). The relationship of perceived ease of use with intention to use and perceived usefulness has been proven in several previous studies regarding PHT (Rubin and Ophoff 2018) and m-health (Zhao et al. 2018).

H1: Perceived ease of use (PEOU) positively influences the intention to use (IU) for PHT applications.

H2: Perceived ease of use (PEOU) positively influences the perceived usefulness (PU) of PHT applications.

Perceived usefulness was defined by Davis (1985) and Chen et al. (2018) as an individual's level of trust in a technology's ability to improve the performance of his or her output. Li et al. (2019) defined perceived usefulness as a reflection of the benefits obtained by users when employing a technology. Several other studies have shown that perceived usefulness has an influence on users' intentions to adopt PHT applications and m-health (Li et al. 2017).

H3: Perceived usefulness (PU) positively influences the intention to use (IU) for PHT applications.

Social influence is defined as the level of trust an individual has toward the people around him or her who consider a technology important to use (Venkatesh et al. 2003; Li et al. 2017). The use of social influence factors is also known to affect the use of mobile applications on mobile devices. This is because the purpose of using mobile devices is connecting various people more easily, thereby strengthening social influence on their use (Yuan et al. 2015).

H4a: Social influence (SI) positively influences the intention to use (IU) for PHT applications.

H4b: Social influence (SI) positively influences the perceived usefulness (PU) of PHT applications.

H4c: Social influence (SI) positively influences perceived ease of use (PEOU) for PHT applications.

Facilitating condition factors have been used in several previous studies to examine the effect on the adaptation or use of health applications, as in research on wearable technology (Rubin and Ophoff 2018; Li et al. 2019) and health and fitness apps (Yuan et al. 2015). Users are more likely to be able to easily adapt to the use of a technology if they can easily access resources supporting its use (Rubin and Ophoff 2018). Good knowledge of the use of applications and the ease of accessing information related to an application can affect a person's level of trust that the application does not require a large amount of physical or mental effort to use.

H5a: Facilitating conditions (FC) positively influence the intention to use (IU) for PHT applications.

H5b: Facilitating conditions (FC) positively influence the perceived usefulness (PU) of PHT applications.

H5c: Facilitating conditions (FC) positively influence the perceived ease of use (PEOU) of PHT applications.

Currently, personal health monitoring applications, which are classified as health and fitness applications, have many entertaining features so that users will be more engaged (Yuan et al. 2015). Entertaining features represent one form of hedonic motivation, because they can provide pleasure. Hedonic motivation has also been proven to be one of the factors influencing technology acceptance and adaptation (Venkatesh et al. 2012; Yuan et al. 2015).

H6a: Hedonic motivation (HM) positively influences the intention to use (IU) for PHT applications.

H6b: Hedonic motivation (HM) positively influences the perceived usefulness (PU) of PHT applications.

H6c: Hedonic motivation (HM) positively influences perceived ease of use (PEOU) of PHT applications.

The use of mobile devices has become a habit in Indonesia, where smartphone use has reached 60% of adults in Indonesia (Hootsuite 2019). Indonesian people also people spend more time using more mobile devices than the average, where Indonesians spend 3.5 hours per day on mobile devices. This shows that the use of cellular devices is a habit in Indonesian society involving repeated behavior (Das et al. 2016). In Venkatesh et al. (2012), it was stated that repetitive behavior can be an ingrained intention, which will then be directed toward an individual's adaptation to use a technology (Rubin and Ophoff 2018).

H7a: Habit (HAB) positively influences the intention to use (IU) for PHT applications.

H7b: Habit (HAB) positively influences the perceived usefulness (PU) of PHT applications.

H7c: Habit (HAB) positively influences perceived ease of use (PEOU) of PHT applications.

Performance risk refers to the extent to which users perceive technology can bring unexpected risks, such as safety risk, functionality risk, and privacy violations (Li et al. 2019). The effect of risk from the use of technology was also applied in previous studies, such as Mangkunegara et al. (2018) and Zhao et al. (2018), which defined it as a factor that explains the risks arising when using m-health applications; these include performance, social, financial, and time risk. m-Health applications for PHT focus on recording users' daily activities. Recording these daily activities can pose risks, such as problems with data security.

H8a: Performance risk (PR) negatively affects intention to use (IU) for PHT applications.

H8b: Performance risk (PR) negatively affects the perceived usefulness (PU) of PHT applications.

H8c: Performance risk (PR) negatively affects perceived ease of use (PEOU) of PHT applications.

Loebnitz and Grunert (2018) defined self-health awareness as a factor that explains a person's awareness of his or her health condition and having confidence to manage it by adopting healthy behavior. Self-health awareness was used by Loebnitz and Grunert (2018) and Deng and Liu (2017) to represent factors that determine one's intentions to adopt healthy behaviors. According to Deng and Liu (2017), the more a person's beliefs about his or her health conditions and ability to manage his or her health increase, the more likely it is for the individual to adopt healthy behaviors, such as considering nutritional intake or seeking health-related information on mobile social media or health applications.

H9a: Self-health awareness (SHA) positively influences the intention to use (IU) for PHT applications.

H9b: Self-health awareness (SHA) positively influences the perceived usefulness (PU) of PHT applications.

In Li et al. (2019), the factor of the self-reported health condition (SRHC) was defined as a reflection of individuals' personal views about their status and health conditions at that time. Based on research in Li et al. (2019), it is known that SRHC significantly affects perceived usefulness and intention to use wearable technology for PHT. However, SRHC did not affect the respondents' perceived ease of use (Li et al., 2019). In addition, Zhang et al. (2017) showed that a good level of health can cause individuals to be more involved in carrying out health-related behaviors.

H10a: Self-reported health condition (SRHC) positively influences the intention to use (IU) for PHT applications.

H10b: Self-reported health condition (SRHC) positively influences the perceived usefulness (PU) of PHT applications.

Methodology

The approach used in this study was quantitative research involving an online questionnaire. The object of this study focused on PHT applications provided by smartphones, namely Samsung Health, iOS Health from the iPhone, and MiFit from Xiaomi. The research carried out in this study consisted of eight stages, namely, problem formulation, literature review, model formulation, instrument preparation, readability testing, data collection, data processing and analysis, and define conclusions and suggestions (Figure 2). Before the questionnaire was distributed, the authors first conducted an initial test by carrying out the readability test. Readability testing is done to determine whether the instrument can be understood by the respondent. The readability test in this study involved nine people who knew about one application between Samsung Health, iOS Health, or MiFit.

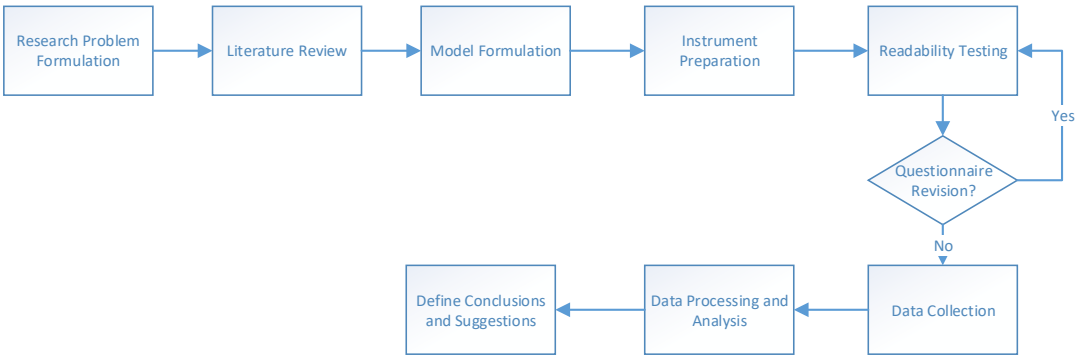

Figure 2. Research Methods

After passing the readability test, the questionnaires were published on various social media channels to reach more respondents. Appendix A described the measurement items used in this study. In addition to social media, we distributed the questionnaires through group chats. Data that had already been collected were processed using partial least squares–structural equation modeling (PLS-SEM) with SmartPLS 3.2.8 software. PLS-SEM was chosen because this research is an exploratory research.

Results

Respondents' Demographics

The questionnaire was distributed online and was available for nearly 2 months, from March 5 to April 22, 2019. The data that were obtained and validated were provided by 531 respondents. Of these, 516 respondents had used the Samsung Health, iOS Health, or MiFit application. The demographic summary of the respondents is given in Table 1.

Table 1. Respondents' Demographics

Demographics		**Number of Respondents**	**Percentage (%)**
Gender	Men	210	40.7
	Women	306	59.3
Age	< 20 years old	127	24.6
	20–30 years old	354	68.6
	31–40 years old	36	5
	41–50 years old	6	1.2
	> 50 years old	3	0.6
Education level	High school	221	42.8
	Diploma	35	6.8
	Bachelor's degree	241	46.7
	Master's degree	17	3.3
	Doctoral degree	2	0.4
Domicile	Greater Jakarta	275	53.3
	Outside Greater Jakarta on Java Island	177	34.3
	Beyond Java Island	64	12.4
m-Health application is used for PHT	Samsung Health from Samsung	222	43
	Health App from Apple	152	29.4
	MiFit from Xiaomi	183	25.4
Activities carried out on the m-health application (can choose more than one)	Sleep time analysis	291	56.4
	Walking distance	433	83.9
	Record of sports time	277	53.7
	Record nutrient intake	85	16.5
	Others	40	7.8

Data Analysis Using PLS-SEM

This stage of analysis involved the specification of the model, testing the outer model, testing the inner model, and finally, testing the model hypothesis. Convergent validity was tested for the value of the outer loadings and average variance extracted (AVE). The value of the outer loadings must be greater than 0.7, and the AVE value is recommended to be greater than 0.5 (Hair et al. 2011). Each indicator in this study fulfilled the requirements by having a value above 0.7. Next, the AVE value was checked, where the AVE value had to be more than 0.5. Details of the AVE value of each factor can be seen in Table 2.

Internal consistency testing can be done by checking the values of Cronbach's alpha (CA) and composite reliability (CR). In this study, these two criteria were considered in testing the reliability of internal consistency (Hair et al. 2016). This value is in the range of 0 to 1, with acceptable values above 0.7, while in exploratory research, values of 0.6–0.7 can still be accepted (Hair et al. 2016). Based on Table 2, it can be seen that all the CA and CR values were already above 0.7. Therefore, the two criteria in the reliability test of the outer model have been fulfilled. This indicates that the outer model has passed the reliability test.

Table 2. AVE, CA, and CR Values

Variable	AVE	CA	CR
FC	0.586	0.765	0.85
HM	0.789	0.865	0.918
HAB	0.776	0.855	0.912
IU	0.841	0.906	0.941
PEOU	0.824	0.893	0.934
PR	0.822	0.784	0.902
PU	0.727	0.875	0.914
SHA	0.633	0.806	0.873
SI	0.631	0.718	0.836
SRHC	0.63	0.711	0.836

Note: FC = Facilitating conditions; HM = Hedonic motivation; HAB = Habit; IU = Intention to use; PEOU = Perceived ease of use; PR = Performance risk; PU = perceived usefulness; SHA = Self-health awareness; SI = Social influence; SRHC = Self-reported health condition

This research is a one-tailed study and uses p-values for testing the hypotheses. For determining whether a hypothesis is accepted, it can be seen that the p-value received must be smaller than or equal to 0.05 or equivalent to a 95% significance level (Hair et al. 2011). The results and conclusions from the hypothesis can be seen in Table 3. Based on this, it can be concluded that there are 5 rejected hypotheses and 17 accepted hypotheses.

Table 3. Hypothesis Testing Results

Hypothesis		***Path coefficient***	***t*-Statistics**	***p*-Values**	**Result**
H1	PEOU -> IU	0.0698	1.5451	0.0613	Rejected
H2	PEOU -> PU	0.0983	2.1846	0.146	Accepted
H3	PU -> IU	0.2496	4.9814	0.000008	Accepted
H4a	SI -> IU	0.0645	1.9672	0.0247	Accepted
H4b	SI -> PU	0.1467	3.8964	0.0001	Accepted
H4c	SI -> PEOU	–0.0946	2.6658	0.0039	Accepted
H5a	FC -> IU	0.1219	3.1608	0.0008	Accepted
H5b	FC -> PU	0.0141	0.3576	0.3604	Rejected
H5c	FC -> PEOU	0.2937	7.3091	0.36×10^{-12}	Accepted
H6a	HM -> IU	0.1458	2.8376	0.0023	Accepted
H6b	HM -> PU	0.2032	4.6257	0.00002	Accepted
H6c	HM -> PEOU	0.3718	8.0647	0.65×10^{-13}	Accepted
H7a	HAB -> IU	0.258	5.6589	0.000001	Accepted
H7b	HAB -> PU	0.2674	6.3518	0.0000005	Accepted
H7c	HAB -> PEOU	0.1087	2.3744	0.0089	Accepted
H8a	PR -> IU	–0.1041	2.5624	0.0053	Accepted
H8b	PR -> PU	–0.1554	4.653	0.00006	Accepted
H8c	PR -> PEOU	–0.1518	3.79	0.0001	Accepted
H9a	SHA -> IU	0.0311	0.8345	0.2021	Rejected
H9b	SHA -> PU	0.2387	6.1567	0.00000003	Accepted
H10a	SRHC -> IU	–0.0295	0.7585	0.2242	Rejected
H10b	SRHC -> PU	–0.0395	0.9819	0.1632	Rejected

Discussion

When research is conducted on new users learning about technology, ease of use is important (Rubin and Ophoff 2018). Further, the use of mobile applications is affected by social influence. Based on data from the respondents who used a PHT application, approximately 50% of respondents learned about the application from social media, friends, or family. The relationship between social influence and intention to use, perceived usefulness, and perceived ease of use needs to be examined more deeply. This is because social influence can have different effects depending on an individual's social role in relation to other individuals. Next, users are also more likely to be able to easily adapt to the use of a technology if they can easily access resources that can support the use of this technology (Rubin and Ophoff 2018). However, external factors included in facilitating conditions are factors that do not affect an individual's view of the usefulness of the application because the surrounding environment can only influence intention and help use the application (Li et al. 2019).

Based on the data collected in this study, approximately 83% of respondents used one of these applications for recording distance (steps per day). Moreover, 56% used an application for analysis of sleep time and 53% for recording time engaged in sports. In the three applications, the feature for recording distance, exercise, and sleep time has targets that can be achieved. Achieving this target is one form of gamification that can lead to feelings of pleasure; in other words, it serves as a form of hedonic motivation (Yuan et al. 2015).

Based on questionnaire data, it is also known that the use of PHT applications has a high percentage of 47%. The repeated use of the PHT application illustrates that habit affects the user's intention to use PHT. This result was in line with Yuan et al. (2015) where usage for health and fitness applications is influenced by habitual usage. Rubin and Ophoff (2018) also finds the same thing that habit is a significantly positive influence on intention to use wearable technology. In addition, with people getting used to using smartphones, the use of PHT applications is seen as easy to use by the users.

The emergence of several risks also causes a negative influence on the views of the usefulness of the application. Based on the results of data from respondents, it is known that the problem that often arises in the use of this application is the data mismatches that sometimes occur. This is one example of a form of risk that has a negative influence on the perceived usefulness of m-health applications for PHT among users. A negative influence of performance risk on perceived usefulness was also found in this study. Further, there was a negative influence of performance risk on perceived usefulness. Therefore, it was concluded that performance risks, such as a data mismatch, slow application, and data security, had a negative influence on the perceived usefulness of the m-health applications for PHT. The same finding was also seen in Li et al. (2019).

The positive influence of self-health awareness on the intention to use was rejected in this study. The same finding was evident in research on the intention to use m-health applications in Indonesia (Mangkunegara et al. 2018). In this study, the hypothesis about self-health awareness and intention to use was not accepted. According to Mangkunegara et al. (2018), the use of the m-health applications in Indonesia is only based on external factors, such as seeking health information and other supporting features, but it does not relate to supporting healthy behavior. In addition, the use of the PHT application was also based largely on its availability on the user's smartphone. Therefore, it can be concluded that, indeed, there was no positive influence of self-health awareness on intention to use.

Further, the research conducted in Li et al. (2019) showed that health condition self-reporting significantly affected perceived usefulness and intention to use in terms of wearable technology for PHT. This result is contrary to the findings of this study, which revealed that self-reported health conditions do not affect perceived usefulness or intention to use concerning m-health applications for PHT. This is also contrary to the claim in Zhang et al. (2017) that a good level of health can cause individuals to be more involved in adopting behaviors to promote health.

Finally, this study has enriched the results of previous research related to the analysis of factors that influence the intention to use PHT applications in Indonesia. Differences in the results of this study can be found in the relationship of several factors, such as the absence of a relationship between perceived ease of use and intention to use. This discovery is different from the findings of Davis (1985), which reported that an application that is easy to use can be easily accepted by users. The practical implications of this study are that service providers must be able to provide services and complete help pages to support user trust as a facilitating condition. In addition, service provider can offer additional information related to health and fitness to enrich the user's knowledge in fields that are suitable for the application.

Conclusion

This study determined factors that can predict intention to use PHT applications, namely, perceived usefulness, social influence, facilitating conditions, hedonic motivation, habit, performance risk and self-reported health condition. From the results of the study, it was also found that approximately 65% of the respondents felt there was a data mismatch in the PHT application. This study has limitations where the respondents involved are more women and respondents located in greater Jakarta. Further research can consider the specific factors related to hedonic motivation and their causes in relation to the intention to use PHT applications, such as their relevance to gamification.

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Prioritizing Critical Success Factors of Requirements Engineering using Analytical Hierarchy Process

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Abstract

Requirements engineering is not as straightforward as asking stakeholders what they want the information systems to do. In most cases, their vision tends to be limited by the status quo. Eliciting a complete set of requirements that fulfil every gap and withstand scrutiny during validation is challenging. Hence, it is important to consider various factors influencing the success of requirements engineering. This paper identifies and prioritizes multiple critical success factors of requirements engineering using the Analytical Hierarchy Process. The initial model was developed from a literature review and validated using evidence from an empirical study. Quantitative data was collected through a questionnaire and then analyzed to rank the success criteria and critical success factors. The results show that user satisfaction is the most important success criterion. Meanwhile, clear definition of project scopes and goals is the most critical factor for the success of requirements engineering.

Keywords: Critical Success Factors, Requirements engineering, Analytic Hierarchy Process, software development, ranking.

Introduction

The role of information systems (IS) in an organization is critical. This technology has been proven effective in accelerating bureaucracy, optimizing resources, reducing costs, and improving decision-making (Zeng et al. 2020). Consequently, the need for IS development is increasing. However, developing good IS is complex and resource-intensive, involving cross-functional or cross-organizational groups. Various factors cause the success of IS development.

IS development success or failure factors are common topics discussed in the literature. Various perspectives, methodologies, and research objects have been applied to research this topic, such as IT project failure factors in Hungary (Aranyossy et al. 2017), outsourced IT project failure factors (Verner and Abdullah 2012), and exploratory studies of IT project failures in emerging markets (Ebad 2018). Apriyanto and Putro (2018) conducted a study to investigate the failure rate of IS projects in Indonesia involving various company sizes, project scales, and project complexity. The study showed that out of the 110 projects studied, only 27% were declared successful. The research also concluded that several factors affect the level of project success, namely the complexity of the system, the size of the company,

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and the size of the project. The highest project success rate was found in low complexity small-scale projects in large companies.

Previous studies have categorized the success factors of IS development projects. For example, Yeo (2002) classifies success factors into process-driven, context-driven, and content-driven. In addition, Sudhakar (2016) divided project management failure factors into six categories: environmental, organizational, team, project, and technology. Meanwhile, Khanfar et al. (2018) classified and ranked the factors into the organization, project management, team, planning, and user categories. They also found that planning is the category of factors that has the highest effect on the success of IS development projects. Planning failures include failure to formulate requirements, unrealistic scheduling and budgets, and cost and time estimates errors. Within the planning category, requirements collection and management is the factor that has the most significant effect for project failure (Khanfar et al. 2018).

Requirements are a statement about system capabilities that all stakeholders must agree upon before modelling (Hussain et al. 2016). Requirements are the source of product development's design, implementation, and validation phases. Compiling requirements by systematically studying, analyzing, and refining users' needs is called requirements engineering (RE) (Hofmann 2013). The main result of RE is called system specification, which is a brief statement of the requirements that the system must meet to fulfil a contract or standard (IEEE 1996). Thus, poor requirements collection and management primarily affect IS development project success or failure (Fricker et al. 2015). Khan et al. (2013) assert that RE is a complicated and crucial phase because unclear requirements are the main reason for IS development project failure. Young (2004) stated that IS development project failures are often related to inadequate, unclear or not well documented requirements, or having excessive expectations. Therefore, RE is an essential component and must be considered in every software development project. Nonetheless, this area is given less attention than it needs. Many projects start with a list of basic requirements, which may not accurately capture the users' needs.

RE has several challenges. The main constraints of the RE processes lie in the tools used, documentation, user involvement, traceability, the adaptation of techniques to the processing context, and the number of sources of requirements (Juristo et al. 2002). Moreover, in specific domains such as the online gaming industry, difficulties in RE include fulfilling market demands, involving genuine users, and meeting non-functional requirements (Alves et al. 2007). These problems increase the chances of software development project failure. Therefore, it is important to identify factors that can reduce or overcome these problems to increase the chances of project success. This study defines these factors as critical success factors (CSF).

Several previous studies have discussed CSFs of the RE processes, such as user engagement and feedback, team member expertise, and organizational culture (Kauppinen et al. 2004; Khan et al. 2013; Shafiq et al. 2020). Although previous studies have explored CSF of RE, CSF ranking needs to be done to see which factors are the most crucial and thus can be prioritized by IS development teams. The relevant factors may significantly improve the requirement coverage and decrease requirements-related problems during software development. However, limited attention has been given to this problem.

Therefore, this study identifies, categorizes, and ranks CSFs based on the significance of their effect on RE success. The goal is to help IS development teams implement best practices by prioritizing the CSFs with the most potential to increase RE success. Therefore, the research question of this study is "What are the most influential factors in determining the success of RE?"

Literature Review

Software Development Life Cycle

Software development life cycle (SDLC) is a method by which software is developed systematically to increase the likelihood of project completion success that abides by deadlines and budgets and has the right quality (Mishra and Dubey 2013). Although various variations exist, SDLC generally includes the following series of activities (Klopper et al. 2007):

1. Understanding the problem through requirements gathering
2. Planning for a solution (system design)
3. Implementing code
4. Perform testing
5. Launching products
6. Maintaining products

Two of the widely used SDLC are Waterfall and Agile. As one of the earliest methodologies used massively, the waterfall laid the foundation for various succeeding methodologies. Waterfall encourages the definition of requirements before implementation (Ruparelia 2010). Agile also emphasizes the importance of RE (Ochodek and Kopczyńska 2018).

Requirements engineering

Requirements engineering is a branch of software engineering that focuses on a computer system's purpose, functions, and limitations. It reflects accurate specifications of the system being developed as the basis for the requirements analysis and validation process against stakeholder needs (Nuseibeh and Easterbrook 2000). In simpler terms, Sommerville (2010) defines RE as the process of searching, analyzing, documenting, and validating the services and limitations of an IS. The collected requirements can be divided into two types, i.e., user and system requirements. User requirements are statements in natural language and diagrams covering what services the system provides to its users. Meanwhile, system requirements are detailed descriptions of a system's functions, services, and operational limitations. The system requirements document, usually called a functional specification, should define what will be implemented and may be part of the contract between the client and the vendor (Sommerville 2010). RE processes consist of a series of activities that are interconnected to produce a requirements document, such as assessing the usability of the system to the business (feasibility study), tracing requirements (elicitation and analysis), and checking whether the requirements meet user requirements (validation) (Sommerville 2010).

