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What Makes Gen Z in Indonesia Use P2P Lending Applications: An Extension of Technology Acceptance Model

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Abstract

This study aims to determine the factors influencing Gen Z members in Indonesia using P2P lending applications. This study extended TAM by collaborating with important constructs, such as trust, perceived risk, and hedonic motivation, to explain Generation Z's intention to use P2P lending applications. This study utilized an online survey to acquire data. The total sample size was 305 users of P2P lending applications from Generation Z. The obtained data were then analyzed using PLS-SEM. The results show that perceived usefulness has no effect on the intention to use P2P lending applications. Meanwhile, trust mediates the relationship between perceived ease of use and perceived usefulness on intention to use P2P lending applications. The results show that Generation Z's intention to use P2P lending applications is influenced by technological sophistication factors, the belief that P2P lending applications guarantee their privacy concerns and security risks, and the existence of pleasant experiences.

Keywords: Hedonic Motivation; Peer-to-Peer Lending; Perceived Risk; Technology Acceptance Model (TAM); Trust

Introduction

The growing dominance of information technology has increased people's mobility, especially in accessing digital financial services. The form of this digital financial service is Financial Technology (fintech) (Hidayat et al. 2020). Fintech is information technology in the form of applications to improve services in the banking and financial sectors (Suryanto 2020; Nicoletti 2017). Fintech transforms buying and selling transactions and payments to become more effective and efficient (Chiu 2017), this is the answer to the many customer complaints when making manual transactions (Hidayat et al. 2020).

Fintech offers several types of services through applications, including peer-to-peer (P2P) payment applications, investment investment (P2P lending), financing, digital wallet payments, and insurance. The most widely accessed and used service by the public is P2P lending services (Hidayat et al. 2020).

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According to a report issued by the Asian Development Bank Institute, P2P application services grew by 43% in Indonesia (Batunanggar 2019). Lending through P2P applications is carried out by 101 applications registered with the Financial Services Authority (OJK). From 2018 to 2020, the development of P2P lending increased by 563.6% (OJK 2020). This rapid growth has made P2P lending services attractive to both local and foreign investors. Additionally, P2P lending services contribute trillions of rupiahs to local companies in Indonesia (Sunardi et al. 2022).

Young people from Generation Z are likely to use financial technology applications because of their familiarity with and proficiency in digital platforms (Nurlaily et al. 2021). In this study, Generation Z comprises those born between 1996 and 2012 (Thangavel et al. 2021). Of Indonesia's overall population of 267 million in 2019, 72.8 million are members of Generation Z Of these, 44 million are regular internet users (Nurlaily et al. 2021). Generation Z is often labeled as the mobile generation because of its massive Internet usage compared to other generations (Nguyen and Nguyen 2020). Based on data from IdScore in June 2023, the average loan through online lending platforms for generation Z reached Rp5.1 million, while for millennials it was only around Rp2.6 million. This shows that generation Z, despite being younger than millennials, tends to borrow more, almost twice as much (Rahardyan 2023). Therefore, this study argues that it is important to find out the reasons why Generation Z uses P2P lending applications.

Prior research has only examined the function of peer-to-peer lending applications, their social impact, and user acceptability. For example, Lee and Lee (2012) analyzed borrower behaviour in P2P applications where companies provide loans to individuals without collateral, and Lee (2017) examined the user acceptability of P2P lending services using the Pindeh and Suki (PS) model. Other studies have discussed individual intentions to apply for lending, but have not explicitly focused on technology use (Boatman et al. 2022; Sarumi et al. 2020; Yazdanparas and Alhenawi 2017). So, this study attempt to fill the literature about the determinants of Generation Z's intention to use peer-to-peer (P2P) lending applications by using social transformation theory. In the context of using P2P lending applications, social transformation theory explains that the use of P2P lending applications reflects significant technological changes in society. Where digital technology has changed the way Generation Z access financial services.

The technology acceptance model (TAM) describes the type of user who decides to employ a specific technology. This study aims to develop TAM by integrating multiple constructs, including trust, perceived risk, and hedonic motivation. This study positions trust as a variable that mediates the relationship between perceived ease of use (PEOU) and perceived usefulness (PU) in the context of Generation Z's intention to use P2P lending applications. The approach of trust constructs as mediating variables has been widely used in various research contexts, such as halal tourism (Berakon et al. 2023), transportation applications (Wang et al. 2021), fitness applications (Beldad and Hegner 2018), e-commerce (Hsieh and Liao 2011) and mobile payment applications (Luarn and Juo 2010).