One of the leading measures of the success of IS is the extent to which the system fulfils the purpose of its creation (Nuseibeh and Easterbrook 2000). The success of IS development depends on its suitability for its users' needs and the business environment. Carefully identified requirements is a major issue for project success since the cost of correcting errors after launching the system is higher than the costs of remedying similar errors during the requirements analysis phase (Pfleeger and Atlee 1998). Therefore, the RE processes are very crucial in the IS development process.

Criteria of factors affecting the success of RE

Emam and Madhavji (1995) categorized CSF of RE in IS development into five categories, as follows:

- **Cost-effectiveness.** This dimension addresses whether the resources used in RE processes are reasonable. The top three measures for this dimension are cost comparison with RE processes in similar projects, the ratio of the RE costs to overall system development costs, and the number of changes made to the RE documentation.
- **Architectural quality.** This dimension addresses the quality of the designed architecture of the RE processes, e.g., how the architecture represents system and business process purposes.
- **Quality of cost/benefit analysis.** This dimension reflects the ability to analyze cost and benefit from a business perspective. A cost-benefit analysis is a process that is used to estimate the costs and benefits of decisions to find the most cost-effective alternative. RE results provide a detailed and accurate picture of the advantages of building a system against its costs. One of the goals is to predict whether the designed system will provide greater benefits than the costs incurred.
- **User satisfaction and commitment.** This dimension is directly related to the user's appreciation of the services provided due to the RE processes. For example, the extent to which users understand the capabilities of the system and users' willingness to use the system.

- **Fitness to the organization.** In addition to users' needs, the requirements must also be in accordance with the needs and capabilities of the organization. This aspect can be measured by looking at the organization's ability to implement the IS and the suitability of the IS with the organization's strategic orientation.

Factors affecting the success of RE

The factors that drive the success of an activity are usually called Critical Success Factors (CSF). CSF refers to "a limited number of areas where satisfactory results will ensure successful competitive performance for an individual, department, or organization" (Bullen and Rockart 1981). We identified eleven critical success factors of RE from the literature. The summary is presented in Table 1.

Table 1. The Extraction of CSFs of RE from the Literature

Factor	Definition	Reference
Environment & Culture	Supportive organizational environment and culture for carrying out the RE processes	(Khan et al. 2013; Saleh et al. 2021)
Management Support	Active support and encouragement from management to perform RE processes	(Kauppinen et al. 2004; Shafiq et al. 2020)
The organization's technical maturity	The level of the organization's technological maturity in implementing RE processes	(Khan et al. 2013; Shafiq et al. 2020)
Relationship among stakeholders	The relationships between stakeholders that can affect the implementation of the RE processes.	(Khan et al. 2013; Saleh et al. 2021; Shafiq et al. 2020)
Understanding & Awareness	Team members' understanding and awareness of each stage in RE	(Kauppinen et al. 2004; Khan et al. 2013; Shafiq et al. 2020)
Skills and Knowledge	Team's ability and expertise in executing each stage in RE	(Kauppinen et al. 2004; Khan et al. 2013; Saleh et al. 2021)
Training	The RE-related training provided by the organization to the relevant teams	(Kauppinen et al. 2004; Saleh et al. 2021; Shafiq et al. 2020)
Best practices	Executing RE according to best methods and practices	(Khan et al. 2013; Shafiq et al. 2020)
Techniques and tools	The use of certain techniques and tools to support the RE processes	(Khan et al. 2013; Shafiq et al. 2020)
Project's scope & goals	Have clear and complete documented objectives and scope before executing RE	(Khan et al. 2013; Shafiq et al. 2020)
User involvement	Involving users or clients to elicit requirements such as through interviews, surveys, or focus groups	(Kauppinen et al. 2004; Saleh et al. 2021; Shafiq et al. 2020)

Analytical Hierarchy Process

There are several Multi-Criteria Decision Analyses (MCDA) that support decision-making with various criteria, such as Analytic Hierarchy Process (AHP), Fuzzy Theory, and Technique for Order Preferences by Similarity to Ideal Solutions (TOPSIS). For example, Chatterjee and Mukherjee (2013) found that decision-making using the AHP method alone or combined with the Fuzzy Theory always produces the same results. Meanwhile, the TOPSIS method has difficulties compiling a ranking because each factor must be compared to the distance with the most ideal and least ideal conditions (Velasquez and Hester 2013). Therefore, using AHP is considered ideal and effective in making complex decisions.

Analytical Hierarchy Process is a multi-criteria decision-making (MCDM) method that describes the multi-factor problems into a hierarchy or a multilevel structure (Saaty 2001). The first level is the objective, followed by criteria, then sub-criteria (if any), and so on, to the last level of alternatives. These alternatives will contribute positively or negatively to the objective through their impact on the criteria. AHP can elicit a subjective assessment of the importance of each criterion and alternative. They are then examined to determine which variable has the highest priority in achieving the expected goal. This approach of breaking down complex problems by transforming an unstructured situation into smaller parts and systematically arranging the elements allows for effective decision-making. AHP has demonstrated its ability as a practical and effective approach to support complex and unstructured decision-making in various application domains. In summary, the steps to prioritize alternatives based on AHP are as follows:

1. Build a hierarchical structure

    a. Define overall goals
    b. Determine the criteria
    c. Determine the actors involved
    d. Determine the goals of the actor
    e. Determine the policy of the actor
    f. Determine the output (alternative) (Saaty 2001).

2. Setting priorities

    At this stage, the alternatives are compared against specific criteria using the pairwise comparison technique displayed in a matrix. This matrix is used to consistently test and obtain information about all possible comparisons and analyze the possibility of priority change.

3. Performing matrix calculations

    This third step aims to get the value of each criterion and alternative. This calculation is based on the eigenvector/eigenvalue principle. How to compute eigenvalues and eigenvectors can be seen in (Strang 2016).

4. Calculating the consistency ratio (CR) value using the formula shown in equation 1-7. The CR value must be equal to or less than 10% (Saaty 2001). Otherwise, there is an error in the assessment, which requires correction. The consistency ratio value close to zero shows the consistency of the comparison matrix. The formula for the consistency test (Saaty 2001) is as follows:

$$\text{CR} = \frac{CI\ (Consistency\ Index)}{RI\ (Random\ Index)} \quad [1]$$

$$\text{CI} = \frac{\lambda max - n}{n-1} \quad [2]$$

$$\lambda\ max = \frac{\sum VB}{n} \quad [3]$$

$$VB\ (Eigenvalue) = \frac{VA}{VP} \quad [4]$$

$$VA\ (\text{Intermediate vector}) = a_{ij} \times VP \quad [5]$$

$$VP(priority\ vector) = \frac{VE}{\Sigma \sqrt[n]{\prod_{i=1}^{n} a_{ij}}} \quad [6]$$

$$VE(Eigen\ Vector) = \sqrt[n]{\prod_{i=1}^{n} a_{ij}} \quad [7]$$

Note: $\lambda\ max$ is the maximum eigenvalue and n is the number of compared alternatives

a_{ij}: matrix of pairwise comparisons

RI is a random index (Random index) issued by the Oak Ridge Laboratory, as seen in Table 2.

Table 2. Random Index (Alonso and Lamata 2006)

N	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41
N	**9**	**10**	**11**	**12**	**13**	**14**	**15**	
RI	1.45	1.49	1.51	1.48	1.56	1.57	1.59	

Proposed Theoretical Framework of CSF of Requirements engineering based on AHP

This study adopts the hierarchical model of AHP described in the previous subsection to describe the relationship between RE success goal, RE success criteria, and RE CSF resulting in a theoretical framework shown in Figure 1. The first level of the framework is the goal, i.e., the success of RE. The second level is the criteria for the success of RE, i.e., cost-effectiveness, quality of architecture, quality of cost/benefit analysis, client satisfaction, and fitness to organization adapted from (Emam and Madhavji 1995) as explained in the previous subsection. These criteria are a comparison indicator of the alternatives. Finally, the third level is the alternative factors affecting RE's success, as discussed before. These factors are computed and ranked based on their significance to support RE's success.

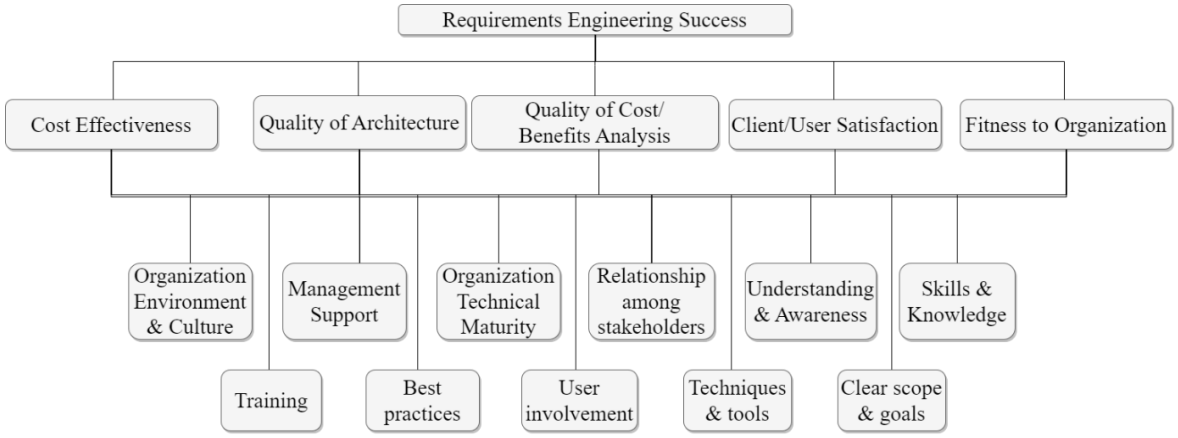

Figure 1. The Theoretical Framework of This Study

Research Methodology

This study uses a quantitative approach to get a broader range of responses in the pairwise comparison model. Data were collected using a questionnaire distributed to respondents working in software development teams and involved in RE processes. The questionnaire is a strategy to collect structured data from a measurable population (Saunders et al. 2016). The selection of the questionnaire was based on the need for pairwise comparison data to validate the proposed theoretical framework.

Previous studies found that the planning stage is the most crucial phase in IS development process (Khanfar et al. 2018) since it requires a lot of analysis and evaluation, determines the resource used and directly affects the end product. Within planning, RE is also resource-intensive (Khanfar et al. 2018). It involves a certain degree of uncertainty since stakeholders may not be able to clearly describe their needs, which may affect the IS development process. This analysis provides a solid foundation for this research's following four stages, as depicted in Figure 2.

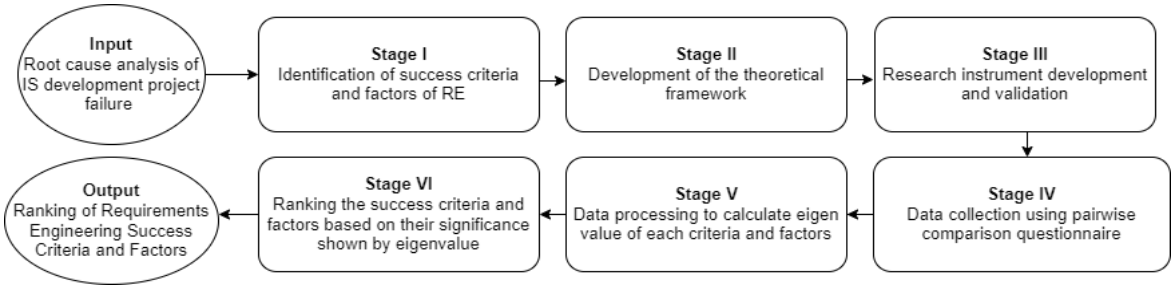

Figure 2. Research Stages

1. Identification of success criteria and CSF of RE from the literature

   This study identifies CSFs from the literature using the Systematic Literature Review (SLR) approach. After formulating the research question, a search strategy was started by first identifying the relevant literature sources based on the platform's suitability for the research topic. This study obtained search results from four sources: IEEE Explore, ACM Digital Library, Science Direct, and Proquest. The keywords used were combinations and synonyms of "Success Factors" and "Requirements Engineering". Papers that fulfilled the following inclusion criteria were included in this study: (1) Discuss the factors that influence the success of RE, (2) Focus on IS development projects, (3) Published in international journals or conference proceeding over the last 20 years, and (5) Written in English.

2. Development of a theoretical framework

   A theoretical framework was developed based on the criteria and factors in the literature review stage. The resulting theoretical framework describes the relationship between criteria and factors by adopting AHP.

3. Research instrument development and validation

   The questionnaire used in this study applied the pairwise comparison method recommended by (Saaty 2001). First, five criteria were compared against each other to determine their significance toward RE success. Similarly, a pairwise comparison was conducted among factors within each criterion. Then, before distribution, a readability test was conducted to ensure that the questionnaire could be understood and completed by respondents. The test was performed by a potential respondent who is a Chief Technology Officer at a start-up company, who was selected due to the respondent's experience and work relevance to the RE processes. Then, the questionnaire was improved based on the results of the readability test.

4. Data collection

   The questionnaire was distributed online to respondents. The purposive sampling approach was taken to select respondents who could provide in-depth and detailed information regarding the phenomenon. Respondents must work in a software development team and be involved in the RE processes. The respondents compared one criterion against another to determine its significance by assigning a value of 1 to 9, as described in Table 3. The output of this stage is data regarding the importance of the criteria and factors to the success of RE.

5. Data processing

   The pairwise comparison data for success criteria and factors were then analyzed using the AHP matrix calculation, explained in the previous section. The weighting is done using Expert Choice 11[2] software as a data processing tool. The output is eigenvalues for success criteria and factors.

[2] https://www.expertchoice.com/2021

The weight of each criterion and alternative was checked for consistency by comparing it with Saaty (2001). The calculation of the consistency ratio (CR) was also carried out using Expert Choice 11 software.

Table 3. Values for Pairwise Comparison Matrix

Value	Definition	Explanation
1	Equally important	Both alternatives have the same contribution to achieving the goal
3	Slightly more important	One alternative is slightly more important than the other
5	More important	One alternative is clearly more important than the other
7	Very important	One alternative dominates or is very important than the over
9	Absolute importance	One alternative has the highest level of importance compared to the other

6. Ranking the success criteria and factors

   The success criteria and factors were ranked based on their eigenvalues that have been declared consistent. The higher the eigenvalue of a criterion or factor, the higher its rank. The researchers also observed the RE practice in the field to validate the results and make notes. Finally, conclusions were made from the findings and suggestions were drawn for further research.

Results and Discussion

Out of 120 respondents, only 28 filled out the questionnaire completely. Nevertheless, the number of respondents obtained satisfied the research requirements with the AHP method because it did not have a minimum data limit (Darko et al. 2018). For instance, Fadli (2013) used AHP and only collected 12 responses. The CR calculation yielded values ≤ 10%, which means that the weight has been consistent so that it can be used as input for the next stage.

Demographic

In terms of industry, most of the respondents worked in the information technology industry, followed by banking and government. In terms of position, the majority of the respondents work as software developers and product managers. Half of them have been working for 2-4 years. More detailed demographic data can be seen in Table 4.

Ranking Requirements engineering Success Criteria

The eigenvalues were calculated for each criterion based on the pairwise comparison matrix. The ranking is then done by sorting them from the largest eigenvalue. As can be seen in Table 5, the criterion with the largest eigenvalue is user satisfaction, followed by fitness to organization, quality of cost/benefit analysis, quality of architecture, and lastly, cost-effectiveness.

Based on the results above, user satisfaction is the criterion with the largest eigenvalue. This finding indicates that user satisfaction with the results of RE is considered the most crucial in determining the success or failure of the RE processes. Basically, requirements in software development are formulated to solve problems faced by users (Sommerville 2010). Therefore, the high ranking of this criterion further emphasizes how crucial user satisfaction is in gathering and defining requirements.

The following most crucial criterion is fitness to the organization, which explains how the results of the RE match the needs and capabilities of the organization. In addition to conformity with user needs, requirements are also considered essential to fit the organization (Emam and Madhavji 1995). Without suitability, the IS developed may not reach its intended use since the organization lack the capability to

utilize it. Additionally, IS adoption may meet resistance from within the organization if there is a misfit between the system and the organizational context.

Table 4. Demographic Data

Respondents' Demographic		**Amount**	**Percentage**
Industry	IT Consultant	8	28.5%
	Marketplace	7	25%
	IT Services	7	25%
	Telecommunication	2	7.1%
	Logistics	2	7.1%
	Banks	1	3.5%
	Government	1	3.5%
Position	*Software Developer*	12	42.8%
	Product Manager	10	35.7%
	Business/System Analyst	2	7.1%
	Lead/Manager	2	7.1%
	Project Management Office	1	3.5%
	UX *researcher*	1	3.5%
Years of Experience	<2 years	4	14.2%
	2-4 years	14	50%
	4-6 years	8	28.5%
	>6 years	2	7.1%

Table 5. Ranking of Success Criteria

Criteria	**Eigenvalue**	**Rank**
User Satisfaction	0.328	1
Fitness to Organization	0.244	2
Quality of Cost/Benefit Analysis	0.186	3
Quality of Architecture	0.130	4
Cost Effectiveness	0.111	5

Furthermore, the quality of the cost/benefit analysis criteria is ranked third. In performing cost/benefit analysis, the software development teams must analyze the functionalities to release at a certain version and the costs. Software functionalities compete with limited resources (Svensson et al. 2010). Therefore, it is required to balance the need for user satisfaction and fitness to the organization with quality of cost/benefit analysis. Hence, it may explain the neutral preference toward Quality of Cost/Benefit Analysis compared to other criteria.

Next, the quality of architecture is ranked fourth. This criterion measures the quality of RE products. Quality of architecture represents how precise the system architecture modelling is as the results of RE. The criterion placed in the second to last position may be because the quality of architecture may not solely reflect the quality of RE. Other factors affect the quality of architecture, other than RE processes, such as the language and architectural framework used and the architect's expertise (Almari and Boughton 2014).

Finally, cost-effectiveness is placed last. This criterion indicates how effectively the development team uses available resources during the RE processes. According to the questionnaire respondents, this criterion is not more important than the other criteria. The goal of achieving cost-effectiveness may hinder the quality of RE (Reddi 1984). For instance, eliciting a complete requirement may require a long time and higher costs. Hence, cost-effectiveness is a competing goal of RE success. Thus, it is considered not significantly important for RE success. This statement is in accordance with the results of research by Emam and Madhavji (1995), who suggest that this criterion is considered the least frequently as a measure of the success of RE compared to the other four criteria.

Ranking Requirements Engineering Success Factors

Table 6 shows the eigenvalues and ranks of all factors for all criteria. First, within **cost-effectiveness** criteria, the three most significant factors affecting RE success are project scope & goals, user involvement, and skills & knowledge. Meanwhile, the three least significant factors are the relationships among stakeholders, training, and organizational environment & culture. Clear project scope and goals are essential to achieve cost-effectiveness, as creeping scope increases costs. Thus, it is crucial to define precise scope during RE. Meanwhile, the least significant factor is the organizational environment and culture, which indicates that the environment does not help create cost-effective RE processes.

Second, for the **quality of architecture** criterion, the three factors considered the most significant are project scope & goals, skills & knowledge, and best practices. Meanwhile, the three factors with the lowest significance are management support, the relationship among stakeholders, and the organizational environment & culture. Like the previous criterion, the project scope and goals factor has the highest eigenvalue among all factors, followed by the skills and knowledge factor. This finding shows how crucial the team's skills and knowledge are in producing good architecture as a result of RE processes. On the other hand, organizational environment and culture factor is the least significant factors. Based on these results, it can be inferred that the environment and organizational culture do not significantly affect the quality of the system architecture from the results of RE.

Third, for the **quality of cost/benefit** analysis criterion, the three factors considered the most significant are project scope & goals, skills & knowledge, and user involvement. Meanwhile, the three factors with the lowest significance are management support, training, and organizational environment & culture. Just like the previous criteria, the project scope and goals and skills and knowledge factors are at the first and second places. The difference with the previous criteria is that the user involvement factor plays a more important role than other factors mentioned above.

Next, for the **user satisfaction** criterion, the three factors considered the most significant are user involvement, project scope & goals, and understanding & knowledge. Meanwhile, the three factors with the lowest significance are management support, organizational environment and culture, and the organization's technical maturity. Contrary to the previous criteria, user involvement is the most significant factor. This finding shows how important user involvement is in creating satisfying RE results for users.

Finally, for the **fitness to organization** criterion, the three factors considered the most significant are project scope & goals, organizational environment and culture, and understanding & knowledge. Meanwhile, the three factors with the lowest significance are user involvement, best practices, and training techniques & tools. However, the significant difference is that the organizational environment and culture factor is in second place with the same eigenvalues as understanding and awareness. This result shows that a supportive environment and culture support RE processes that produce results that match the needs and capabilities of the organization.

Table 6. Summary of Eigenvalues and Ranks for All Criteria

Factor	Cost-effectiveness		Quality of Architecture		Quality of Cost/Benefit Analysis		User Satisfaction		Fitness to Organization		Global	
	Eigenvalue	**Rank**	**Eigenvalue**	**Rank**	**Eigenvalue**	**Rank**	**Eigenvalue**	**Rank**	**Eigenvalue**	**Rank**	**Eigenvalue**	**Rank**
Project's scope and goals	0.179	1	0.167	1	0.177	1	0.118	2	0.109	1	0.138	1
User involvement	0.136	2	0.088	6	0.104	3	0.249	1	0.089	9	0.132	2
Skills and knowledge	0.102	3	0.146	2	0.121	2	0.091	4	0.089	8	0.104	3
Understanding and awareness	0.088	5	0.091	5	0.096	4	0.115	3	0.106	3	0.102	4
Best practices	0.085	6	0.114	3	0.095	5	0.087	5	0.073	10	0.087	5
Organization's technical maturity	0.098	4	0.086	7	0.081	7	0.044	11	0.089	6	0.078	6
Relationship among stakeholders	0.064	9	0.048	10	0.07	8	0.081	6	0.089	7	0.076	7
Techniques and tools	0.071	7	0.111	4	0.083	6	0.062	7	0.064	11	0.074	8
Management support	0.067	8	0.049	9	0.064	9	0.052	9	0.096	4	0.072	9
Organizational environment and culture	0.059	11	0.041	11	0.052	11	0.047	10	0.106	2	0.07	10
Training	0.061	10	0.058	8	0.056	10	0.054	8	0.09	5	0.069	11

For all criteria, the top two factors affecting the success of RE processes are (1) project scope and goals and (2) user involvement. A clear definition of the scope and project objectives is the most significant factor determining the success of RE. After that, the project team can also focus on engaging users. Involving users in RE can minimize defects in design, reduce unnecessary costs, and acquire users' buy-in for the system (Alvertis et al. 2016). This result aligns with (Fricker et al. 2015), who stated that there is a strong positive correlation between the precise definition of project scope and the success of RE. The definition of scope and goals also helps mitigate risk (Islam and Houmb 2010), which may affect the high ranking of the factor, especially in the cost-effectiveness and quality of cost/benefit analysis criteria.

Meanwhile, the high ranking of user involvement is in line with the results of (Kujala 2003), which states a positive correlation between user involvement and user satisfaction in software development. The study concluded that early user involvement would improve requirements quality and suggested that users should not only be passive informants but must actively contribute from the beginning of IS development.

The following two most significant factors are (3) skills and knowledge and (4) understanding and awareness. Both factors are related to an individual's ability in the software development team. Memon et al. (2010) stated that skill shortage is one of the biggest challenges in executing RE processes. This finding supports the importance of skills and knowledge factors in determining the success of RE. While Ouhbi et al. (2013) also state that RE failure is caused by a lack of skills, knowledge, and awareness related to RE.

The last factor in the top five most crucial factors is (5) implementing best practices throughout the RE processes. Best practices have been implemented in various domains. They have been proven the correct way to do many things, including RE, through trial and error. Previous studies have proposed various RE best practices, such as Young (2004), who suggests 30 best practices for implementing requirements development and management. Fricker et al. (2015) also proposed three RE success-correlating practices, i.e., defining scenarios for sequential use and system development, developing business cases to consider the business consequences, and conducting workshops.

The sixth to last ranks are occupied by (6) the organization's technical maturity, (7) the relationships among stakeholders, (8) techniques and tools, (9) management support, (10) organizational environment and culture, and (11) training. Although these factors were discussed previously as CSF, the findings of this study show otherwise. Four of the six factors with the lowest ranking align with Saleh et al. (2021), namely, the organization's technical maturity, the relationships among stakeholders, management support, and organizational environment and culture. Regarding the technique and tools factors, some researchers argue that there is no comprehensive specific technique for performing RE (Davis and Zowghi 2006). Existing techniques are used inconsistently, as some techniques may be used by some projects but not by others (Neill and Laplante 2003). Some preferences regarding the techniques and equipment used include Quality Function Deployment, prototyping, Data Flow Diagrams, role-playing, and decision trees (Rouibah and Al-Rafee 2009). However, it is not stated whether any of these techniques is correlated with the success of RE (Fricker et al. 2015).

Conclusion

This study identified and prioritized CSF of RE using the Analytical Hierarchy Process. The initial model was developed from literature review and validated using evidence from empirical research. The results show the ranking of the criteria affecting the success of RE is, starting from the most significant to the least significant: (1) user satisfaction, (2) fitness to organization, (3) quality of cost/benefit analysis, (4) quality of architecture, and (5) cost-effectiveness. Meanwhile, the order of significance of CSF for RE is (1) project scope and goals, (2) user involvement, (3) skills and knowledge, (4) understanding and awareness, (5) best practices, (6) the organization's technical maturity, (7) relationship among stakeholders, (8) techniques and tools, (9) management support, (10) organizational environment and culture, and (11) training. The results of ranking the determinants of the success of

RE using the AHP method above show the most crucial factors. Therefore, these factors can be prioritized when executing RE.

Although the criteria for measuring the success of RE have been discussed, limited attention has been given to prioritizing the criteria using the AHP method. The results of this study complement (Emam and Madhavji 1995) by ranking the CSF of RE. Practically, the results of this study can contribute to developing strategies that minimize the risk of project failure. Based on the results of the ranking criteria, user satisfaction is the most crucial. Therefore, in the RE processes, the team is advised to focus on user satisfaction as the primary criterion for RE success.

Additionally, the software development teams can also invest more time and resources when defining the scope and objectives of the project since it is the most significant factor contributing to the success of RE. The team can also consider increasing user involvement in RE processes. The next two important factors are closely related to the individual abilities of team members. Therefore, to increase the success of RE, the teams can accommodate up-skill and awareness-building programs to improve RE processes.

This research has some limitations. It used a quantitative approach. Future research can use a qualitative approach through interviews or focus group discussions on triangulating the results of this study. Further research can investigate other criteria or factors not included in this study. Future avenues can also discuss the implementation of the CSF, such as how to precisely define project boundaries and objectives, increase user involvement, and individual team members' abilities in terms of expertise, knowledge, understanding, and awareness of RE.

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Integrated Information and Communication Media Modeling Based on Organization Goal-Oriented Requirement Engineering (OGORE)

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Abstract

The BPD NTT pension fund is a company incorporated as a legal entity that manages and runs a pension benefit program for BPD NTT employees. In its current business process, BPD NTT does not yet have a capable media to accommodate the information and communication needs of participants and interested parties, as a business branding and service facility for the participants. The problem that occurs is in the requirements elicitation stage when developing the information and communication media. For example, if the development is carried out by applying the Global eXtreme Programming (GXP) model, in the exploration phase the Organizational Goal-Oriented Requirement Engineering (OGORE) method will be applied to elicit requirements that base each activity on organizational goals. The results of the research are in the form of web-based information and communication media modeling based on IT goals which are described in various tasks equipped with actors and resources used as well as KPIs that are integrated into each goal.

Keywords*: GXP, information and communication media, IT goals, KPI, OGORE*

Introduction

Currently, there has been a disruption in technology and information which has resulted in the encouragement of every sector to adapt and adjust the facilities used according to specific needs and the business processes being carried out. One of the tools that are qualified to be applied in this era is online-based information and communication media. This media not only have an important role to play in improving effective decision-making processes in a company (Tjiptabudi et al. 2019), but can also provide other benefits in the form of an increasing business competitive advantage which is a significant added value.

To accommodate the important role and benefits required for a high level of information accessibility, the right information media to apply is a website. Why should a website, because the website is a medium for communication and delivering complete information to the general public online (Hadi and Rokhman 2020). Apart from being a medium of information, the website can also function to build business branding, as a promotional medium, as a consumer service medium, and as a means of delivering criticism and suggestions (Huda 2020).

Despite its various advantages, the application of a website as a medium of information cannot always fully meet the needs of a company. The cause is a problem that quite often occurs at the stage of a need

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elicitation when developing the website. As the results of research conducted by Kartiko et al. (2021) and Shofi et al. (2020) which show that the risk of failure in system development can increase when user needs do not match the generally accepted standards because user needs are only based on personal desires. Another example, if the development is carried out by applying the Global eXtreme Programming (GXP) model; then there is a stage known as the Exploration Phase, wherein this stage is focused on aligning the vision between the system developer and the client, identifying the actors involved and analyzing system requirements, user needs, and company business processes (Tavares and Tjiptabudi 2020). Errors that occur in this stage certainly can increase the risk of failure in website development as a medium of information and communication for a company (Adikara et al. 2016).

Various techniques or methods were developed to minimize or even eliminate problems that often occur in the process of requirements elicitation. For example, Agile Techniques for Agent Based Goal Elicitation (STAGE) who adopted minimum possible documentation for state the requirements natural language (Iswari 2012), User Persona techniques that focus on the analysis and design of software based on user characteristics (Kusuma et al. 2020), and Goal-Oriented Requirement Engineering (GORE) which focuses on rationalizing needs based on the goals to be achieved. Why use GORE for needs elicitation in this study? Because, based on organizational goals can provide traceability from strategic issues to technical details so as to generate rationale for system requirements and models systematically. Other than that, formalization of organizational goals can prove if the improvement is correct and complete so that it can show a structure that can be understood in the requirements document (Aljahdali et al. 2011) (Rehman et al. 2010). In practice, GORE alone does not appear to be sufficient for the requirements engineering process, therefore a more specific method was developed which is a derivative of GORE, namely Organizational Goal-Oriented Requirements Engineering (OGORE). The OGORE method is a needs elicitation method that bases each of its activities on organizational goals, starting from the elicitation process, followed by analysis and refinement, to the validation stage of its needs. The purpose of the OGORE method is to minimize various risks that may arise due to user needs that are only based on personal desires (Adikara et al. 2020).

The BPD NTT pension fund is a legal entity company with the task of organizing and managing a pension benefit program for BPD NTT employees. Based on the results of interviews with the President Director, it is known that in carrying out its current business processes, BPD NTT does not yet have a capable media to accommodate the information and communication needs of participants and interested parties. In addition to the purposes, BPD NTT also needs a media that can be a business branding and service facility for its participants. The general needs that have been conveyed certainly cannot be the basis for the development of the media, this is because a weak definition of requirements can lead to project failure. Therefore, in this study, we will discuss the need elicitation process in more depth by applying the OGORE method so that it emphasizes the company's goals and not the user's personal needs.

Literature Review

Organizational Goal-Oriented Requirements Engineering (OGORE)

OGORE is a new method developed based on the GORE method (Adikara et al. 2020). GORE is a way of engineering requirements by making various system requirements that will be built rationally, based on predetermined goals so that requirements are engineered not only based on data and manual business processes. Then, the method was developed into OGORE which focuses on company goals, with the aim of reducing personal needs with all the risks. The approach used in this method is to extract the company's goals into IT goals and add a Key Performance Index (KPI) to each of these goals (Shofi et al. 2020).

As in Figure 1, the first step in this method is to define a profile, especially the company's vision in order to understand the business objectives of the company. Then, developers and company leaders discuss the IT goals that are expected to be achieved with the system or media that will be developed. Alignment of business **objectives** with IT goals is used by companies to reduce costs, increase efficiency and relationships with consumers and suppliers, as well as create new products and business

solutions. Based on **IT** goals, will be extracted in the form of tasks, actors involved for each task, as well as the required resources. This will be used as the basis for designing the system or media that will be developed.

Furthermore, developers and company leaders will determine the Key Performance Indicators (KPI) for each goal as targets to be achieved as well as controllers. Developers and company leaders must ensure that the KPIs that have been determined can be achieved if the system or media developed has been implemented and in accordance with the stated objectives (Adikara et al. 2016).

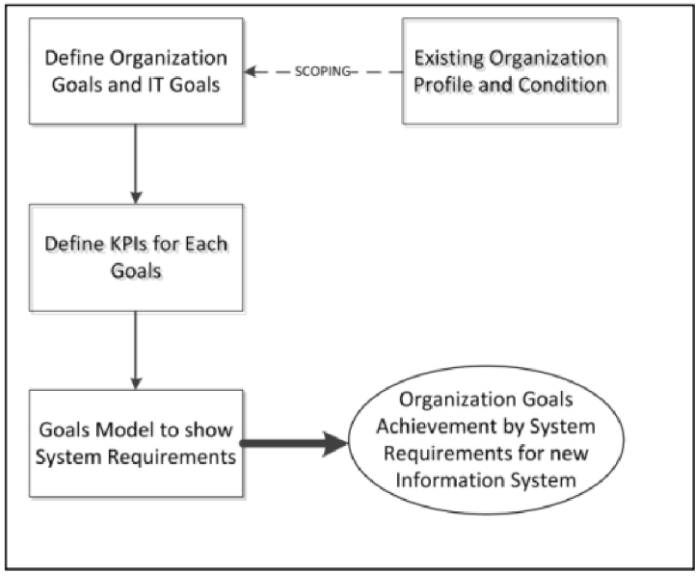

Figure 1. Requirement elicitation concept using organization and IT goals

According to (Adikara et al. 2016), there are three main OGORE processes, namely:

a. Requirements elicitation process.
b. Requirements refinement process.
c. Requirements analysis process.

In this study, it is only limited to the requirements elicitation process based on OGORE, which consists of 3 (three) activities as follows:

1. Determine the target based on the profile of the organization/company.
2. Mapping system goals.
3. Integrating KPIs.

The results of the elicitation of these requirements are then modeled using a diagram called the Goal Tree Model (GTM) which is adapted from the Goal Requirement Language (GRL) modeling method using symbols as shown in Figure 2 (Marosin et al. 2014).

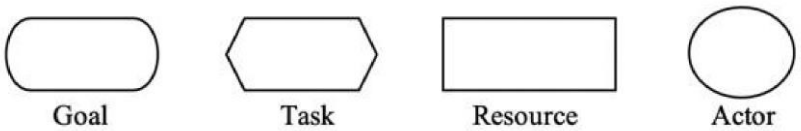

Figure 2. Goal Tree Model (GTM) elements in OGORE (Marosin et al. 2014)

Global eXtreme Programming (GXP)

According to Ferdiana, GXP was first put forward in the journal internationally. GXP defined as a method that emphasizes intense communication between client and team, efficient development through test models intense, to iterative models and incremental. The GXP model has 5 (five) phases, namely Exploration, Planning, Iteration, Production and Maintenance. Each phase will manage input and generate outputs to be managed in next phase (Tavares and Tjiptabudi 2020).

a. Exploration Phase

In this phase, the focus is on equalizing the vision between developer and client, identification of actors and system requirements analysis. At this stage, the business objectives and IT goals are reformulated and reorganized to produce a product vision. Result of this stage is a set of user requirements that aimed at the next stage.

b. Planning Phase

The results of the previous stage in the form of a set of user requirements are used as input at this stage. These inputs will be selected according to the limitations of the client and team. This phase agreement produces a release plan and iteration plans. The release plan is attaching the features that will be developed in the the agreed timeframe and the iteration plan produce a set of steps that will carried out along with the output obtained for each the stages.

c. Iteration Phase (Development phase)

This phase is also known as the development phase solution. The iteration phase executes the iteration plan as a result of the previous stage and customer feedback through a series of technical activities such as generate architecture, code and performing unit tests for each module. The output of each iteration are known as partial releases or small releases.

d. Production Phase

This phase uses the release plan resulting from the planning phase as input and tests any partial or small releases as a result of each iteration of the previous phase. In this phase, testing of each iteration that has been set between the researcher and the client. This test is known as acceptance testing for find out if the system is working properly provisions to address the current problem this. At this stage, verification and integration of existing results and release plans. Results this phase is a solution that is well tested by the team as well as clients and need to be implemented in real conditions.

e. Maintenance Phase

The results of the production phase in the form of solutions that have been well tested by the team and clients and have been implemented in real conditions are used as input in this phase. This phase focuses on support services after the software is developed. This phase makes repairs of errors that found in the solution as well as minor adjustments to solution, in addition, at this phase it is also possible there is an agreement for the development of a system that more detailed and adapted to developments requirements in the next release.

Methodology

This research applies a case study research method, which is a case study conducted on a website-based information and communication media development project for a company, in this case, the BPD NTT Pension Fund which has not owned or applied the information and communication media before. The purpose of applying the case study method is to identify the requirements elicitation process in the company based on the organization's goal-oriented requirements engineering (OGORE) technique by involving various stakeholders from the company side represented by the President Director, Head of

section and staff, pension fund participants, and from the developer side represented by analysts and programmers.

In the process of collecting data, there are several ways, namely through direct observation of the company, conducting interviews with the company and participants, and conducting literature studies on supporting documents. For the information media and communication development process, the Global eXtreme Programming (GXP) model is used. This model is defined as a model that demands the intensity of communication between the client and the development team and the efficiency of the development process through the test model. The GXP model consists of 5 (five) phases, namely exploration, planning, iteration, production, and maintenance as shown in Figure 3.

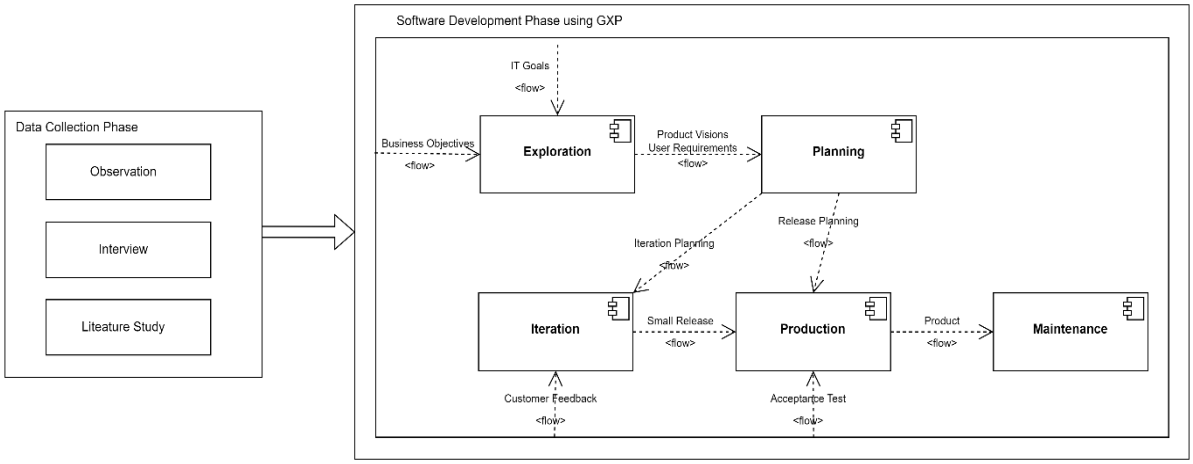

Figure 3. Research design based on GXP (Tavares and Tjiptabudi 2020)

The application of the OGORE to elicit the requirements for website-based information dan communication media development was implemented in the exploration phase of GXP, with stages that can be seen in Figure 4:

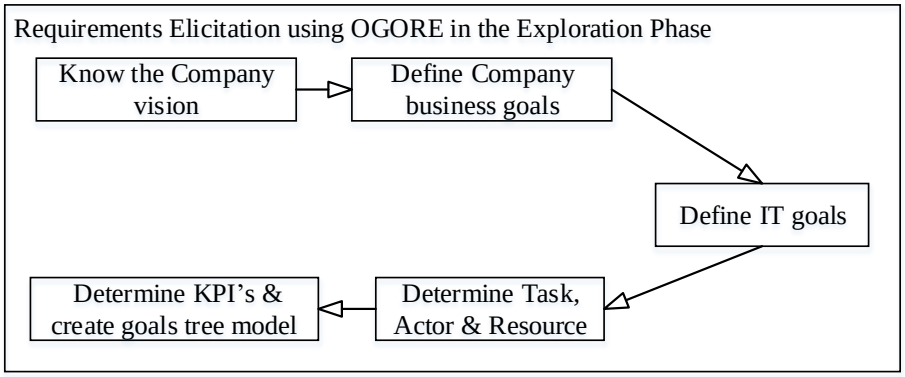

Figure 4. Stages of requirements elicitation using OGORE

In this study, the requirements for the elicitation stages used the OGORE method based on Adikara et al. (2020) which were modified and detailed, so that consisted of several stages. First, understanding the vision of the company can be done by applying the literature study method and interviews with several sources from the company. Furthermore, based on this vision, the company's business goals to be achieved will be formulated. Due to the information, and media to be built based on IT, the company's business goals that have been set are converted into IT goals. Each IT goal consists of a series of tasks performed by actors using certain resources; therefore, the next step is to determine the tasks, actors and also resources involved. The last step is to determine the KPI for each goal that is determined and described in the goal tree model.

Results

This study is focused only by using OGORE to elicit the requirements of website-based information and communication media, so that not all phases of GXP will be carried out and only includes two phases, namely the exploration phase and planning phase.

Exploration Phase

This phase has several main activities such as equalizing perceptions between the system development team and the client, identifying the actors involved, and analyzing system requirements (Tavares and Tjiptabudi 2020). In this case, the development team must understand the vision, mission, and ongoing business processes of the BPD NTT Pension Fund to elicit complete requirements and then be able to determine company business goals, set IT goals based on the company business goals, and determine KPIs for each IT goal. which is then used as the basis for creating a goals tree model. So that in this phase will produce the formulation of the product vision and business goals as well as user requirements which will be used in the next stage.

a. Know the company vision

Through the data collection process carried out by applying the methods of observation, interviews, and also literature studies, it is known that the vision of the BPD NTT Pension Fund is "to become a Pension Fund that is growing stronger to provide services to all interested parties and to guarantee the continuity of income for participants and retirees, in an on-time, in the right number and the right recipient".

b. Define company business goals

Based on the company's vision, the development team saw that two important things that became the focus of the company's vision so that it could be formulated into the company's business objectives, namely:

1. Provide services to all interested parties.
2. Provide a guarantee of continuous income in a timely manner, in the right amount, and to the right recipient.

c. Define IT goals

To provide maximum service to various interested parties, especially the participants, the development team digs deeper into the related requirements. The services that will be provided on the website are focused on pension fund participants while some of the information needed by participants is strictly confidential, therefore it is clear that a complete and well-recorded process of managing participant data is needed. This is also related to granting access rights to participants.

Moreover, the information services are provided not only to participants but also to various interested parties including the general public, so it is important to ensure that the information presented must be complete and meet the needs of all parties. However, there is information that is confidential and may only be known by participants, so a facility for direct communication is needed, between participants and administrators, for example through chat-box services or so on. Of course, this service can only be accessed by participants who have access rights, as evidenced by the existence of participant accounts with usernames and passwords. This is certainly related to the first point that has been described, namely the existence of features for managing participant data.

In addition, to ensure continuity of income promptly, with the right number of recipients following the second company business goal, the website must be able to provide real proof of transaction service regarding the process of disbursing funds so that it can include some important information such as how much was disbursed when it was disbursed and in accordance with the rights of each participant. Based

on these requirements, IT goals are defined that can be set to answer the company's business goals, including:

1. Membership data is well managed.
2. All information is well managed and presented.
3. User inquiries are well managed and responded to.
4. Access to MP (*Manfaat Pensiun*) receipts online is served properly.

The IT goals that have been set and their relationship to the various business goals of the company to be fulfilled can be seen in Table 1 below:

Table 1. Relationship between IT Goals and Company Business Goals

No	IT Goals	Company Business Goals	
		Provide services to all interested parties.	Provide a guarantee of continuity of income in a timely manner, in the right amount and in the right recipient.
1	Membership data is well managed.	√	
2	All information is well managed and presented.	√	
3	User inquiries are well managed and responded to.	√	√
4	Access to MP receipts online is served properly.	√	√

Based on Table 1, it can be seen that all designed activities can meet the organization's business objectives. So based on this, it can be described in a goal tree model as follows:

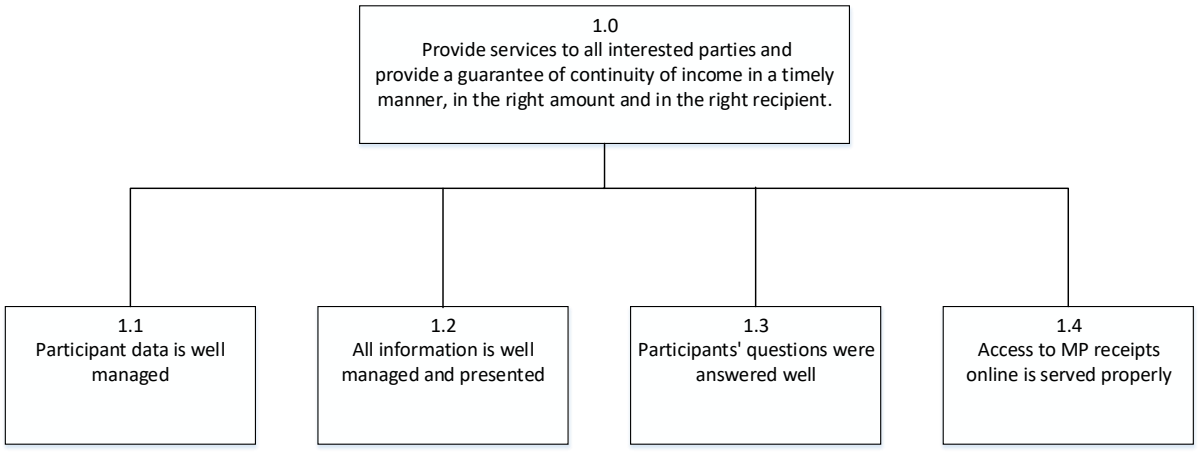

Figure 5. IT goals as a derivative of company business goals

d. Determine task, actor, and resource

Before determining Key Performance Indicators (KPIs) and integrating them into each goal, it is necessary to determine the tasks, actors, and resources needed for each goal first. Furthermore, the integration of KPIs into each goal is made in a goals tree model (see Figure 5). Figure 6 shows some of the tasks that will be carried out by an administrator or officer from the company including the resources used. These tasks are processes that must be carried out to meet the IT goals that have been set. Figure 7 also shows a series of tasks that will be carried out by pension fund participants.