Literature Review

Social Transformation Theory

Social transformation theory is a framework used to explain how societies undergo significant changes in their structure, values, culture, and institutions (Ervin 2016). Social transformation can be triggered by various factors, including technological change, economic change, cultural change, social conflict, political change, and so on (Feola 2015). Social transformation can occur through various processes, one of which is modernization (Pogosyan 2021). In the context of using P2P lending applications, social transformation theory explains that the use of P2P lending applications reflects significant technological changes in society. Where digital technology has changed the way we access financial services. This research argues that Generation Z, often labeled as the mobile generation, is more likely to adopt and rely on technology for their lending and financial needs. This reflects a change in Generation Z's preferences for meeting their financial needs and accessing financial resources when compared to other generations.

Financial Technology (Fintech)

The financial sector effectively uses the accelerated development of information technology by producing innovations in financial technology (fintech) (Das 2019). Fintech is an innovation that has effectively transformed the online financial services provided by financial sector companies, which were previously only offered in a conventional manner (Dang and Vu 2020; Nguyen et al. 2020). Also, this shows that there is a social transformation in the use of technology. Fintech is expanding rapidly in Indonesia, where it is presently divided into two categories: fintech 2.0 and fintech 3.0. The term "fintech 2.0" is used to describe technological developments in banking, capital markets, and non-banking financial businesses. By contrast, fintech 3.0, which is being developed by new financial technology companies (Yunus 2019).

Technology Acceptance Model (TAM)

TAM is the most popular theory in information systems research and is rooted in the theory of reasoned action (TRA) (Fishbein and Ajzen 1977). Davis developed this theory, which is a streamlined version of the TRA (Davis 1989). According to this theory, individual decisions to implement new information technology are based on two key factors. The first is perceived ease of use (PEOU), which is the effort required to operate the technology. Second, applying information technology can boost work productivity, also known as perceived usefulness (PU) (Chuttur 2009). Mugo et al. (2017) contend that TAM can serve as an evaluator for system developers in assessing how individuals respond and conduct when using new information technology.

Many studies in the field of technological innovation have used TAM, such as electronic marketing (AlHadid et al. 2022; Hong et al. 2016), education (Chintalapati and Daruri 2017; Scherer et al. 2019), banking (Abd Ghani et al. 2017), and electronic money (Aji et al. 2020; Widayat et al. 2020). Further, studies on P2P lending platforms have incorporated the TAM (Hidayat and Aristio 2022; Sunardi et al. 2022). Other studies have discussed TAM for P2P lending services to increase individual intentions when using P2P online lending services (Khan et al. 2021; Ichwan and Kasri 2019).

Peer-to-Peer (P2P) Lending

P2P lending facilitates direct fund transfers between individuals rather than through traditional financial institutions. This means that individuals as lenders can directly provide lending to other individuals without going through official intermediaries such as banks (Lee 2017). P2P lending services first emerged in developed countries, with mature credit systems and efficient financial sectors (Jiang et al. 2021). In Indonesia, P2P lending services have emerged to provide convenience to the public in the online lending service process, which was previously still done manually. In addition, this online lending service process is a form of declining public confidence in banks' existing lending service systems (Abubakar and Handayani 2018).

Lee (2017) stated that online P2P lending services offer borrowers and investors reduced interest rates and larger returns compared to traditional banking. This is because P2P lending companies offer their services online, allowing them to reduce their operational costs. Ultimately, the service fee charged to customers can be reduced, making it cheaper than the lending services available to banks. Galloway (2009) and Moenninghoff and Wieandt (2013) in their research also state that online P2P lending service providers benefit from the cost of each successful transaction made by users.

Perceived Ease of Use (PEOU), Perceived Usefulness (PU), and Trust in P2P lending

Two factors have been used to explain individual intentions when employing information technology: perceived ease of use (PEOU) and perceived usefulness (PU) (Berakon et al. 2023; Zhang et al. 2022). PEOU is an individual's conviction that utilizing technology requires minimal effort. By contrast, PU is an individual's conviction that technology can increase job productivity (Davis 1989). Several empirical findings indicate that PEOU improves PU (Alamri 2022; Habes et al. 2022; Liao et al. 2022; Mohamed Riyath et al. 2022). This is because many assume that utilizing only technological tools can boost productivity (Beldad and Hegner 2018).

In the context of P2P lending services through applications, this study argues that many individuals use P2P lending applications because they feel that the applications can help them quickly when they need money. In addition, the relatively easy use of the application also encouraged them to use it. In addition to the ease and usefulness of P2P lending applications, individual confidence in using the app arises because many official applications have been registered with the Financial Services Authority (OJK). This argument is also supported by Ullah et al. (2022) and Hsieh and Liao (2011), who state that PEOU has an important role in increasing individual trust when transacting online. Senali et al. (2022) explained that PU is an important construct for individual trust in using digital wallet applications. Thus, this study develops the following hypothesessis:

H1: PEOU positively influences an individual's PU toward P2P lending applications.

H2: PEOU positively influences an individual's trust toward P2P lending applications.