In Figure 6, tasks performed by the administrators include adding data, updating data, creating participant accounts, answering participant questions, and also making MP receipts. Each of these tasks requires database resources, especially the task of answering participant questions requires an engine to connect the website with the WhatsApp or email application. All tasks performed by this administrator are related to the four IT goals that have been set previously.

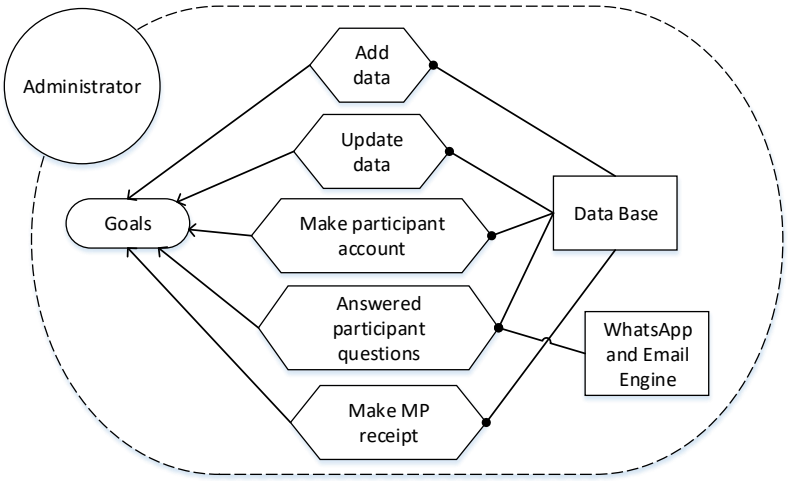

Figure 6. Tasks performed by the administrator

In Figure 7, the participating actors can perform two tasks, namely asking the administrator and also asking for MP receipts. Each of these tasks requires database resources. The task leader is related to the 3rd IT goal, namely "user requests are managed and responded to properly" and the 4th IT goal, namely "Access online MP receipts served properly".

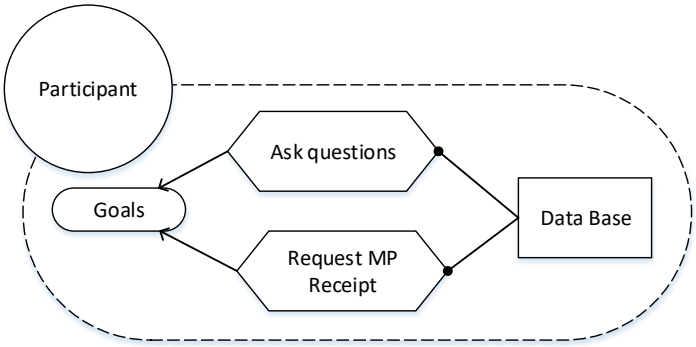

Figure 7. Tasks performed by participants

e. Determine KPIs and create a goals tree model

Implementing KPIs is an important way to ensure that everything that is done can support the company's overall goals. The determination of each good performance indicator must be in line with the objectives to be achieved (Mourtzis et al. 2017; Nozari et al. 2019). Each indicator determined as a KPI is not intended to make the process of assessing something more difficult, but rather to become a tracking and measuring tool that is easy to use. Thus, the most important thing about KPI is that it is simple and easy to use but measurable (Pîrlog and Balint 2016; Stricker et al. 2017). Therefore, in this study, KPI is used to become a standard in measuring how well the company's requirements that have been elicited are met in website-based information media that will later be implemented.

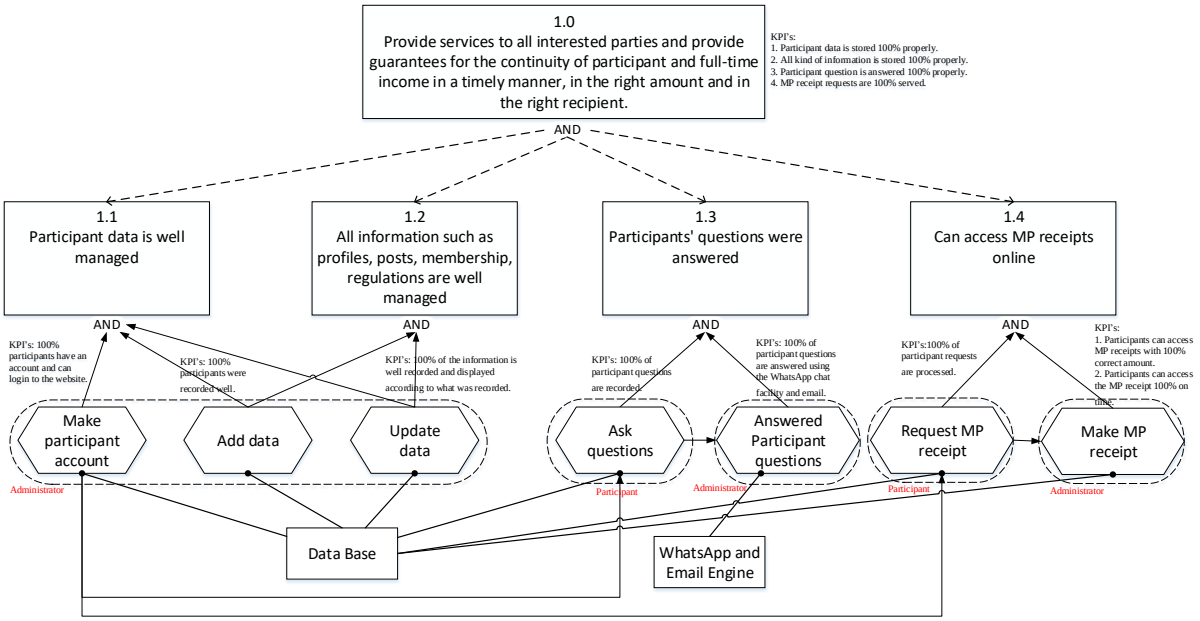

Figure 8. Goal's tree model with KPI

Figure 8 shows a series of goals that have been set and depicted in a tree model equipped with the tasks performed by each actor, the required resources, and also the KPIs for each of these goals. The KPIs that have been set will be assessed when the communication media website is completed and implemented. The point is that every task that will be carried out has been adjusted to the IT goals that were previously set based on the company's business goals and company vision. These tasks will later be implemented in various features provided on the website as a result of the planning phase which will then be carried out in the GXP development model.

Planning Phase

The planning phase is carried out after the exploration phase is complete and will produce various release plans consisting of the product functions of the website to be built and an iteration plan in the form of details of the next stages accompanied by various outputs obtained (Bratakusuma et al. 2018). In this phase, the Unified Modeling Language (UML) will be used to create a model of the website-based information media.

a. Technology Architecture

Information and communication media to be built based on the website. This is to support the rapid dissemination of information so that every interested party can access information from anywhere, anywhere, and anytime. The general website architecture can be seen in the Figure 9.

Figure 9 shows that every actor, both administrator and participant, can access the website via the internet. Every data inputted and managed by the administrator will be stored on the web server, which will then be presented to participants according to the request given. To further improve the accessibility of information, this information media is made multiplatform, which means that every user can access the information media using various devices ranging from personal computers, and laptops to smartphones.

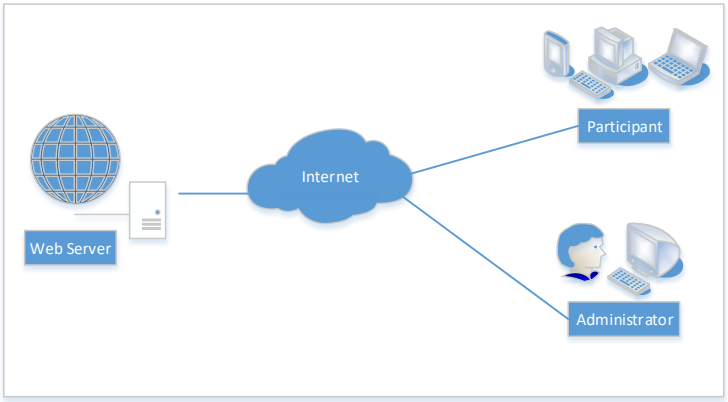

Figure 9. Website architecture

b. Behavior diagrams

The use case diagram is used to visualize which users (actors) are involved and the interactions that occur with the system being built. This diagram is used because it can provide a clear picture of the context of the system to be built to clarify the scope and limits of the system (Kurniawan 2018).

Following its function, the use case diagram in this study is used to model the features provided by the system and its interactions with any actors. In Figure 10, it is clear that the information media that was built has two actors involved, namely administrators and participants. Each actor accesses different features according to the ownership of the access rights determined through the login process. Administrators can access admin dashboard features, manage participant data, profile data, contacts and information postings, process MP receipt requests, answer participant questions, manage FAQs, admin data and web utilities. Meanwhile, participants can access the dashboard, view profiles, contacts and information, request MP receipts and also ask questions. The features provided are the implementation of the tasks that are designed and must be carried out to achieve the goals that have been set as in the previous discussion.

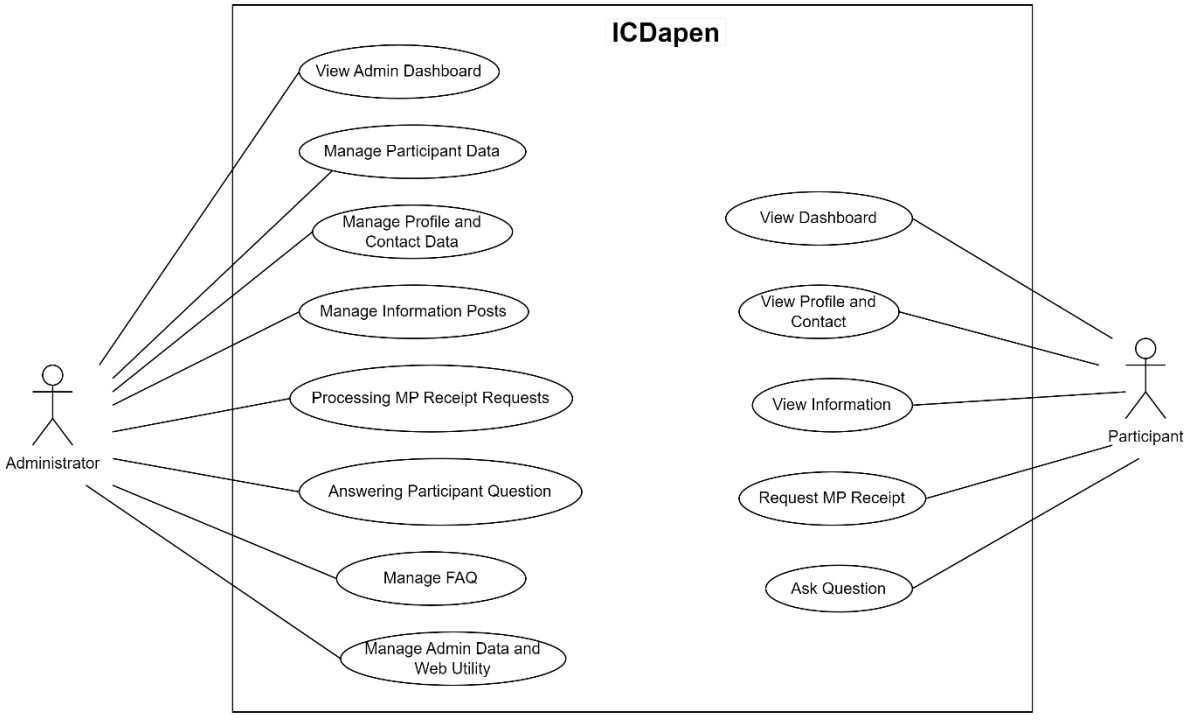

Figure 10. Use case diagram

c. Structured Diagram

The class diagram is a UML diagram with a function to visualize the structure of a system statically (Aprianti and Maliha 2016). The several classes declared in the website-based information media that were built can be seen in Figure 11.

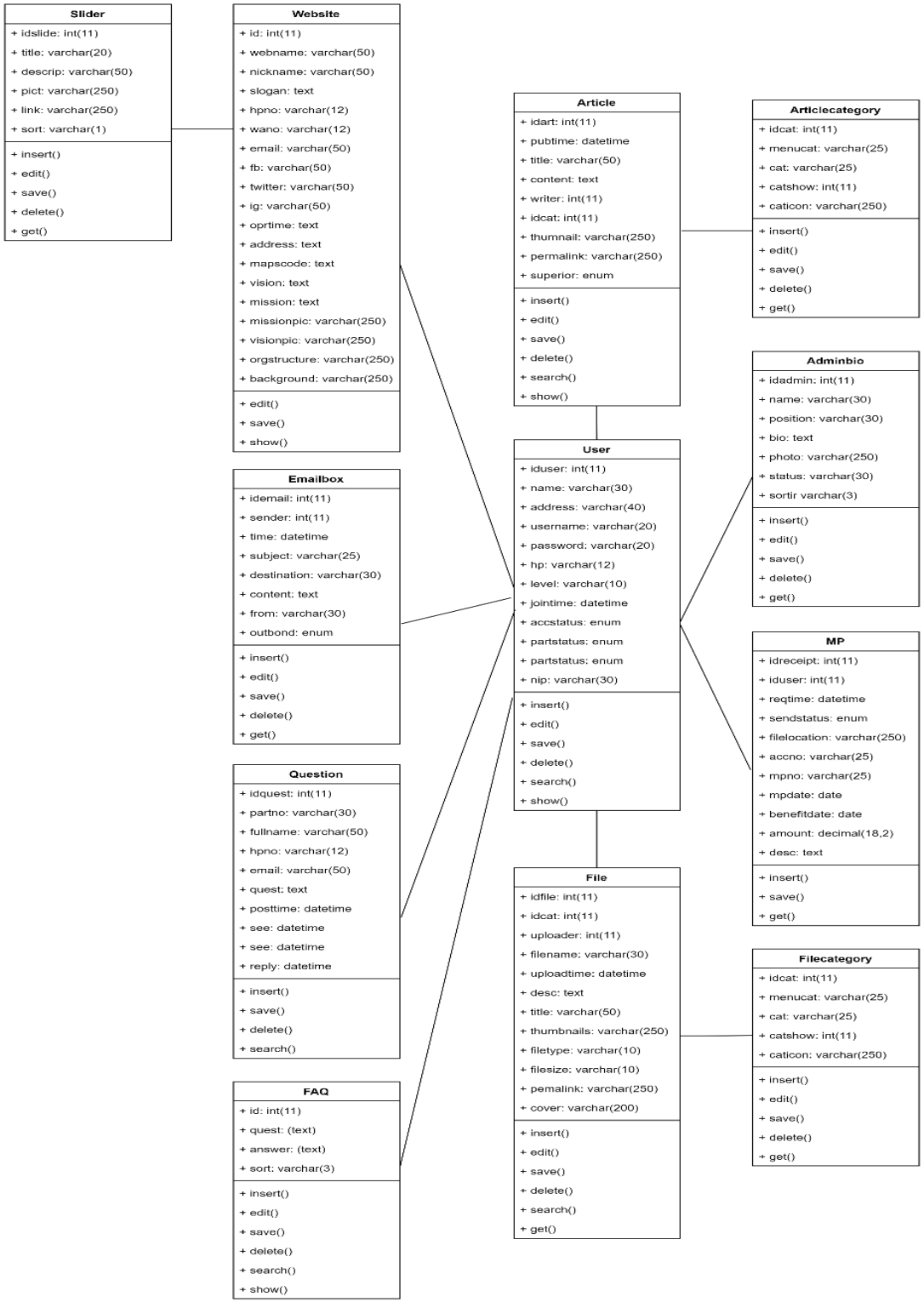

Figure 11. Class diagram

Based on the class diagram that shows the functional and also the structure of the information and communication media will be built, then it will be described in the form of a display design. This view is the interface that will be used by the user to interact with the media in accordance with the access rights that have been determined for each type of user. For example, in Figure 12 which is a display design that can be used by pension fund participants to request and download MP receipts. In addition, Figure 13 shows the administrator interface design to send information to users via Email or WhatsApp services.

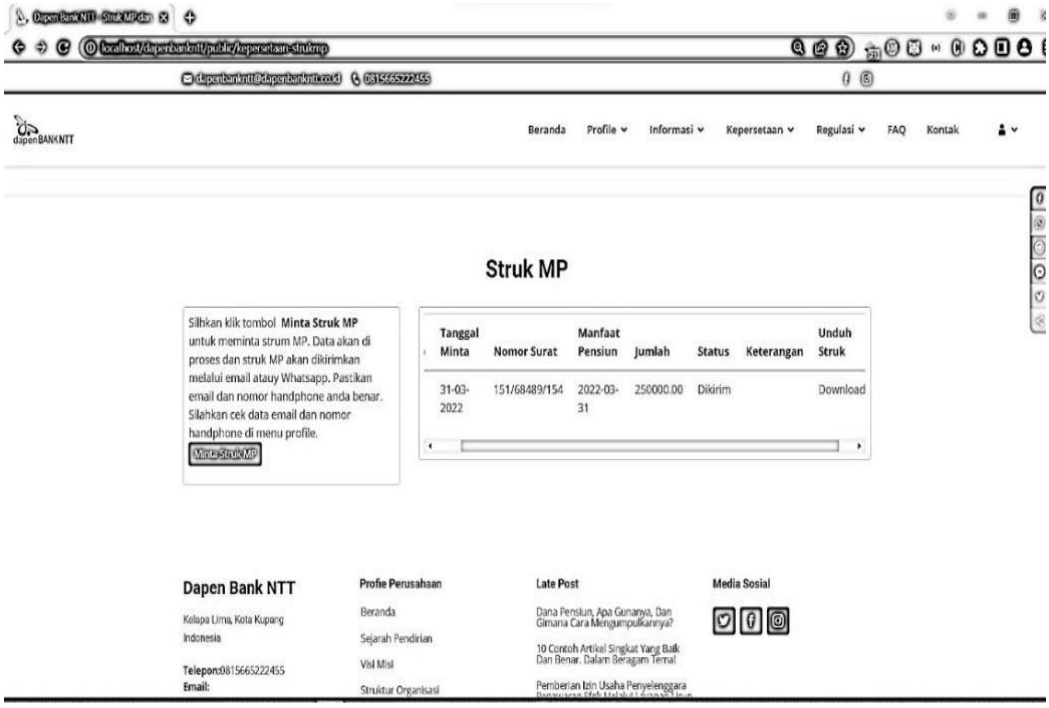

Figure 12. Design form for MP receipt request

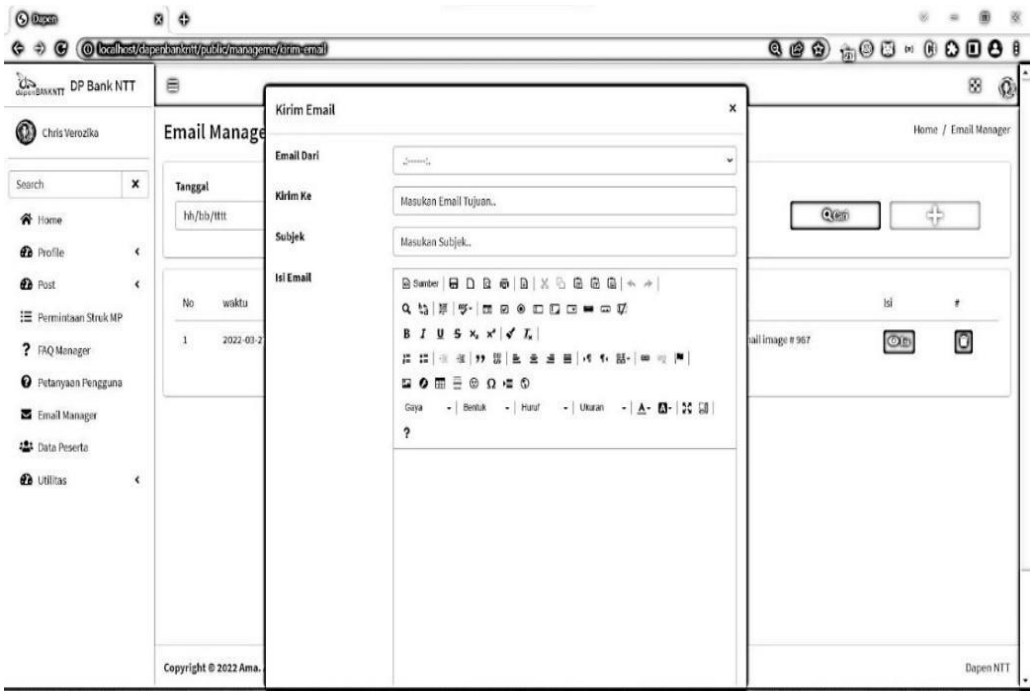

Figure 13. Design form of sending information via email

Discussion

According to Gaol et al. (2019), the OGORE method is a collection of requirements gathered from the interviews and small discussion groups which involve stakeholders in the company such as the President Director, Head of section and staff, pension fund consultants and experts, system analyst, and system developers. The discussion begins with the company's vision, mission, and objectives, including an ongoing operating system, procedure, and expected system implementation results.

The first step is to define the organization vision, mission, and goals of the organization. Where the engineers requirements to identify organizational goals should be achieved by developing this system. The second step is to define a KPI for the setting goals followed by the elicitation processes (Tjiptabudi and Bernardino, 2020), which are steps of understanding the business domain, Goal Tree Model, and the KPI. The third step is to improve the results of the elicitation process with a problem-solving method.

Based on (Adikara et al. 2020), OGORE can be used to determine the initial requirements of an organization or company as a basis for system development. OGORE is very useful for anticipating the emergence of personal requirements that deviate or conflict with company requirements. Likewise in this study, OGORE can make a very large contribution in the requirements elicitation stage, which is a fundamental stage in the process of developing a system. If the requirements obtained are not suitable, it will increase the risk of failure.

Moreover, Requirement Engineering (RE) is one of the first key elements of the system development process (Aljahdali 2011).

The application of OGORE is very appropriate because it has various advantages in the requirements elicitation process. First, OGORE can identify and also determine the general goals of a company, then these goals can be specified into more detailed goals as a complete summary of the requirements of each stakeholder level. Next, based on the requirements obtained, a basic model of system development can be made by determining and compiling a goals tree model element in the system requirements consisting of goals, tasks, resources, actors and KPIs. So, OGORE not only determines requirements, but also determines KPIs so that they can measure each goal quantitatively.

Based on these advantages, the application of OGORE in the need elicitation process makes a lot of sense because every company must have a vision, mission and goals, so that they can be further elaborated into system requirements to be developed and become the basis for designing systems to be developed.

Conclusions

Organization Goal-Oriented Requirement Engineering (OGORE) methods modeling a website as a medium of information and communication of the BPD NTT Pension Fund. It might conclude that the application of OGORE can identify specific company requirements based on the company's vision, mission, objective, and not personal requirements. The requirements of the elicitation process in using the OGORE method deliver in three phases, and they are as follows: The first phase is to define the company's or organization's vision, mission, and goals of the organization. The second phase is to define a KPI. The third phase is to improve the results of the elicitation process with a problem-solving method. OGORE can simplify complex requirements engineering in the systems development stage. OGORE can convert company business goals into IT goals whereas described in various tasks equipped with the use of the actors and resources. Such as the tasks, actors, and resources become the basis for modeling the information and communication media to be built and visualized using the unified modeling language (UML), namely the use of case diagrams and class diagrams. The KPIs integrated into each goal have been defined with clear steps to ensure they can be delivered, evaluated, and achieved. This OGORE modeling can be a basis for developing a system application required by information and communication media. In the future, the researchers may compare this OGORE method with the other like Agile method or User Persona method to test the capability advantage.

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An Indonesian Adaptation of The Students' Preparedness for University e-Learning Environment Questionnaire

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Abstract

Although most students are digital natives, online learning requires different skills as compared to conventional face-to-face learning. This paper aims to adapt and test the reliability and validity of the Students' Preparedness for the University e-Learning Environment questionnaire developed by Parkes et al. into Bahasa Indonesia. The original questionnaire covers a wide range of competencies relevant to e-learning preparedness for university e-learning environments in three dimensions. Prior to reliability and validity checking, pilot testing is conducted to test the unidimesionality of the instrument and the rating scale. An item-match analysis test is also carried out to observe the suitability of each item. Then, the final version of the questionnaire is administered to a large representative sample of respondents for whom the questionnaire is intended. The results show that, with a total of 1446 students from a public university in Indonesia as respondents, the adapted questionnaire is valid and reliable.

Keywords: preparedness, e-learning, item-match analysis, rasch model, validity test, reliability test

Introduction

Despite students being digital natives, the results of implementing e-learning in higher institutions do not always support the attainment of the learning objectives. Online learning requires different skills compared to traditional learning. In addition to technical skills, students must be able to interact with teaching materials in various formats and communicate virtually without the help of non-verbal languages, e.g., intonation, facial expressions, and body language. While in most cases students show

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competencies to use computer technology and able to effectively access and navigate course content, previous findings show that students remain relatively unprepared in some non-technical skills, such as for giving and receiving critique or other critical thinking skills (Parkes et al. 2015).

Pandemic COVID-19 escalate utilization of e-learning in various education degree of education, leaving a question whether the students were prepared for e-learning. Are students competent to adapt new directions in learning in both of technical and non-technical skills? As reported by World Economic Forum, online learning platform Coursera has recorded 20 million new student registrations in 2021 (Wood 2022). The highest rate of new learner growth came from emerging economies, such as Paraguay, Lebanon, Philippines, Guyana, and Indonesia, with more than 60% growth in 2021.

To be effectively implement e-learning, lecturers must understand the level of students' e-learning readiness. Accordingly, instruments in the form of a student learning readiness questionnaire are needed to assess students' preparedness for university online learning environments. By measuring this level of preparedness, lecturers can define appropriate instructional strategies accordingly.

The terms e-learning readiness or e-learning preparedness were used indistinctly. However, several researchers prefer the term 'e-learning readiness' (Alem et al. 2014; Blankenship and Atkinson 2010; Kaymak and Horzum 2013; Hung et al. 2010; Ilgaz and Gülbahar 2015; Kaur and Wati 2004; Watkins et al. 2008; Yu 2014), while others use 'e-learning preparedness' (Hong and Gardner 2018; Parkes et al. 2015). They have defined contextual differences between those terms. Watkins et al. (2008) described e-learning readiness as the level of readiness of certain institutions or organizations regarding various aspects of the technology of e-learning in advance of the entire e-learning environment being applied for a range of purposes. Other researchers employed the term 'preparedness' to focus on what students need to do, rather than what students have to be (Hong and Gardner 2018; Parkes et al. 2015), as in the current study.

Previous studies have worked on developing an instrument to measure the e-learning readiness or e-learning preparedness (Alem et al. 2014; Kaymak and Horzum 2013; Hong and Gardner 2018; Hung et al. 2010; Parkes et al. 2015; Smith 2005; Watkins et al. 2008; Yu 2014). Among those of questionnaires, the current study selected the instrument developed by Parkes et al. (2015) for translation and adaptation into Bahasa Indonesia, the Indonesian national language, for the following reasons. First, it includes a wide range of competencies relevant to e-learning preparedness for university e-learning environments, including competencies associated with online collaborative learning. Through online collaborative learning, 'students are encouraged and supported to work together to create knowledge: to invent, to explore ways to innovate, and, by doing so, to seek the conceptual knowledge needed to solve problems rather than recite what they think is the right answer' (Harasim 2017). Second, the e-learning competencies identified in the study described in observable and measurable terms the requisite knowledge, understandings, skills, attitudes and behaviours students required for effective performance (Parkes et al. 2015).

The original preparedness questionnaire was developed in an English-speaking country. A cross-cultural adaptation of the instrument was necessary to maintain the validity of the original questionnaire for application in another country and another language, such as Bahasa Indonesia. Cross-cultural adaptation is a process that considers language (translation) and cultural adaptation issues in the process of preparing a questionnaire for use in another setting (Beaton et al. 2000). This study recommended the six stages in the adaptation process to include forward translation, synthesis of the translations, back translation, expert committee review, pre-testing and submission and appraisal of all written reports by developers or a committee (Beaton et al. 2000). Beaton et al. (2000) suggested that this thorough adaptation process is designed to maximize the realization of semantic, idiomatic, experiential, and conceptual equivalence between the source and target questionnaire.

After the translation and adaptation process, further testing of the adapted instrument was also suggested to measure the properties needed for the designed application using conventional statistical approaches (Beaton et al. 2000; Gjersing et al. 2010; Sousa and Rojjanasrirat 2010). Some measures were evaluated during pre-testing; however, larger sample sizes from the target population are encouraged. The final

instrument should establish internal consistency reliability, stability reliability, homogeneity, construct validity, criterion validity, factor structure, and the model fit of the instrument (Beaton et al. 2000; Sousa and Rojjanasrirat 2010).

Literature Review

Definition of E-learning Readiness, Preparedness, or Competencies

Prior to introducing the instruments for adaptation in this paper, we briefly discuss some of the contextual terms that often arise, i.e., e-learning readiness, e-learning preparedness, and e-learning competencies. Readiness (for something) is the state of being ready or prepared for something ("Readiness" n.d.). Watkins et al. (2004) defined e-learning readiness as the level of readiness of certain institutions or organisations regarding various aspects of the technology of e-learning in advance of the entire e-learning environment being applied for a range of purposes. E-learning readiness includes human resources (learners/students, teachers, management, staff and planners), infrastructure and all factors that affect the development of the e-learning environment (Hashim and Tasir 2014).

A term that closely follows readiness is preparedness. Preparedness (to do something) is defined as the state of being ready or willing to do something ("Preparedness" n.d.). In the context of the study, preparedness is defined in terms of readiness. On the other hand, some experts define e-learning readiness in terms of preparedness, where the former can be expressed as the 'mental or physical preparedness of an organization for some e-learning experience or action' (Borotis and Poulymenakou 2004). Several researchers prefer the term 'e-learning readiness' (Alem et al. 2014; Blankenship and Atkinson 2010; Kaymak and Horzum 2013; Hung et al. 2010; Ilgaz and Gülbahar 2015; Kaur and Wati 2004; Watkins et al. 2008; Yu 2014), while others use 'e-learning preparedness' (Hong and Gardner 2018; Parkes et al. 2015). In this paper, we use 'preparedness' as a synonym of 'readiness' to focus on what students need to do, rather than what students have to be (Hong and Gardner 2018; Parkes et al. 2015). The context of this study is the e-learning environment within a higher education system. Watkins et al. (2004) defined e-learning readiness as the level of readiness of certain institutions towards various aspects of the technology of e-learning.

Readiness or preparedness is different from competency. Competency (in something) or competency (in doing something) is the ability to do something well. In developing an instrument for measuring e-learning preparedness, experts refer to the corresponding competency categories as the dimensions or factors of preparedness.

Assessment of E-learning Preparedness/Readiness

Assessments of students' preparedness for e-learning provide valuable information for institutions and students. Alem et al. (2014) conducted a systematic literature review on student preparedness for e-learning assessment tools between 1990 and 2010. The results showed that a standard tool does not exist in this regard. Only 10 instruments for assessing students' online preparedness have been developed and published during that period.

Watkins et al. (2008) proposed self-assessment questionnaires comprising 27 items. The instrument includes six dimensions, i.e., technology access, online skills and relationships, motivation, online audio/video, internet discussion and importance to personal success. Unfortunately, data collected to support the external validity of the instrument could not be analyzed due to technical problems.

Smith (2005) tested the readiness for online learning questionnaire for reliability and factorability on a sample of 314 Australian university students. The study concluded that the instrument shows promise in both research and practice contexts. Blankenship and Atkinson (2010) replicated the previous study by Smith (2005) with 146 undergraduate students at a mid-sized public university in the United States of America as respondents. The study proposed the revision of the 'comfort with e-learning' factor to 'comfort with non-face-to-face communication'. The questionnaires included a total number of 13 items. The findings indicated that students may have believed their background and experience with

using the internet helped them with self-management related to learning and made them more comfortable with non-face-to-face communication; accordingly, these characteristics were found to be beneficial to their studies.

Hung et al. (2010) expanded the concept of e-learning readiness developed before by adding new facets included additional dimensions. The final instrument comprised five dimensions, i.e., computer/internet self-efficacy, self-directed learning, learner control, motivation for learning, and online communication self-efficacy. Data was gathered from 1051 college students in five online courses in Taiwan. The findings revealed that, in general, the higher grade (junior to senior) students exhibited significantly greater readiness in the dimensions of self-directed learning, online communication self-efficacy, motivation for learning, and learner control compared to lower grade students (freshmen and sophomores). The results of the study also revealed that two readiness dimensions required special attention (learners' control and self-regulated learning). The authors suggested that teachers may need to help students develop self-directed learning and learner-control skills and attitudes for engaging in online learning (Hung et al. 2010).

Kaymak and Horzum (2013) reported that a correlation existed between the readiness levels of students for online learning and the perceived structure and interaction in online learning environments. The study employed a cross-sectional survey model. The survey utilized the readiness scale for online learning and adapted it into Turkish (Hung et al. 2010). The preferred sampling method was convenience sampling. The sample comprised 320 online-learning postgraduate students among 1,180 students completing postgraduate learning programs at Sakarya University's Institute of Social Sciences. The study revealed that readiness for online learning is important in terms of its structure, which can affect learning results and interaction factors. It should be noted that the participants were postgraduate students, who may have embodied different characteristics from undergraduate students.

Yu (2014) proposed the student online learning readiness (SOLR) scale with 22 self-reported items categorized into four dimensions: technical competencies, social competencies with class peers, social competencies with the instructor and communication competencies. The study tested the instrument using exploratory factors and reliability analyses. The findings confirmed the four-factor structure of the instrument. Its four categories are: (1) technical competencies, (2) social competencies with classmates, (3) social competencies with the instructor and (4) communication competencies. Communication competencies include the ability to express opinions in writing to others, respond to other people's ideas, express opinions in writing so that others can understand what he/she means and providing constructive and proactive feedback to others even when he/she disagrees.

A study conducted by Hong and Gardner (2018) was triggered by conflicting results from existing studies. On the one hand, there is the general view that students are 'digital natives' and have high expectations that technology will play a significant role in their education. On the other hand, studies have suggested that even though they may be technically competent in terms of using fashionable and up-to-date tools such as social media, learners may not be well-prepared for using e-learning tools (Boud 2014). Students were not well-prepared for activities such as reading and writing, providing clear and concise responses, synthesizing ideas, planning strategies, formulating arguments and team work (Parkes et al. 2015).

Incorporating the community of inquiry model, Learning Process and Learning Outcome (LEPO) and additional frameworks, Parkes et al. (2015) listed eight relevant constructs as signifying the dimension of the instrument, i.e. learners' characteristics (e.g. self-efficacy, self-regulation, social competence, digital competence), engagement in blended activities, the learning facilitators' presence and the learning environment (e.g. learning and technology design). The study aimed to explore the online learning (e-learning) preparedness of first-year students by using a blended learning approach and reviewing its effectiveness in facilitating their transition from high school to the university learning environment. The findings of the study showed that students possessed good regulatory skills. Most of the respondents stated that they were comfortable contributing to online discussions and able to work well in and enjoyed group work.

One of the strengths of online learning is that it facilitates online collaborative learning. Online learning competencies include the ability to participate in online discussions and other group work. Student preparedness for university online learning environments that also emphasizes interaction among learners, and between learners and instructors, was proposed by Parkes et al. (2015). The objective of this study was to identify and rank the importance of the competencies required by students for effective performance in a university e-learning environment using Learning Management System (LMS) and situating it within the social constructivist learning paradigm. The Hybrid BARS process used in the study was implemented in five stages as follows. Stage one: selection and formation of two expert panels; stage two: the generation of e-learning competencies by these panels; stage three: the amalgamation of lists affected by the researcher; stage four: verification of an amalgamated list by panel members; stage five: the external validation of the e-learning competencies. The identified competencies were grouped into three categories based on groupings used by Birch: (a) management of learning and the e-learning environment; (b) interaction with the learning content; (c) interaction with the e-learning community (Parkes et al. 2015).

Two expert panels identified 58 e-learning competencies considered essential for e-learning. Among these, 22 competencies are related to the use of technology, and the remaining 36 competencies encapsulate a range of practices considered to be essential for learning within a social constructivist framework (e.g., online discussion). Six of the competencies were either newly added or substantially different from competencies identified in the existing literature. These areas were as follows: (1) acknowledgement of the facilitative role of the lecturer in the learning environment; (2) critiquing a website concerning content; (3) critiquing the responses of others constructively; (4) evaluating a set of search results critically; (5) making allowances for the virtual nature of the learning environment; (6) recognizing the lecturer's response as a contribution and not the final word on an issue.

Parkes et al. (2015) utilized the instrument they developed to explore student and staff perceptions of the level of preparedness among students for a university e-learning environment mediated by a learning management system. The respondents were students, staff, and e-learning stakeholders at a regional university in New South Wales, Australia. The study showed that it can be challenging to develop e-learning environments that accommodate social constructivist principles. Four important issues emerged from the study. First, students perceived themselves to be poorly prepared in terms of balancing academic and social work. Second, in the competencies associated with interactions with content, the study identified low levels of student preparedness. Third, in general, students were considered to have relatively high levels of preparedness for technical competences or competencies associated with the use of technology and the internet. Fourth, they were not well prepared in the competencies involving working with others but appeared to be reasonably prepared for dealing with responding to others. These competencies are essential in online collaborative learning (Parkes et al. 2015).

Methodology

This study adopted the English version of the Students' Preparedness in the University e-Learning Environment questionnaire developed by Parkes et al. (2015). Competency categories were included in the questionnaire as follows:

1. The management of learning and the e-learning environment
2. Interaction with the learning content
3. Interaction with the e-learning community

Each category included 20, 13, and 21 items, respectively. The adaptation of the instrument was conducted based on the guidelines of adaptation proposed by Sousa and Rojjanasrirat (2010) to ensure the translation result was valid, reliable, and consistent with the original questionnaire.

Adaptation Process

Initial Process

The initial process consists of five stages, as follows:

a) Forward translation
This process began by translating the original questionnaire), i.e., the English version, into Bahasa Indonesia by two people, a professional translator, and an expert, as well as an instructor in the field of online learning. They conducted the initial translations independently. The results of the translations of these two translators were discussed together with the researchers to produce the first draft in Bahasa Indonesia (Draft v1).

b) Backward translation
Draft v1 was translated back into English by a different expert from the expert who carried out the forward translation. The expert was fluent in the original language and had a good understanding of the target language. This stage produced Questionnaire v1.

c) Expert committee review
For finalization of the draft, the research team compared Questionnaire v1 and the original questionnaires to identify the differences. The researcher then discussed the differences with the assistance of experts to revise Draft v1 to Draft v2. The experts were including the instructors in the field of online learning in higher education. The only differences found related to word choice, where some words had similar meanings (synonyms).

d) Instrument pre-tested
In this phase, a readability and face validity test were conducted. Draft v2 was distributed to 15 students (the target respondents). The respondents were asked to read the questionnaire items and asked what they thought about the items, their choice of answers, and whether the questions about the items were confusing; they were also asked for suggestions when they were confusing. All respondents completed the test. Three students were somewhat confused by long sentences and suggested breaking these into simpler ones. The final draft resulted from the revision of Draft v2 based on the analysis of the face validity test and the respondents' suggestions. The final draft of this stage was used in the pilot testing to discover rating scales and the unidimensionality of the questionnaire; item fit was evaluated using the Rasch model.

Pilot Testing

The final draft was administered to a large representative sample of respondents for whom the questionnaire was intended. If the pilot test was conducted using small samples, relatively large sampling errors may have reduced the statistical power needed to validate the questionnaire. The purpose of pilot testing is to test the unidimensionality and rating scale of the questionnaire. An item match analysis test was also carried out to review how suitable each item was for the questionnaire. Tests were carried out using Winstep (3.73) and were based on the Rasch model. The questionnaire was distributed to 73 students from the university's Faculty of Computer Science who had been randomly selected. However, only 55 students completed the questionnaires and informed consent.

Data processing was completed using Winstep software (Linacre 2020). The answer choices on the questionnaire represented ordinal data provided as a five-point Likert scale. Because the data were ordinal, it was transformed into a logit function to formulate it as interval data. Data analysis was performed using this logit data. Data transformation was carried out using the Rasch model (Boone et al. 2013). The first test conducted after the data had been converted into a logit function was to test the suitability of the model, a reliability test related to respondents, items and person–item interactions. Next, the instrument's unidimensionality, the validity of the rating scale and item fit were tested.

Unidimensionality test. The unidimensionality test measured the extent to which the diversity of instruments measured what needed to be measured. The test provided information as to whether the

instrument met the requirements of unidimensionality, i.e., the instrument items did not cluster into several different dimensions, thereby ensuring the measurement of instruments according to measurement objectives.

The format and rating scale test. This test checked whether the format and rating scale were suitable for the target population. In other words, the rating scale test was employed to verify whether the ranking used was in any way confusing to the participants. The item format was represented by a five-point rating scale: (1) strongly disagree, (2) disagree, (3) uncertain, (4) agree, (5) strongly agree. The test was conducted by considering the order of the average observed values. If the observed values are ordered it indicates that the respondents are not confused about the order of choices. The test can also indicate whether the scales required simplification. Next, fit analysis for each item was performed. After the items satisfied the above analysis tests, a further validity test was performed.

Validity and Reliability Checking

After the translated questionnaire items passed the rating scale and unidimensionality test, the validity and reliability checking were conducted. We distributed the questionnaire to the students of Universitas Indonesia, a large public university in Indonesia and gathered 1446 respondents. Afterwards, we conducted validity and reliability checks by applying the factor and item validity tests for each part of the questionnaire. Once the questionnaire had passed the validity test, the reliability test was conducted by measuring the Cronbach Alpha's values to investigate the consistency of each part and the questionnaire. We summarized the adaptation process in the following figure (Figure 1).

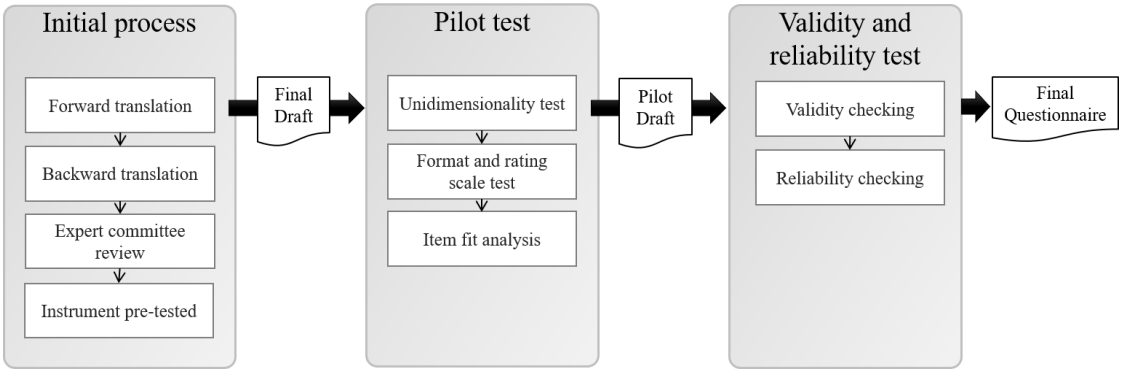


Figure 1. A summary of the adaptation process

Results and Discussion

This section presents the results of research and discussion. Results can be presented in figures, graphs, tables and others that make the reader understand easily (Beaton et al. 2000; Hashim and Tasir 2014). Following the results in each subsection, we discuss the findings.

Preliminary testing

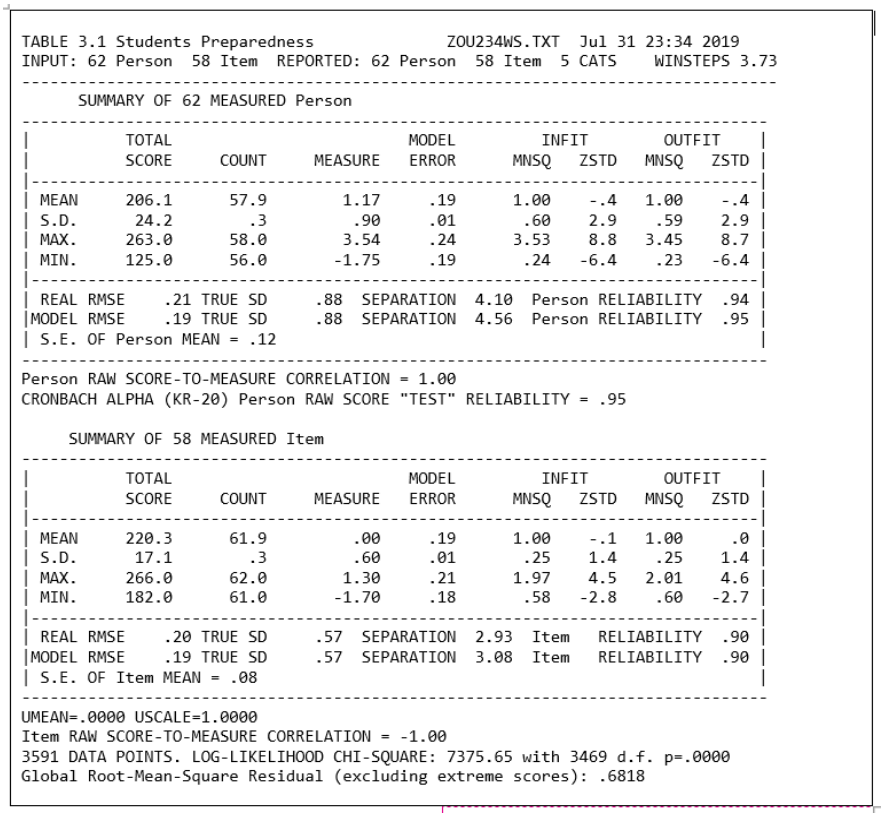
Fit Analysis of the Rasch Model

Data fit evaluation of the Rasch model is identified from the values of infit, outfit and person reliability, item and person–item interaction. The infit is the value of how close the item measures with the person measure, while the outfit is the value of how far the item measures to the person measure. The values used to test the suitability of the data against the model were MEAN (MNSQ and ZSTD) infit and outfit and item reliability. These values were compared to the fit criteria as presented by Sumintono and Widhiarso (2014). Table 1 presents statistics of the overall fit of the questionnaire items compared to the accepted values presented in Bond and Fox (2013) and Sumintono and Widhiarso (2014).