H3: PU positively influences an individual's trust toward P2P lending applications.

Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Trust, and Intention to Use P2P Lending Applications

This study extends the TAM by introducing the idea of trust as a mediating variable between PEOU and PU with regard to an individual's intention to participate in technology. Trust is a mediating variable since it helps explain the relationship between PEOU and PU. Other studies have utilized this methodology, such as Luarn and Juo (2010) in the context of digital payments, Palvia (2009) in the context of e-commerce, and Kim (2012) in the context of online purchases. According to Beldad and Hegner (2018), people's trust in technology is largely based on their impressions of its use.

Incorporating the trust concept into the TAM, this study focuses on two fundamental aspects. First, there is a deficiency in prior research examining the influence of PEOU and PU on individuals' intentions to use information technology. For instance, Vărzaru et al. (2021) indicate that PEOU has a positive effect on individuals' intentions to utilize m-commerce, whereas Phan et al. (2019) demonstrate that PEOU has no effect on Vietnamese consumers' intentions to use foreign bank cards. Yang et al. (2022) observed a positive correlation between PU and an intention of individuals to use an academic learning site. Other studies, such as those by Jawad et al. (2022) in the context of online payments and Aji et al. (2020), confirm the importance of PEOU and PU in understanding individuals' intentions to use technology in electronic money. In addition, Iskandar et al. (2020) found that PEOU and PU did not affect Malaysia's intention to adopt hospital information systems.

Owing to the discrepancy between the above-described research findings regarding the effect of PEOU and PU on individual intention to use technology, this study argues that other constructs play a role in mediating these constructs. Therefore, the second consideration in this study was to include trust as a mediating variable in TAM. This is also predicated on the dearth of literature discussing the relationship between the trust construct and TAM, particularly in the financial services sector and P2P lending applications. Although trust has been included in the TAM framework in several studies, it has not been considered a mediating component (Egea and González 2011; Luarn and Juo 2010). Following Berakon et al. (2023) and Usman et al. (2022), this investigation incorporates the trust construct as a mediating variable. Moreover, this study develops the following hypothesis:

H4a: PEOU positively influences an individuals' intention to use P2P lending applications.

H4b: Trust mediates the relationship between PEOU and an individual's intention to use P2P lending applications.

H5a: PU positively influences an individuals' intention to use P2P lending applications.

H5b: Trust mediates the relationship between PU and an individual's intention to use P2P lending applications.

Trust and Intention to Use P2P Lending Applications

Trust is described as an individual's conviction of another individual's traits, as stated by Mayer et al. (1995). When attempting to describe the connection between people and the technology they use, the concept of trust is crucial. This is explicitly confirmed by Kim et al. (2008), who state that a person's trust in a technology can reduce their concern about its risks. The hazards associated with the use of technology, such as personal data security issues and the security level of an accessed website. According to Dam (2020), trust positively affects an individual's desire to purchase a product online. In a different context, Chemingui (2013) explains that trust is an important construct for individual intentions when utilizing financial service applications. Meanwhile, a recent work by Wang et al. (2020) revealed that trust is crucial for explaining individual intentions to use online service applications for lodging. This study argues that Generation Z who grew up in the era of digital technology and are accustomed to using various online platforms. They are more open to technological innovation and tend to trust applications that offer digital financial solutions. Then, this research develops the following hypothesis:

H6: Trust positively influences an individuals' intention to use P2P lending applications.

Hedonic Motivation and Intention to Use P2P Lending Applications

Hedonic motivation refers to the way people view their use of technology in terms of pleasure and satisfaction, as described by Brown and Venkatesh (2005) and Venkatesh et al. (2003). Hedonic motivation is closely related to the emotional aspects and enjoyment of individuals who acquire products or services (Holbrook and Hirschman 1982). According to the motivation theory, individuals' openness to new technologies depends mainly on their hedonic motivations (Subhash and Bapurao 2015). When people are more likely to adopt new technology if they think it looks nice and is a good value for what they pay for it (Liébana-Cabanillas et al. 2021).

Venkatesh et al. (2003) stated that individuals care not only about the performance of a technology but also that its use provides a pleasant sensation or experience. Consequently, this impacts their intention to adopt technology. According to Salimon et al. (2017), individuals with positive experiences when using technology will encourage them to use it again and even recommend it to others. In a different context, Al-Azawei and Alowayr (2020) asserted that hedonic motivation is one of the key constructs for explaining individual's intention to use learning applications. Several other researchers have examined how hedonic motivation affects people's plans to adopt new technologies, including mobile Internet usage (Nikolopoulou et al. 2021), and digital wallets (Megadewandanu 2016). This study argues that P2P lending applications that are designed to provide a fun and intuitive user experience can cater to Generation Z's hedonic motivations. They are more likely to be attracted to applications that not only fulfill their financial needs, but also provide a positive user experience. This leads to the formulation of the following hypothesis:

H7: Hedonic motivation positively influences an individuals' intention to use P2P lending applications.