Table 1. The Fit Statistics of Items Based on The Rasch Model

Criteria	Statistics	Accepted value	Result	Ideal value
infit	1.00	0.5 - 1.5	ideal	1.00
infit ZSTD	-0.4	-2 - +2	fit	0.0
outfit MNSQ	1.00	0.5 - 1.5	ideal	1.00
outfit ZSTD	-0.4	-2 - +2	fit	0.0
item reliability	0.90	> 0.7	high	

The MNSQ (mean squared) infit value is close to ideal, and the MNSQ (mean square) outfit value is equal to the ideal one. The ZSTD (Z-standard) infit and outfit values are close to the ideal value of 0.00, and the item reliability is good. In conclusion, the data fits the model. Additionally, based on the overall suitability of the data with the model, the fit-test can be conducted up to the item level, person reliability, and person–item interactions. A summary of the initial statistical data is presented in Figure 2.



```
TABLE 3.1 Students Preparedness              ZOU234WS.TXT  Jul 31 23:34 2019
INPUT: 62 Person  58 Item  REPORTED: 62 Person  58 Item  5 CATS    WINSTEPS 3.73
-------------------------------------------------------------------------------
      SUMMARY OF 62 MEASURED Person
-------------------------------------------------------------------------------
|          TOTAL                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     206.1      57.9        1.17     .19      1.00    -.4   1.00    -.4 |
| S.D.      24.2        .3         .90     .01       .60    2.9    .59    2.9 |
| MAX.     263.0      58.0        3.54     .24      3.53    8.8   3.45    8.7 |
| MIN.     125.0      56.0       -1.75     .19       .24   -6.4    .23   -6.4 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .21 TRUE SD     .88  SEPARATION  4.10  Person RELIABILITY  .94 |
|MODEL RMSE    .19 TRUE SD     .88  SEPARATION  4.56  Person RELIABILITY  .95 |
| S.E. OF Person MEAN = .12                                                   |
-------------------------------------------------------------------------------
Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .95

     SUMMARY OF 58 MEASURED Item
-------------------------------------------------------------------------------
|          TOTAL                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     220.3      61.9         .00     .19      1.00    -.1   1.00     .0 |
| S.D.      17.1        .3         .60     .01       .25    1.4    .25    1.4 |
| MAX.     266.0      62.0        1.30     .21      1.97    4.5   2.01    4.6 |
| MIN.     182.0      61.0       -1.70     .18       .58   -2.8    .60   -2.7 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .20 TRUE SD     .57  SEPARATION  2.93  Item   RELIABILITY  .90 |
|MODEL RMSE    .19 TRUE SD     .57  SEPARATION  3.08  Item   RELIABILITY  .90 |
| S.E. OF Item MEAN = .08                                                     |
-------------------------------------------------------------------------------
UMEAN=.0000 USCALE=1.0000
Item RAW SCORE-TO-MEASURE CORRELATION = -1.00
3591 DATA POINTS. LOG-LIKELIHOOD CHI-SQUARE: 7375.65 with 3469 d.f. p=.0000
Global Root-Mean-Square Residual (excluding extreme scores): .6818
```

Figure 2. Summary Statistics

Figure 2 shows the participant's reliability and the validity of items in the questionnaire, and the interaction between persons and items (Cronbach's Alpha). Overall, the average participant's score (person mean measure) is 1.00; this is higher than the average item score (item mean measure) of 0.0, indicating that the respondents tended to have a good understanding of the questionnaire, therefore the probability of the question answered correctly by the respondents can be related to the ability of the respondent. Figure 2 also shows that person and item reliability are, respectively, 0.94 (very good) and 0.90 (good). The Cronbach's Alpha value of 0.95 exhibits excellent interaction between the respondents and items.

Unidimensionality Test

The Rasch model is useful to test the unidimensionality of items, one of the fundamental tests needed. To investigate whether the items of the questionnaire are unidimensional, the raw variance and the unexplained variance of the data are compared to the acceptable values. The information about the two types of variances is shown in the Figure 3.

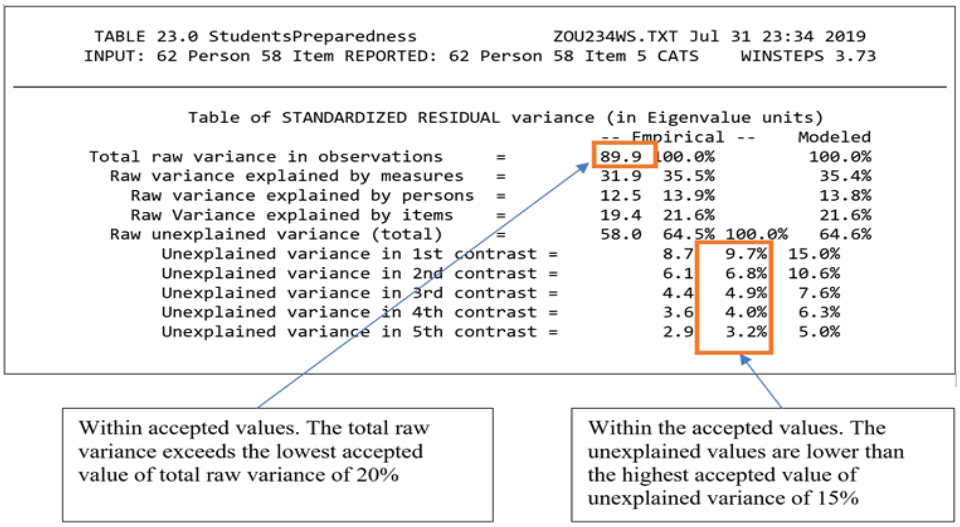


Figure 3. The Unidimensionality Test

The raw variance of 35.5% exceeds the lower limit of the lowest accepted value of 20%. The raw variance is used to show that the data distribution is close to the data central. In addition, all unexplained variances are less than the highest accepted value of 15%. Therefore, the instrument meets the unidimensional requirements, i.e., the instrument items do not cluster into two or more different dimensions. Therefore, the instrument is functional according to the measurement objectives.

Rating Scale Validity Test

The choices for the rating scale on the e-learning readiness questionnaire are: (1) unprepared; (2) not very prepared; (3) somewhat prepared; (4) prepared; (5) very prepared. The rating scale measurement (RSM) validity test was conducted to check whether the respondents understood the order of choices well.

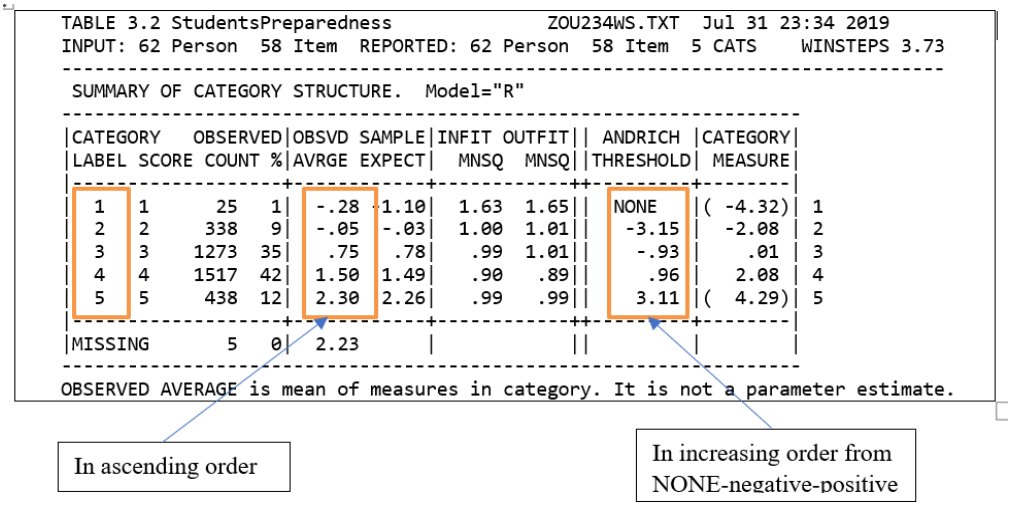


Figure 4. Statistics for Rating the Scale Test

Figure 4 shows the value is sorted to positive value, it indicated that the rating scale was valid, and the respondents were not confused about the order of choices. Figure 4 also shows that each choice of the rating scale was selected by participants. The choices were well understood by the respondents. They were able to distinguish between choices 1, 2, 3, 4 and 5. In addition, the table provides the Andrich threshold values are: NONE, -3.15, -0.93, 0.96 and up to 3.11. The values are in an orderly manner to positive numbers. It indicates that the choices are valid and do not need to be simplified.

Item-fit Statistics

To test whether each item fit the model, the item measure scores are compared to the standard item match values. Item C14, i.e., 'encourages others to post through positive responses' (*mendorong orang lain untuk memberi tanggapan positif*) does not fit the model. The MNSQ INFIT value of 1.97 was greater than 1.25, (MEAN + SD MNSQ INFIT); the MNSQ OUTFIT value of 2.01 was greater than the acceptable limit, i.e., 1.5; the ZSTD OUTFIT value of 4.6 exceeded the upper limit accepted value of 2; the Pt values measuring CORR. was 0.23, less than the acceptable lower limit of 0.4. This misfit may have been caused by the meaning of the item coming across as ambiguous and open to more than one interpretation (Boone et al. 2013). In-depth interviews with selected respondents revealed that they were confused about the meaning of 'positive responses' as 'providing encouragement or appreciation', or narrowly interpreted this as 'responses about positive aspects only'. The sentence for item C14 was then simplified to, *'mendorong orang lain memberi tanggapan yang bermakna'*, which has a slightly different meaning, 'Encouraging others to give meaningful responses', 'Meaningful responses' has neutral and a more general meaning. It may refer to types of critiques about failures (e.g., indicating misconceptions) or to comments about achievements. The final questionnaire contains 3 latent variables: (A) Management of e-learning and e-learning environment that have 24 indicator variable, (B) Interaction with e-learning content that have 13 indicator variable, and (C) Interaction with e-learning community that have 21 indicator variable (see Appendix).

Validity and Reliability Checking

The translated questionnaire items passed the rating scale and unidimensionality tests. Subsequently, a test was conducted among intended populations for validation.

SAF Data Collection and Analysis

The data was collected in May 2019, in the middle of the second semester of the 2019/2020 academic year. The sampling method used is proportional random sampling by each faculty. The sample size of 1446 included first-year students from Universitas Indonesia, a large public university in Indonesia, who completed the questionnaire and signed the informed consent form. Initially, 2081 respondents participated; however, some of them did not complete the questionnaire. Table 2 shows total number of participant and age qualification of the participant.

Table 2. Study Participants

Total number of participants	**Age**
1446 students	18-23 years old

The questionnaire comprised three parts. Part A included the management of learning and the e-learning environment. Part B addressed interaction with the learning content. Part C represented interaction with the e-learning community. Validity and reliability checks were applied for each part of the questionnaire (factor and item validity).

The factor validity measured the validity of the items throughout the corresponding part (A, B, or C) and for the entire questionnaire. The item validity measured the validity of each item throughout the corresponding part. Once the questionnaire had passed the validity test, the reliability test was conducted to investigate the consistency of each part and the questionnaire.

The Validity and Reliability of Items in Part A: Management of Learning and E-learning Environment

The validity test for the items in Part A was carried out by observing the 'Corrected Item-Total Correlation' column in Table 3. The value in this column was the calculated r-value of each item in Part A. If the r-value of an item is greater than the R Table, the item is deemed valid. The R Table value used for DF = n-2 = 1466-2 = 1464, and of alpha = 0.05, is 0.0512. Table 3 summarizes the results of the validity tests for each item of Part A.

Table 3. The Validity of Items in Part A

Item-Total Statistics							
Item	***Scale Mean if Item Deleted***	***Scale Variance if Item Deleted***	***Corrected Item-Total Correlation (r-value)***	***Squared Multiple Correlation***	***Cronbach 's Alpha if Item Deleted***	***R Table***	***Output***
A1	185.82	366.663	.466	.334	.930	.0512	Valid
A2	185.13	375.056	.404	.389	.931	.0512	Valid
A3	185.63	366.787	.514	.484	.930	.0512	Valid
A4	186.03	360.137	.567	.497	.929	.0512	Valid
A5	185.59	366.561	.535	.517	.929	.0512	Valid
A6	187.37	350.843	.549	.414	.930	.0512	Valid
A7	186.28	357.099	.681	.561	.927	.0512	Valid
A8	185.65	362.907	.655	.625	.928	.0512	Valid
A9	185.99	362.653	.656	.502	.928	.0512	Valid
A10	185.68	365.771	.583	.454	.929	.0512	Valid
A11	186.90	350.717	.586	.492	.929	.0512	Valid
A12	186.29	353.378	.661	.594	.927	.0512	Valid
A13	185.97	363.387	.544	.398	.929	.0512	Valid
A14	186.46	357.330	.673	.549	.927	.0512	Valid
A15	186.15	356.281	.554	.441	.929	.0512	Valid
A16	186.40	357.018	.587	.449	.929	.0512	Valid
A17	185.89	361.726	.643	.494	.928	.0512	Valid
A18	186.39	361.702	.543	.384	.929	.0512	Valid
A19	186.49	352.756	.693	.567	.927	.0512	Valid
A20	186.20	357.658	.593	.478	.929	.0512	Valid
A21	186.20	358.744	.529	.418	.930	.0512	Valid
A22	186.15	358.395	.661	.481	.928	.0512	Valid
A23	186.43	358.497	.579	.622	.929	.0512	Valid
A24	186.53	355.592	.612	.661	.928	.0512	Valid

The reliability test of items in Part A was carried out by considering the value in 'Cronbach's Alpha based on standardized items' (see Table 5). If the Cronbach's Alpha value was greater than 0.7 the items were reliable (Bolarinwa and others 2015). A low Cronbach's Alpha value indicated a low correlation between items. It should be noted that Cronbach's Alpha is not an estimate of reliability for a questionnaire under all circumstances; it only indicates the extent to which the questionnaire is reliable for a population.

Table 4 shows that the Cronbach's Alpha value is 0.934, higher than the lower limit of 0.7, it indicates the items in Part A are reliable.

Table 4. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.931	.934	24

Had the value been greater than the Cronbach's Alpha in the reliability statistics table (Table 4), the item should have been excluded. Consider the column 'Cronbach's Alpha if item deleted' in Table 3. All items should be included in Part A since the value of Cronbach's Alpha in this column is smaller than the Cronbach's Alpha in Table 4. In other words, the questionnaire will be more reliable if this item is deleted from Part A. In conclusion, based on the results of Table 3 and Table 4, the items in Part A are valid and reliable for measuring students' readiness in terms of management of learning and the e-learning environment.

The Validity and Reliability of Items in Part B: Interaction with the Learning Content

Part B comprised 13 items related to competencies for accessing, managing, and utilizing teaching materials in various formats. The validity of the items in Part B was identified by observing the 'corrected item-total statistics' column of Table 6. Consider the column 'Cronbach's Alpha if item deleted' in Table 5. All values in this column are lower than 0.907 and the "Corrected Item-Total Correlation" value in each item is higher than R table (0.502); therefore, all items should be included in Part B, all items were valid.

Table 5. Validity Items of Part B

Item-Total Statistics							
Item	***Scale Mean if Item Deleted***	***Scale Variance if Item Deleted***	***Corrected Item-Total Correlation (r-value)***	***Squared Multiple Correlation***	***Cronbach's Alpha if Item Deleted***	***R Table***	***Output***
B1	113.6088	141.794	.617	.517	.897	.0512	Valid
B2	113.7108	140.392	.681	.571	.894	.0512	Valid
B3	113.4372	139.779	.580	.522	.898	.0512	Valid
B4	113.4454	142.626	.580	.388	.898	.0512	Valid
B5	113.5075	140.161	.659	.566	.895	.0512	Valid
B6	113.5089	139.499	.626	.516	.896	.0512	Valid
B7	113.0655	142.861	.629	.534	.896	.0512	Valid
B8	113.4441	142.609	.604	.464	.897	.0512	Valid
B9	113.6596	140.598	.673	.586	.895	.0512	Valid

Item-Total Statistics							
Item	***Scale Mean if Item Deleted***	***Scale Variance if Item Deleted***	***Corrected Item-Total Correlation (r-value)***	***Squared Multiple Correlation***	***Cronbach's Alpha if Item Deleted***	***R Table***	***Output***
B10	113.6965	143.298	.556	.406	.899	.0512	Valid
B11	113.6576	141.202	.685	.532	.894	.0512	Valid
B12	113.5089	141.990	.593	.400	.897	.0512	Valid
B13	113.8315	140.456	.563	.357	.899	.0512	Valid

Table 6. Reliability Statistics Part B

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.904	.907	13

Table 6 shows the reliability test for part B. As shown in Table 6, the value of Cronbach's Alpha was 0.904, greater than 0.7. Therefore, the items in Part B are reliable. In conclusion, the items in Part B are valid and reliable for measuring students' preparedness in interacting with the learning content.

The Validity and Reliability of Items in Part C: Interaction with E-learning Community

Part C of the preparedness questionnaire focuses on interactions between the student and other participants (other students, tutors, and instructors) in an online discussion forum and other types of group work. Table 7 presents the validity test results for each item of Part C. The final column (output) indicates that each item is valid.

Table 7. The Validity of Items in Part C

Item-Total Statistics							
Item	***Scale Mean if Item Deleted***	***Scale Variance if Item Deleted***	***Corrected Item-Total Correlation (r-value)***	***Squared Multiple Correlation***	***Cronbach's Alpha if Item Deleted***	***R Table***	***Output***
C1	173.1760	352.224	.564	.430	.933	.0512	Valid
C2	173.1561	347.915	.259	.099	.944	.0512	Valid
C3	173.3894	346.752	.590	.434	.932	.0512	Valid
C4	174.1248	330.436	.654	.548	.931	.0512	Valid
C5	173.4556	342.420	.677	.586	.931	.0512	Valid
C6	174.0357	338.571	.648	.532	.931	.0512	Valid
C7	173.5934	341.845	.710	.607	.930	.0512	Valid
C8	173.1844	348.681	.620	.512	.932	.0512	Valid
C9	172.9338	351.314	.605	.550	.932	.0512	Valid
C10	173.6442	341.944	.688	.589	.931	.0512	Valid
C11	173.6843	343.015	.744	.640	.930	.0512	Valid

Item-Total Statistics							
Item	***Scale Mean if Item Deleted***	***Scale Variance if Item Deleted***	***Corrected Item-Total Correlation (r-value)***	***Squared Multiple Correlation***	***Cronbach's Alpha if Item Deleted***	***R Table***	***Output***
C12	173.4986	342.272	.729	.610	.930	.0512	Valid
C13	173.3485	346.632	.650	.523	.932	.0512	Valid
C14	173.9140	340.865	.643	.538	.931	.0512	Valid
C15	173.6899	345.171	.697	.609	.931	.0512	Valid
C16	173.6304	344.726	.673	.516	.931	.0512	Valid
C17	174.4368	332.236	.636	.534	.932	.0512	Valid
C18	173.4921	343.977	.662	.515	.931	.0512	Valid
C19	173.6855	341.618	.713	.612	.930	.0512	Valid
C20	173.7073	341.616	.701	.566	.931	.0512	Valid
C21	174.1954	337.886	.632	.531	.932	.0512	Valid
C22	173.4655	343.567	.512	.433	.934	.0512	Valid

Overall, the items in Part C were reliable as shown by the value of Cronbach's Alpha at 0.934 (Table 8).

Table 8. Reliability Statistics in Part C

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.934	.944	22

Note that the value of 'Cronbach's Alpha if item deleted' for item C2 was 0.944, greater than 0.934. It indicates that Part C of the questionnaire will be more reliable if item C2, 'seeks information through either own enquiries or the questioning of others' is removed. In this case, Cronbach's Alpha value from 0.934 will rise to 0.944. However, we also can use the column "Cronbach's Alpha Based on Standardized Items", by comparing the Cronbach's Alpha value in Table 8 with Cronbach's Alpha C2 in Table 7, the value is equal. It indicates that overall, the items (including item C2) were reliable. Next, the validity and reliability of parts A, B, and C were tested against the questionnaire.

The Validity and Reliability of Parts A, B, and C

After each indicator in part A, B, C was tested by validity and reliability test. Table 9 is present the validity test for each part. The values of R-Count were greater than the R Table. Therefore, all parts of the questionnaire are valid.

Table 9. The Validity of Parts A, B and C

Part	R-Count	R Table	Output
Part A	.806	.0512	Valid
Part B	.817	.0512	Valid
Part C	.770	.0512	Valid

Furthermore, Table 10 is shown the reliability statistic test for overall parts. The Cronbach's Alpha presented in the reliability statistics table is 0.897 higher than 0.7, indicating that all parts of the questionnaire were reliable. We concluded that parts A, B and C of the questionnaire were valid and reliable for measuring students' preparedness to study in an e-learning environment.

Table 10. Reliability of Parts A, B and C

Cronbach's Alpha	N of Items
.897	3

The correlation between each pair of parts of the questionnaire is important to ensure the impact of a change in certain items on others. Next, we investigate the correlation among parts of the questionnaire.

Correlations Among Parts A, B, and C

The correlation among parts A, B and C is shown in Table 11. Table 11 shows the correlation between the pairs of the three parts. The correlation score between Part A and Part B is 0.782. This indicates that the items of Part A had a strong relationship with the items of Part B. Similarly, the correlation score between Part A and Part C is 0.719, indicating that the items of Part A had a strong positive relationship with the items of Part C. Items of Part B and items in Part C have strong correlation as indicated by the correlation score of 0.735. In conclusion, the items of parts A, B and C have a positive and strong correlation.

Table 11. Correlations between the three questionnaire parts

Part		A	B	C
A	Pearson Correlation	1	.782**	.719**
	Sig. (2-tailed)	-	.000	.000
	N	1466	1466	1466
B	Pearson Correlation	.782**	1	.735**
	Sig. (2-tailed)	.000	-	.000
	N	1466	1466	1466
C	Pearson Correlation	.719**	.735**	1
	Sig. (2-tailed)	.000	.000	-
	N	1466	1466	1466

** Correlation is significant at the 0.01 level (2-tailed).

Summary of Results

Based on the fit statistics of all items in Table 1, the data fits the model. The summary statistics in Figure 2 shows the respondents tended to have a good understanding of the questionnaire and the person and item reliability are very good and good. Furthermore, the Cronbach's Alpha value exhibits excellent interaction between the respondents and items.

The unidimensionality test in Figure 3 depicts that the instrument is functional according to the measurement objectives. Rating scale validity test indicated that it is valid, and the respondents do not confuse about the order of choices (Figure 4). Moreover, item fit statistics shows all items fit except item C14; this was due to the multi-interpretational nature of the item. The item was included in the following revision (pilot questionnaire).

After passing the rating scale and unidimensionality tests, a test was conducted among intended populations (n = 1446) for validation and reliability checking. The results show that the items in each part (A, B, or C) are valid and reliable for measuring students' preparedness in terms of management of learning and the e-learning environment, interaction with the learning content, and interaction with the learning community. All parts of the questionnaire are also valid and reliable for measuring students' preparedness to study in an e-learning environment. Additionally, the items of parts A, B and C have a positive and strong correlation.

Conclusion

The current study selected the instrument for translation and adaptation into Bahasa Indonesian based on its wide range of competencies coverage, including online collaborative learning competency. In addition, the e-learning competencies identified in this study described in observable and measurable terms the requisite knowledge, understanding, skills, attitudes, and behaviors students require for effective performance in the university e-learning environment. The adaptation process followed the following steps: forward translation, backward translation, expert committee review for the finalization of the draft and instrument pre-testing.

Pilot testing was conducted to test the unidimensionality, rating scale validity, and item fit of the questionnaire. The results showed that the instrument was unidimensional and that the respondents understood the rating scale well. Following the pilot testing, the validity and reliability tests for items in parts A, B and C concluded that the items of each part are valid and reliable. Likewise, parts A, B and C of the questionnaire were deemed valid and reliable. The items in these three parts also indicated a positive and strong correlation. Therefore, the final questionnaires can be used to measure student preparedness to learn in an e-learning environment in the perception of students. It is well suited for Indonesian because it considers language (translation) and cultural adaptation issues.

By understanding students' level of readiness for the university e-learning environment, lecturers can design proper instructional strategies accordingly and help them to improve their readiness. Additionally, the cross-cultural adaptation method used in this study can be applied in different context of translation to increase its validity and reliability. The limitation of the present study was that the participants, despite being multi-ethnic, all studied at the same university. Further questionnaire adoption involving several universities from different regions or educational degrees may serve as a potential research topic in the future.

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Appendix

Code	Competencies (Original version)	Kompetensi (Bahasa Indonesia version)
A	**management of e-learning and e-learning environment**	***pengelolaan pembelajaran daring dan lingkungan pembelajaran daring***

A1	downloads and uploads information and resources	*mengunggah dan mengunduh informasi dan sumber bela jar*
A2	uses search engines effectively	*menggunakan mesin pencari secara efektif*
A3	uses a web browser with skill and purpose	*menggunakan webbrowser dengan terampil sesuai tujuan*
A4	integrates a variety of software applications to create a product	*mengintegrasikan berbagai aplikasi perangkat lunak untuk menciptakan suatu luaran/produk*
A5	uses technology to assist in the construction of knowledge	*menggunakan teknologi untuk membantu pemahaman da n pembentukan pengetahuan*
A6	works to a disciplined timeframe	*belajar/ bekerja secara disiplin dan terjadwal*
A6	adapts learning style to the e-learning environment	*beradaptasi dengan gaya belajar yang sesuai dengan lingkungan pembelajaran daring*
A7	uses technology to support own learning style	*menggunakan teknologi untuk mendukung pembelajaran sesuai dengan gaya belajar*
A8	identifies the requirements necessary to complete a task	*mengidentifikasi semua kebutuhan untuk menyelesaikan tugas*
A9	searches the Internet strategically	*mencari informasi menggunakan Internet dengan strategi yang baik*
A10	anticipates and makes allowances for "wait time" in asynchronous discussions	*mengantisipasi dan memberikan waktu tunggu (jeda waktu menunggu tanggapan) dalam diskusi asinkron*
A11	demonstrates knowledge and use of the Learning Management System	*menunjukkan pengetahuan dan kemampuan menggunakan Learning Management System*
A12	undertakes set tasks independently	*mengerjakan tugas secara mandiri*
A13	uses problem solving strategies	*menerapkan strategi penyelesaian masalah*
A14	priorities competing tasks within the time available	*membuat skala prioritas dalam mengerjakan tugas-tugas yang harus diselesaikan secara bersamaan*
A15	uses feedback to evaluate own performance (self-critique)	*memanfaatkan umpan balik untuk mengevaluasi kinerja diri sendiri (mengritik diri sendiri)*
A16	selects the appropriate technology tool for the task at hand	*memilih teknologi yang sesuai untuk menyelesaikan tuga s yang dihadapi*
A17	employs a logical process to identify and solve a computer problem	*menerapkan tahapan logis untuk menyelesaikan masalah terkait dengan penggunaan komputer*
A19	plans an appropriate strategy to undertake a task	*membuat perencanaan strategi yang sesuai untuk menyelesaikan tugas*
A20	views oneself positively as a learner	*memandang diri sendiri secara positif sebagai pemb elajar*
A21	balances work, social, family and study commitments	*menyeimbangkan beban kerja, komitmen belajar dengan kehidupan sosial dan keluarga*
A22	makes allowances for the virtual nature of the learning environment	*menggunakan keleluasaan yang ditawarkan oleh lingku ngan belajar virtual*
A23	engages in the process of reflection	*terlibat dalam proses refleksi (menilai diri sendiri)*
A24	understands own cognitive processes and thinking strategies	*memahami proses berpikir sendiri dan strategi bernalar*
B	**interaction with the learning content**	***interaksi dengan konten pembelajaran***
B1	forms connections between prior knowledge and new knowledge	*mengaitkan antara pengetahuan lama dengan pengetahuan yang baru dipelajari*
B2	able to navigate large bodies of content	*mampu menavigasi konten (materi) pembelajaran dalam jumlah banyak*
B3	presents information in a variety of formats (video, audio, etc)	*menyajikan konten (materi) pembelajaran dalam berbagai format (video, audio, dll)*
B4	reads and writes at an appropriate level	*membaca dan menulis sesuai dengan kebutuhan*
B5	extracts information from a variety of formats	*mengambil intisari dari informasi yang tersaji dalam berbagai format*
B6	cross references between sources to determine accuracy	*membandingkan berbagai sumber informasi untuk menguji akurasinya*
B7	accesses information from a variety of sources (e.g. web pages, podcasts)	*mengakses informasi dari berbagai sumber (contoh: halaman web, podcast)*
B8	able to distinguish between relevant and irrelevant items	*mampu membedakan informasi mana yang relevan dengan yang tidak relevan*

B9	evaluates a set of search results critically	*mengevaluasi hasil penelusuran secara kritis*
B10	identifies and rectifies gaps in one's own understanding	*mengidentifikasi kesenjangan pemahaman sendiri dan berupaya memperbaikinya*
B11	develops responses which synthesize a range of ideas	*mengembangkan respons/tanggapan yang meramu dan mengintegrasikan berbagai gagasan*
B12	goes outside the technology and learning community to seek information	*mencari informasi dari luar tidak terbatas pada teknologi dan komunitas belajar daring*
B13	critiques a web site in relation to content	*mengritik website berkenaan dengan konten yang dimuatnya*
C	**interaction with the e-learning community**	***interaksi dengan komunitas pembelajaran daring***
C1	responds to others with respect)	*menanggapi anggota lain dengan rasa hormat kepada a nggota lain*
C2	seeks information through either own enquiries or the questioning of others	*menggali informasi dengan bertanya pada diri sendiri atau orang lain*
C3	applies the rules of netiquette consistently	*menjunjung etika dalam berkomunikasi lewat internet dengan konsisten*
C4	uses interpersonal communication skills	*menerapkan kemampuan komunikasi interpersonal*
C5	considers and acts upon feedback from members of the learning community	*mempertimbangkan dan menggunakan umpan balik dari komunitas belajar*
C6	shares personal experiences in responses when relating to topic and others	*berbagi pengalaman pribadi yang terkait dengan topik bahasan atau anggota lain*
C7	works with others to collaboratively construct knowledge	*bekerjasama secara kolaboratif untuk membentuk pengetahuan*
C8	willing to have ideas challenged	*bersedia gagasannya dikupas dan dikritisi*
C9	acknowledges the facilitation role of lecturer in the learning environment	*menghargai dan mengakui peran dosen sebagai fasilitator dalam lingkungan belajar*
C10	contributes new ideas to a discussion	*berkontribusi dengan mengajukan ide baru dalam diskusi*
C11	provides responses in clear, concise and unambiguous language	*memberi tanggapan dengan jelas, tepat, dan tidak ambigu (bermakna ganda)*
C12	views oneself as a member of the learning community	*memandang diri sebagai bagian dari komunitas belajar*
C13	asks for guidance or seek clarification for misunderstandings	*meminta pendapat atau menglarifikasi pemehaman yang salah*
C14	encourages others to post through positive responses	*mendorong anggota lain untuk memberi tanggapan yang bermakna*
C15	justifies own stance on an issue	*mengajukan justifikasi pendapat atau pendirian terhadap masalah*
C16	determines when it's time to 'listen' to or contribute a response	*menentukan kapan 'mendengar' dan kapan berkontribusi memberi tanggapan*
C17	arranges schedule to allow for regular online sessions	*mengatur waktu untuk mengikuti sesi daring secara teratur*
C18	recognizes lecturer's response as a contribution and not final word on an issue	*memahami bahwa tanggapan dosen merupakan kontribusi dan bukan keputusan akhir dalam menyelesaikan masalah*
C19	critiques the responses of others constructively	*mengajukan kritik konstruktif terhadap tanggapan orang lain*
C20	seeks interaction with other members of the learning community	*berupaya berinteraksi dengan anggota lain dalam komunitas belajar*
C21	comments upon or critiques a response made by the lecturer	*memberi komentar atau mengritisi tanggapan yang diberikan dosen*

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Acceptance Analysis of the Electronic Kohort Information System for Maternal and Child Health Using the Technology Acceptance Model at the Bima City Health Center

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Abstract

The Maternal and Child Health Program (MCH) in Indonesia is faced with a diversity of achievements between regions caused by disparities in the capacity of the health system and exacerbated by the Covid-19 pandemic which has caused a decrease in service activities and reporting quality so that digitalization of services is needed. This type of research is qualitative research with a phenomenological study design using thematic analysis with the help of the Nvivo 12 application. Primary data collection was carried out by observation and in-depth interviews with research informants by purposive sampling. To increase the credibility of the data use source triangulation. The research informants consisted of the head of the family health service section, the head of the health center, and the midwife as an e-kohort user. Thirteen informants (11 women and 2 men) participated in the study. Most informants can use the core functions of the e-kohort app's navigation menu. The study proposes that perceived perceptions of ease of use may not be in line with perceived expediency to explain variations in the successful acceptance of MCH e-kohort applications. The study also found that there were differences in outcomes between user perceptions at the operational level and policymakers at the managerial level. In general, the analysis collected several types of obstacles and potential problems that negatively affect the usability of e-kohort applications: not being able to make the work of midwives easier and faster, ineffective, and not so much increased performance productivity. With regard to ease of use, users feel that the e-kohort can be easily learned and used. E-kohort is considered to have value as a system that makes the work of midwives more difficult and hinders work, but the

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appearance, elements, features, and design are considered quite easy to use. In addition, users also highlighted the need to consider how the system can be implemented to minimize impact and optimize usability

Keywords: Admissions, Health Information Systems, Electronic Kohort. Maternal and Child Health, Technology Acceptance Model

Introduction

Maternal and Child Health (MCH) is one of the fundamental health service programs in Indonesia and is a world priority. This is the initial stage of the treatment series in which the mother, baby, and children are inseparable in care needs. Unfortunately, there are differences in MCH results between regions caused by the uneven capacity of the health services system such as human resources, facilities, infrastructure, tools, and financing. In addition, the COVID-19 pandemic has also caused a decrease in reporting on maternal and child health services (Smeru 2020) monthly routine reports are also underutilized for decision-making. The low use of such data is indicated due to problems in data accessibility (Zainal et al. 2013).

Several factors cause the high rate of maternal mortality cases, namely not utilizing existing information media facilities (Rachmawati et al. 2017), delays in making decisions to be referred (Rachmawati et al. 2017) and lack of data collection of pregnant women. One of the important components to reducing the causes of the high maternal mortality rate (MMR) is the accessibility of accurate, precise, and up-to-date information (Wicahyono et al. 2019).

The use of information technology in the health sector can support the accessibility of precise and accurate data and information (Yani 2018). Boring and less effective manual recording should be transformed into technology-based recording that can further improve access to data and information (Lazuardi et al. 2021). This is in accordance with the National Medium-Term Development Plan (RPJMN) 2020-2024, which is to improve health services towards universal health coverage supported using technology or digital transformation, one of which is the use of information technology for services and reporting in the MCH program. However, there are still some health service problems, namely access to health data, data consistency, data standardization, and data recording (Kemenkes RI 2021a).

The main benefits of using technology-based information systems are economic advantages and benefits of information system management, as well as making better planning (Sadoughi & Erfannia 2017; Payne et al. 2019) can help stakeholders to make the right choices in decision-making (Yusuf et al. 2018; Davlyatov et al. 2019). Electronic health record data can extract much more useful information from data sources that are currently under-analyzed from the community level and reduce errors and can work on clinical cycles and patient outcomes (Küllmar & Zarbock 2018; Rush et al. 2019)

However, recently the acceptance of the use of information innovations or new technologies has become something very interesting to research (Kabbiri et al. 2018). Use is the main key in estimating the achievement of a system. User acceptance is also the most powerful factor in the implementation and use of information systems because regardless of how modern the system is, it will not be done correctly without user support (Sharifian et al. 2014).

The data shows a downward trend in the MMR indicator (per 100,000 live births), with a decrease of -1.80 percent per year from 390 in 1991 to 230 in 2020. Despite the decline, MMR has not reached the 2015 MDG target of 102, nor has it reached the 2030 SDG target of less than 70 per 100,000 live births. In addition, the AKB indicator also shows a downward trend from 68 in 1991 to 24 in 2017, down by -3.93 percent per year. AKB, like AKI, has not yet reached the 2015 MDGs target of 23 or the 2030 SDGs target of 12 (Kemenkes RI 2020). In Bima City alone, the number of MMR reported in 2019 was 183 per 100,000 live births. In the midst of the COVID-19 pandemic situation, maternal and infant mortality rates have soared. The maternal mortality rate increased by 300 cases from 2019 to around

4,400 deaths in 2020 while infant deaths in 2019 around 26,000 cases increased by almost 40 percent to 44,000 cases in 2020 (Arlinta 2021).

From September 2019 to January 2020 the e-kohort application has been tried in 15 districts/cities selected as pilot project locations in Indonesia and NTB itself represented by Central Lombok Regency. Based on the results of an implementation survey conducted at the end of December 2020, the e-kohort application is considered very helpful for health workers and in 2021 it began to be applied throughout Indonesia (Sijariemas Teknologi Inovasi 2021). In September 2021, puskesmas in Bima City started implementing it. In the initial research, information was obtained that some users felt depressed and burdened by the existence of the MCH e-kohort application, so this study was the initial stage of evaluating the acceptance of information systems.

Several theories can be adopted to analyze this phenomenon. However, TAM gained significant popularity and is considered a "key model" (Marangunić & Granić 2015), or "gold standard" (Holden & Karsh 2010), being able to explain the determinants of acceptance (Ammenwerth 2019), being a measurement tool rapidly, while assessing the needs of different user groups (Ammenwerth 2019; Shachak et al. 2015). (Holden and Karsh 2010)TAM can also provide the best commitment in anticipating and describing user recognition (Utomo et al. 2018), can find components that directly affect user behavior (Kinanti & Pertiwi 2019; Shachak et al. 2019), can understand and study the factors that influence the acceptance of the use of computer-based technological innovations (Joo et al. 2018; Kinanti & Pertiwi 2019), (Joo et al. 2018)even being an important model in understanding the indicators of human behavior towards the possible acceptance or rejection of technology (Marangunić & Granić 2015).

This study tried to identify trends in the acceptance of technology-based information systems (e-kohorts) by users using the TAM method. From the review of the results of previous studies, it was found that inconsistencies or differences in the research results in the two main constructs of TAM, namely the perception of usefulness and the perception of ease of use so researchers feel that this still needs to be studied again such as Nugroho et al. (2021) and Mikarsih et al. (2020) saying that both do not affect implementation, but other opinions such as Rumana et al. (2020) and Mulyono et al. (2020) said that each of the two constructs has an implementation.

The Technology Acceptance Model (TAM) method was used in this study because it was in line with the purpose of the study, namely, to identify the acceptance of the MCH e-kohort application information system using two main constructs in TAM theory and become a model that is able to answer questions in this study. TAM can also provide the best commitment in anticipating and describing user recognition of technological innovations in an organization.

Literature Review

Maternal and Child Health Kohort (MCH)

MCH e-kohort is a web and mobile-based application that could record maternal, infant, and child health services that produce cohorts for maternal, infant, and child health checks (MCH). The KIA e-Kohort is a digitization of the MCH services cohort. This structure is an electronic MCH cohort that remembers information for health services for pregnant women, maternity mothers, post-pregnancy mothers, toddlers (babies), newborns, and babies or children under 5 years old (Kemenkes RI 2021b).

The MCH cohort is an important data set because it contains total important information data, records of assessment results, and health services provided from the stage of pregnancy until the child arrives at the age of 5 years (Sijariemas Teknologi Inovasi 2021). The MCH e-kohort application is also a digitization of the cohort of maternal and child health services, which includes data on health services for pregnant women, maternity mothers, postpartum mothers, neonates (newborns), infants, and toddlers (under the age of 5 years). This MCH cohort is important data because it contains complete information about basic data, recorded examination results, and health services provided from the gestation phase of the mother to the toddler age of 5 years (Kemenkes RI 2021b). The use of e-kohort

is also expected that the data search process can be carried out faster, health workers will get notifications or notifications when pregnant women, babies, and toddlers have a risk of danger so that they can immediately follow up and with a dashboard can help health workers to monitor MCH service indicators (Laksmi 2021).

E-kohort can function in timely monitoring, namely with multilevel monitoring (starting with the determination carried out by the puskesmas, then it can be seen by the district/city health office as well as the provincial health office and the Directorate of Family Health of the Ministry of Health of the Republic of Indonesia so that they provide mutual feedback), Remote or remote monitoring to minimize visit activities, and the method of filling in the e-kohort can compare indicators over time. This digital-based group has been registered and its servers are in the data and information center of the Indonesian Ministry of Health (Laksmi 2021).

Technology Acceptance Model (TAM)

This theory was first put forward by Fred D. Davis in 1986 for a doctoral proposal as shown in Figure 1. An adaptation of the Theory of Reasonable Action (TRA), TAM is specifically designed to model user acceptance of information systems or technologies (Davis 1986). Subsequently, it was used and developed by several researchers, for example, Adam et al 1992 (Adams et al. 1992), Szajna Bernadette 1994 (Szajna 1994), Magid Igbaria 1994 (Igbaria 1994), and Viswanath Venkatesh and Fred D. Davis 2000 (Venkatesh & Davis 2000). (Venkatesh and Davis 2000)

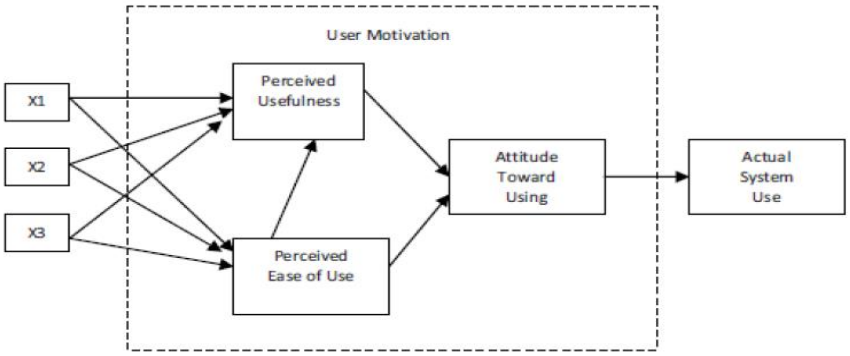

Figure 1. Original Technology Acceptance Model (Davis 1986)

The essential TAM model includes and tests two specific beliefs, namely perceived usefulness (PU) and perceived ease of use (PEOU) as shown in Figure 2. PU refers to the subjective possibility of a potential user that the use of a particular system will enhance his or her actions (Davis et al. 1989), whereas PEOU is defined as the extent to which a potential user expects the target of the system to be easy. Both TAM constructions determine the attitude toward using technology. It is this attitude towards use that later becomes the determinant of the behavioral intention to use, which can be interpreted as the acceptance of technology (Holden & Karsh 2010).

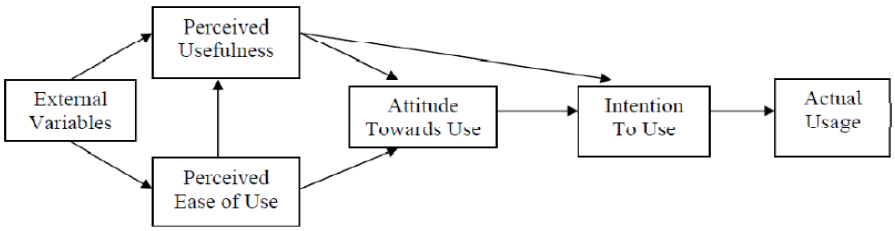

Figure 2. First Modified version of TAM (Davis et al. 1989)

The final form of the technology acceptance model was formed by Venkatesh and Davis (1996) as shown in Figure 3, after the main findings of perceived usefulness and perceived ease of use had a direct

influence on behavioral intentions, thus eliminating the need for an attitude construction (Venkatesh & Davis 1996).

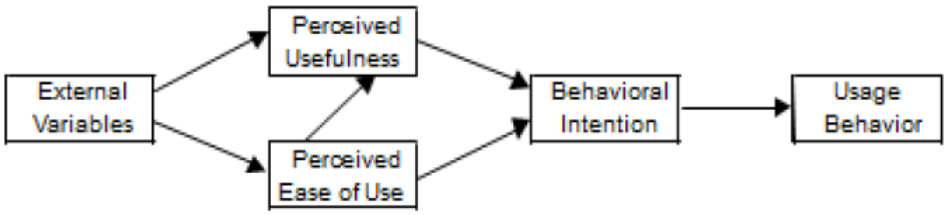

Figure 3. The final version of TAM (Venkatesh & Davis 1996)

Methodology

Type, Design, Time, and Place of Research

This research is qualitative research with a phenomenological study design. The research was conducted at the Health Office and its work area, namely all Puskesmas in Bima City, West Nusa Tenggara Province, in 2022.

The type of qualitative research chosen in this study, in addition to finding *research gaps* in previous research, namely all previous research in the study source in this study uses quantitative, also to answer research objectives that identify and explore the perception of usefulness and perception of ease of use by rebuilding a concept or meaning in depth. This research emphasizes qualitative research because it has at least several reasons, namely dynamic, research that favors the truth of the context in the field, involves a process of reflection and emotion to build new logic and arguments about facts in the field, and is subjective.

To answer research questions, this study only uses primary data sources. Primary sources are information that is directly provided by informants to researchers (Sugiyono 2011). Primary data from this study was obtained from in-depth observations and interviews with all informants, both key informants, namely the head of the family health section of the Bima City health officials, the main informant, namely the coordinating midwife as a user or user of the information system for the e-kohort application for maternal and child health and supporting informants, namely the head of the puskesmas.

Research Informant

Two important standards in the withdrawal and determination of sample size for data collection in this study are the principles of conformity and depth. The principle of conformity is applied through the conformity between the research objectives, the way of sampling, and the size of the sample. Meanwhile, the principle of depth is assessed through the saturation of the information obtained (saturation) and the credibility of the data obtained (Utarini 2020). The number of samples in this study was not justified based on statistical generalizations to the population, but rather the quality of the information produced which is a function of the principle of the suitability of the research objectives and the way of sampling.

The decision regarding the size of the sample refers to the principle of saturation and the credibility of the data. In sampling, this study uses the purposive sampling technique, which is a non-random sampling technique where researchers determine sampling by setting specific criteria that are in accordance with the research objectives so that they are expected to answer research problems. The reason for using the purposive sampling technique is that not all samples have criteria that correspond to the phenomenon under study. Therefore, the authors chose this technique by establishing certain considerations or criteria that must be met by the samples used in this study.

Sampling Design

There are two important standards in shooting and determining sample size for data collection in this study, namely the principle of suitability and depth (Utarini 2020). The decision regarding sample size refers to the principle of saturation and the credibility of the data. Sampling using a purposive sampling technique. The main informants of the research in this study were midwives who used the MCH e-kohort application or users, the key informants were the Head of the Health Service Family Health Services Section, and the supporting informant was the head of the health center.

Research Variables

In this study, the focus of the study was on two main constructions of the Technology Acceptance Model (TAM), namely how the perception of usability and the perception of ease of use will affect the implementation of the KIA e-kohort application information system.

Inclusion Criteria

The criteria for determining the selection of informants (inclusion criteria) are as follows:

a. Willing to be interviewed as an informant.
b. The principal informants have operated the maternal and child health (MCH) e-kohort application.
c. Does not have a specific purpose or interest in research so that objective information can be obtained.

d. For the main informants, they have attended training or socialization on the use of the maternal and child health e-kohort application online or *zoom meeting* media.

Research Instruments

a. Observation

This technique is by making direct observations of the object under study, namely at the Bima City Health Center. This approach was chosen because it can use all data collection methods by building good relationships, and can be used to form relevant questions, and understand processes, events, and relationships in its social context (Utarini 2020). In this observation, researchers observed the use of the maternal and child health e-kohort application information system at the Bima City Health Center with the hope that the data obtained would be more complete. With this approach, it is hoped that researchers will obtain more complete and actual information.

b. In-depth Interviews

Interviews in this study used an *in-depth interview* type. The interview guide used is as follows:

1) How can implement the MCH e-kohort application on the MCH service section speed up your work?
2) How can the implementation of the MCH e-kohort application in the MCH service department improve your performance from the previous one?
3) How can implementing the MCH e-kohort application increase your performance productivity?
4) How can implementing the MCH e-kohort application make your work more effective?
5) How can implementing the KIA e-kohort application make your job easier?
6) How can implementing the MCH e-kohort application benefit your work?
7) How do you think the application of the MCH e-kohort is easy to learn in its use?
8) How do you think KIA's e-kohort application makes your job flexible?
9) How do you think KIA's e-kohort app can easily make you proficient or skilled in your tasks?
10) How do you think the KIA e-kohort app is easy to use?

c. Documentation

The documentation referred to in this study is the result of recorded interviews with users or users of the maternal and child health e-kohort application at the Bima City health center and documentation in the form of input of maternal and child health data conducted by users as evidence to strengthen those users have run and used the maternal and child health e-kohort application.

Data Analysis

In this study, the data analysis technique used was *thematic analysis.* Thematic analysis was chosen because it is a very effective method to explore in detail the qualitative data possessed to find the relationship of patterns in a phenomenon and explain the extent to which the phenomenon occurs through the lens of researchers (Yates & Partridge 2015). Even Holloway & Todres (2003) said that *this thematic analysis* is the basis or foundation for the benefit of analyzing in qualitative research. The stages of its implementation are shown in Figure 4.

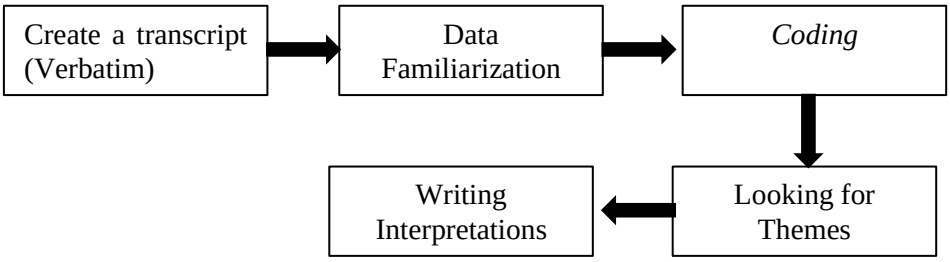

Figure 4. Data analysis steps

Result

Description of Research Informant

The informants in this study numbered 13 people. Data collection is carried out by in-depth interviews or in-depth interviews. During data collection, the means used to increase trust is source triangulation. To meet the criteria for timely feedback in this study, the analysis technique used is a qualitative thematic content analysis by describing predetermined categories. The interview was conducted with the Head of the Family Health Section of the Bima City Health Office because of his responsibility in managing the information system of the MCH e-kohort application, midwives who use the e-kohort system, and the head of puskesmas as supporting informants. Data collection with in-depth interviews is then compiled in the form of transcripts and coding carried out by researchers.

To maintain the rules of research ethics, the procedure for obtaining oral approval and anonymity is enforced and research ethics have been obtained from the Faculty of Medicine UGM. The interview starts from February 23, 2022, to March 01, 2022. Of the 7 puskesmas that were the object of the study, one of them did not meet the requirements for inclusion criteria in this study, namely the puskesmas had not run the MCH e-kohort application so the total number of puskesmas carried out data mining was 6 puskesmas. All informants have access to computers, cell phones, and the internet both at home and at the health center.

The most common age group of informants is 30 – 45 years, two informants are over 45 years old. Interviews are completed in an average of 10 minutes, during which time most research informants answer all questions relevant to their respective experiences. Table 1 provides detailed information about the characteristics of research informants.

Table 1. Characteristics of Research Informants

No	Initials	Age (year)	Position	Kind Informant	Gender	Education
1.	RA	32	User e-Kohort KIA	Main	Woman	Diploma IV
2.	AT	45	User e-Kohort KIA	Main	Woman	Bachelor
3.	MS.	39	User e-Kohort KIA	Main	Woman	Diploma III
4.	YF	36	User e-Kohort KIA	Main	Woman	Diploma III
5.	UH	35	User e-Kohort KIA	Main	Woman	Diploma III
6.	ST	33	User e-Kohort KIA	Main	Woman	Diploma III
7.	SW	39	Kasi Kesga	Key	Woman	Bachelor
8.	NR	48	Head of Puskesmas	Supporter	Woman	Bachelor
9.	AD	53	Head of Puskesmas	Supporter	Man	Bachelor
10.	FR	45	Head of Puskesmas	Supporter	Woman	Master
11.	AM	53	Head of Puskesmas	Supporter	Man	Bachelor
12.	NH	39	MCH Coordinator	Supporter	Woman	Diploma III
13.	RT	42	Head of Puskesmas	Supporter	Woman	Ners

Key Findings

Figure 5 and Figure 6 below show the results of the manual code with the help of the Nvivo 12 application which has the same contents grouped and named according to the meaning contained in the code.

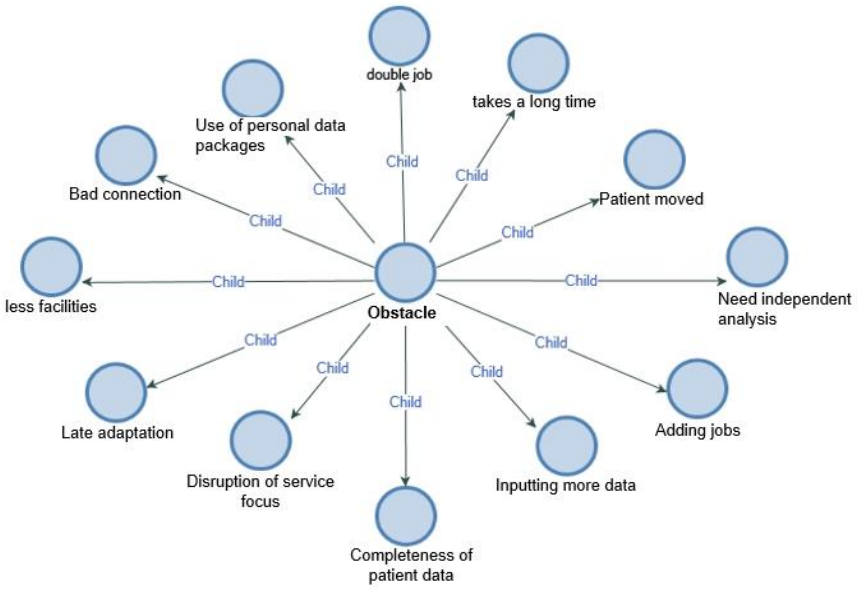

Figure 5. Grouping of barriers to perceived usability

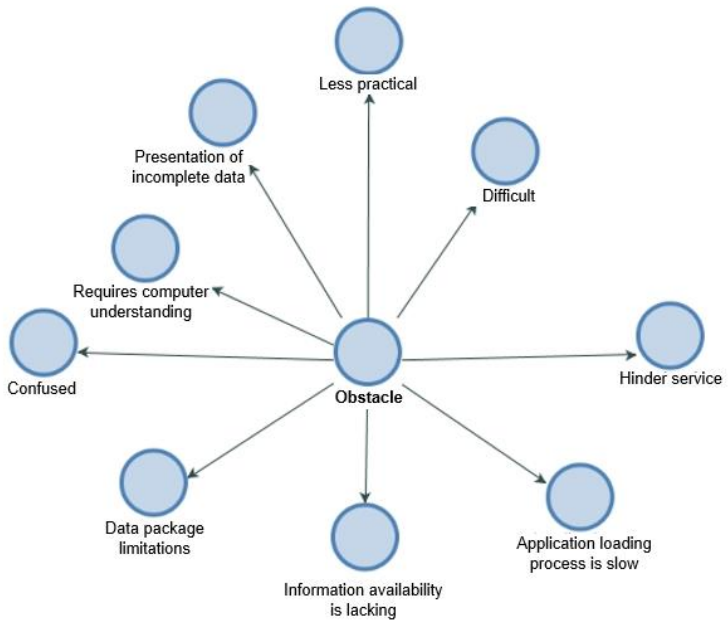

Figure 6. Grouping of barriers on the perception of ease of use

During interview sessions and in-depth observation, midwives can complete and demonstrate tasks using the core functions of the e-kohort app's navigation menu, including viewing information, entering data, and evaluating it. Most of the users can understand the features after a while of exploring the e-kohort.

The study proposes that perceived perceptions of ease of use may not be in line with perceived expediency to explain variations in the successful acceptance of MCH e-kohort applications. The study also found that there were differences in outcomes between user perceptions at the operational level and policymakers at the managerial level. In general, the analysis collected several types of obstacles and potential problems that negatively affect the usability of e-kohort applications namely: not being able to make the work of midwives easier and faster, ineffective, and not so much increased performance productivity. Regarding ease of use, users feel that the e-kohort can be easily learned and used.

Related obstacles to the use of e-kohort were conveyed by several different informants, namely:

> "*... don't speed up. In fact, it adds to the burden of time, and thoughts, we have recorded, already in the cohort, already in the register, the mother's card, and the patient's mother, then we must input again. So instead increase the workload. It makes it even more difficult with the addition of work"* **(Informant 5)**

> *"... In our opinion, this e-kohort is to speed up work, it doesn't seem to be well. Why? Because when we finish the service, we are usually full of service. So, our service must be ANC up to standard, there are a lot of standards that we have to adhere to. Then if this e-kohort once the service is finished, it must be inputted, for example, for example, we must get pregnant women's examination services, we must input while there are other pregnant women who come to check on one pregnant woman, it takes a lot of time, om well. Then if the input after completion is for example network, network problems can also be, problems that do not have packages also because of that, you must use packages too. Use the personal package again om hehehehe. Personal plan. for example, the name is online, right, om whose name is input if for example suddenly an error, yes tired we have to repeat it again from the beginning"* **(Informant 6)**

"... Ineffective. Double job and it takes a long time and cannot be done at the same time. It's very different if we use a manual one, we could have written right away at that service" (**Informant 2)**

"It has no effect on work productivity. Therefore, we still use the manual one as well for the recording, even more using the manual one. Not to mention that we have difficulties with patient data. So, this application demands complete data, but still, most of our patients who do not carry identities continue to exist from outside the region as well. So, well it makes it harder again" **(Informant 4)**

Data Source Triangulation

Triangulation of data sources is to explore the truth of certain information through various sources of data acquisition. In this case, the researcher conducted interviews with 6 supporting informants, namely 5 people including the head of the puskesmas and 1 KIA service coordinator, 6 main informants, namely users of the e-kohort application at the puskesmas and 1 key informant, namely the head of the family health service section of the Bima City Health Office. The interview process is carried out in different spaces and by being given the same type of questions to see the extent of similarity or similarity of answers. This method is expected to produce different evidence or data, which will further provide different views (insights) regarding the phenomenon under study. These views will give birth to freedom of knowledge to obtain reliable truths. To see the similarity of answers from various research informants can be seen in Figure 7.

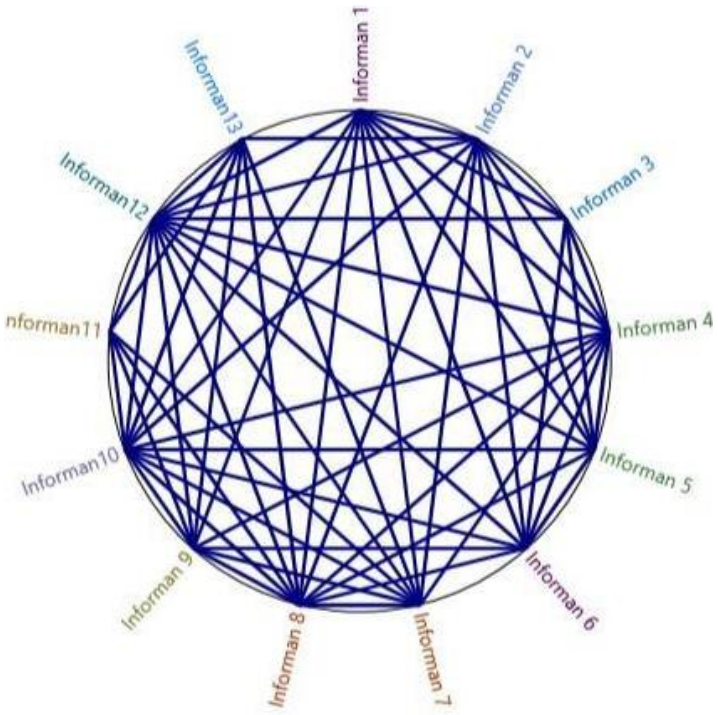

Figure 7. Items grouped according to word similarity

The reliability of this study was assessed using a similarity matrix between Pearson's correlation coefficient and Cronbach's alpha. The general reliability threshold is 0.7 as recommended by Ghozali and Latan (Ghozali & Latan 2015).

Based on figure 1 above, a very high degree of similarity was obtained, namely with an average value of >0.7 so it has a strong relationship. However, there are some whose alpha is <0.70 so in the picture above we do not find a line of connectedness, for example, one of them is informant 7 and informant 5. Despite this, its alpha is still >0.60 and under the provisions of Ghozali & Latan (2015) it is still tolerable

and still acceptable. , so it can be concluded that the results of the triangulation of this source have a fairly high similarity or similarity of answers.

Discussion

This study proposes that perceived perceptions of ease of use may not be in line with perceptions of usability to explain variations in the successful acceptance, absorption, and sustainability of the use of technology-based health information systems, namely *MCH e-kohorts*. Understanding how end users view the ease of use and usability of technology is important because these factors have been linked to the user's intention to adopt the technology (Davis 1989; Legris et al. 2003; Venkatesh & Davis 2000; Yi et al. 2006).(Legris et al. 2003)(Venkatesh and Davis 2000)(Yi et al. 2006) The study found that for users who experienced the ease of use of e-kohort applications, it does not actually bring about a change in the perception of usability that would then lead to higher acceptance. In a small percentage of cases, users say that the appearance, elements, features, and design are quite easy to use, thus increasing the sense of comfort in accessing, but e-kohort is considered by some users to be a system that hinders and makes the work of midwives more difficult.

This happens because no matter how easy the assumption is regarding the use of e-kohort applications, it does not bring changes to the perception of usability which will then lead to higher acceptance due to suggestion or rejection behavior in the first place. So that things that hinder the process of using the application will automatically weaken self-confidence and motivation in users. This is in line with what was conveyed by one user, namely "we are actually comfortable and used to the use of kohorts that were previously pak (manual). Not to mention that the burden of our duties is quite a lot, so with the use of this application from the beginning, friends have complained. In fact, there are also many midwife friends who from the beginning said we still use the old ones. So yes, we are no longer motivated to hear sir (informant 3)"

In addition, interoperability between applications is also an urgent demand in the development of technology-based information systems in Indonesia, especially in the field of MCH so that the principle of the continuum of care can be fulfilled (Pradita et al. 2022). This is due to the need for inter-field and multisectoral data in the context of policymaking to overcome problems involving data from various fields and between related sectors. While the current state of e-kohort applications, generally still sectoral, cannot communicate with each other applications, is heterogeneous and focuses only on maternal *health*. Although if this e-kohort application is successfully implemented, it will be the most complete maternal and child health database because the incoming data variables are the most numerous and can be the *data supply* for related parts such as infectious diseases and birth control services. So, this research also proposes the need to develop system interconnectivity with other systems, interrelated and interrelated with potential systems such as nutrition services such as e-PPGBM, care applications to protect, namely pedulilindungi applications, infectious and non-communicable diseases such as the PPTM application., immunization of schoolchildren and so on to improve the efficiency and utilization of use. This is also to support the achievement of digital health transformation activities, namely realizing one health record because the source of e-kohort data is sourced from individual data by prioritizing the principle of the continuum of care.

The presence of the KIA e-kohort application information system is not guaranteed to have a significant impact on the mentality of users who have been patterned about the complexity of new information systems that must be learned and applied in solving daily tasks. Although the purpose of implementing a technology-based information system is to improve work effectiveness and ease of work (Yulianti et al. 2015), the truth based on the context in the field in this study says another thing, namely inhibiting and complicating the work of midwives as users. Nonetheless, this study is still in the early stages of evaluating user acceptance of e-kohort applications and this is not the end of its journey. The use of e-kohort is still a work in progress and it could be that if re-evaluated the results will be different.

The study also found that there were differences in outcomes between perceptions of e-kohort users at the operational level and policymakers or users at the managerial level. If at the operational level, some of the main informants as e-kohort users say that the presence of an e-kohort application can add to the

burden, complicate, and hinder the work, is ineffective, and has no effect on work productivity but on key informants and all supporting informants at the managerial level as policymakers, then it is said otherwise that e-kohorts. The application is very helpful and supports their duties and authorities and has a positive impact on their performance.

This can happen due to differences in information needs at the operational and managerial levels. To make logical and rational decisions at the managerial level, it is necessary that accurate and timely information is very important and needed by the leaders of the organization. Through the implementation of the MCH e-kohort application, policymakers can quickly find out the success, impact, and constraints of MCH services by monitoring MCH service indicators (Susanto & Haryati 2019). On the other hand, decision-makers at the health facility level have an important role to play as they will be related to death, safety, and public health. Therefore, stakeholders must seriously strive to optimize this role so that the use of the e-kohort application information system is one way to facilitate decision-making that focuses on improving the degree of public health. According to Sigilipu (2013), the application of the information system will affect performance and decision-making at the managerial level (Sigilipu 2013). In terms of user aspects, the use of the MCH e-kohort application requires midwife skills as a user so according to Desvronita (2021) perceptions, beliefs, attitudes, knowledge, workload, and skills will affect the increasing interest in the use of new information systems (Desvronita 2021).

This study chose to focus on the two main constructions of TAM because there are still gaps or differences in results found by previous studies, also hypothesized as determinants of computer use. It has even been consistently reported as the main determinant influencing user behavior to use technology (Jing et al. 2020). These efforts have been successful in several ways, namely demonstrating a significant empirical relationship with self-reported measures of user behavior. Also, some new insights are generated about the perceived benefits and ease of use as determinants of user acceptance as a gradual process to achieve the successful use of new information systems (Nadal et al. 2020).

Previous research has shown that user acceptance of information systems has been identified as a problem. For example, Mikarsih et al (2020) and Hardiana et al (2022) recently stated that the perception of usability does not affect the acceptance of the use of computer-based information systems (Hardiana et al. 2022; Mikarsih et al. 2020; Nugroho et al. 2021). Perception of usability and ease of use (Nugroho et al. 2021) will largely depend on management support in the acceptance of the use of health information systems (Handayani et al. 2017), the perception of ease of use (Barzekar et al. 2019; Handayani et al. 2017).

Other literature also explains how perceived usability and ease of use can affect the acceptance of a system. For example, Mardiana et al (2015) says that the perception of usability is the strongest predictor in the reception of information systems. Perceived usability and ease of use can increase user acceptance in the adoption of technology-based health information systems so it needs to be considered in planning to run new systems (Garavand et al. 2017; Kowitlawakul 2011; Jo et al. 2017).

Similar qualitative studies include a model of acceptance of health information systems, but user responses in the study data were processed using SEM and AMOS 21.0 (Handayani et al. 2017). Another health application study measuring acceptance of the use of care applications (Usmanova et al. 2020) explores the perspectives of health providers and managers. Design, features, and functional elements will influence the improved ease of use and highlight the need for users to consider how the system can be easily implemented to optimize usability (Kurahashi et al. 2018).

The results of this study show that users still feel that organizational support is still low in the implementation of the MCH e-kohort information system at the Bima City Health Office and Health Center. This is indicated by several obstacles revealed by the research informant, such as double jobs, input outside of working hours, limited network availability, and the use of personal data packets. According to Nugroho et al (2016), the support of superiors or organizations in the implementation of the MCH information system refers to the encouragement given by the direct supervisor and manager of the information system. This should be a serious concern for supervisors and system administrators.

Active mentoring and supervision will condition users to always actively implement information systems (Nugroho et al. 2016)

This study has grouped themes based on indicators from each of the two main constructions of the Technology Acceptance Model (TAM) and then considered how the acceptance of midwives as users of the MCH group is related to each of those indicators.

Research Implications and Limitations

This research has provided an overview of how the perception of usefulness and perception of ease of use is felt by users of the MCH e-kohort application at the Bima City Health Center in recording and reporting maternal and child health services. From a theoretical perspective, the results of this study serve as indicators to reveal the level of acceptance of midwives as end users to the application of MCH e-kohorts in the context of recording and reporting MCH services using TAM. From a practical perspective, the use of the related MCH e-kohort application reported by users provides references and suggestions for special stakeholders within the Bima City Health Office and Puskesmas to make policies in minimizing various obstacles to potential failure and acceptance and use of e- KIA cohort in the field. For example, providing advanced training to minimize delays in the adaptation by midwives.

The challenges shown in this study also confirm the areas of improvement for the implementation of the MCH e-kohort application, such as facilitating the facilities and infrastructure of access devices that are used more widely to support the implementation of e-kohort applications. From a broader perspective, the use of technology-based health information systems is likely to become a growing trend in health services during the pandemic and even the post-pandemic era, with the government's consensual on the 2024 health digital transformation strategy.

The limitation of this study is that the midwife coordinator who is not willing to be an informant must select and sort out the midwives in the village who are outstanding and who are most active in using the e-kohort to be recommended to be informants in this study. This will tend to the selection of informants based on the emotional proximity of the recommender to affect the subjectivity of the information provided. In addition, the model proposed in this study also does not include all other TAM constructs and only 2 main constructs, namely the perception of usefulness and the perception of ease of use. Primary data sources are only from users and policymakers of the organizations studied, so other researchers in the future are also expected to explore perspectives from the patient's view as a service recipient.

When observed, the user is asked to input data on his e-kohort system. At the same time, users are more likely to express negative feedback and less likely to comment on features that are easy to navigate when interacting with the system. The study also did not schedule follow-up interviews to measure changes in their user experience. Thus, this data represents a point-in-time measurement. In addition, this study also did not measure user experiences that might be relevant when an application is studied.

Conclusion

For the perception of usability, some users feel that the presence of the KIA e-kohort application can increase the burden, complicate, and hinder work, is ineffective, and does not affect the work productivity of midwives. This is due to several things, namely (a) the network is not always available, (b) the use of personal data packets, (c) requires independent follow-up analysis, (d) the patient moves, (e) more input forms, (f) the input requires a process and takes a long time, (g) adds work, (h) incomplete patient data, (i) late adaptation, (j) the input interferes with the focus of other services, (k) dual work, and (l) lack of MCH e-kohort access devices

For the perception of ease of use, all user informants feel that the appearance, elements, features, and design are very easy, thus increasing the sense of comfort in accessing the KIA e-kohort application. This is due to several things, namely (a) detailed data, (b) detailed format, (c) systemized and automatic,

(d) flexible, (e) easy access, (f) clear filling format, (g) easy, (h) practical, and (i) only need the interest to use.

Acknowledgments

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