Perceived Risk and Intention to Use P2P Lending Applications

Perceived risk is the potential negative consequence of a product or service purchase (Bauer 1967). One of the most critical aspects of how consumers feel about a product or service, especially if they have just purchased it, is their level of perceived risk (Dowling 1986). Therefore, businesses need to comprehend the impact of such hazards when marketing their products or services to develop more effective strategies for their potential customers (Laroche et al. 2003). It has been established that consumer's aversion to risk is the key factor keeping them from making repeat purchases (Salimon et al. 2017). People who are more willing to take risks are less likely to use internet banking services, as shown by studies such as those conducted by Marafon et al. (2018) and Namahoot and Laohavichien (2018). However, Trinh et al. (2020) show that an individual's sense of risk is a barrier to credit card use.

According to Li et al. (2016) on P2P lending services in China, those with a higher risk tolerance tend to avoid them. In addition, a significant factor in moderating millennial's intentions to use peer-to-peer

(P2P) lending applications is their perception of risk, as found by Poeteri et al. (2021) in the context of Indonesian research. Sipangkar and Wijaya (2020) state in their research that consumers will be interested only in P2P lending services if they perceive the investment risk to be low. This study argues that Generation Z is often highly sensitive to privacy issues. They may be more wary of the risk of their personal data being leaked or misused. P2P lending applications that offer strong privacy guarantees will be more appealing to them. In this study, perceived risk refers to the security and privacy risks that individuals embrace when utilizing an online application service. In addition, this investigation formulated the following final hypothesis:

H8: Perceived risk negatively influences an individual's intention to use P2P lending applications.

Methodology

This quantitative research design seeks to predict and test hypotheses using appropriate research instruments (Cooper and Schindler 2011). Figure 1 showed research model of this study. Researchers use the survey method to determine about people's knowledge, opinions, and behaviors so they can describe, compare, or explain them (Fink 2003). Before the questionnaire was distributed, the authors initially conducted a readability test. The purpose of the readability test was to assess whether the instrument could be comprehended by the respondents. This test involved 10 people from Generation Z who had used P2P lending applications.

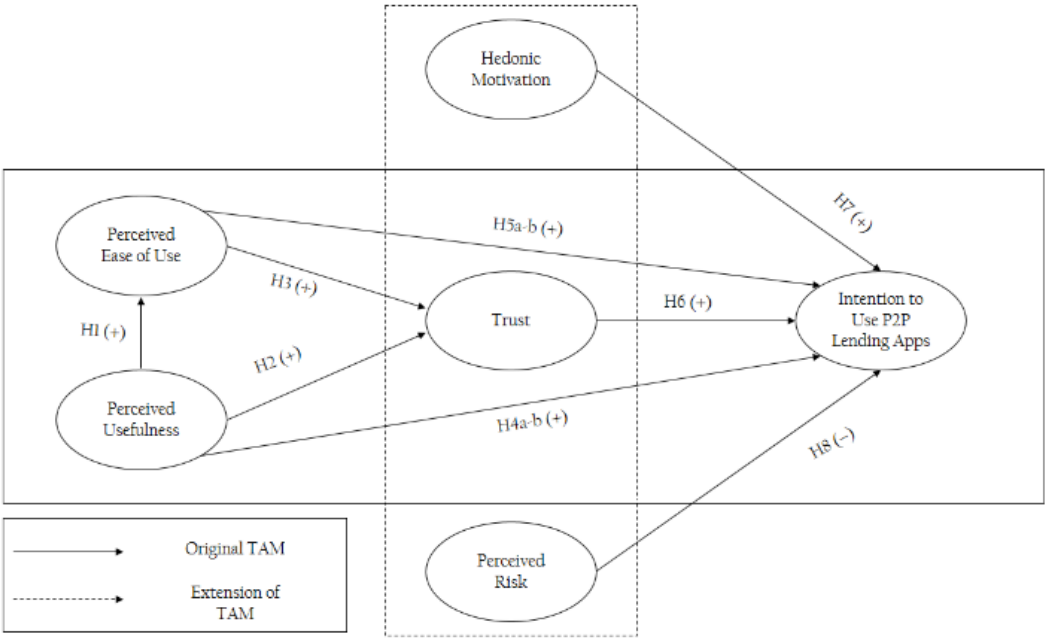

Figure 1. Research Model (An Extension of Technology Acceptance Model)

The questionnaire's Likert scale measured each concept. State 1 strongly opposes and State 5 firmly agrees. In addition, this study employed six constructs, with a total of 20 queries posed, considering the indicators of all existing constructs. The indicators of each construct indicators were modified from earlier research to retain the validity and reliability of the measuring instrument. These included three items from Davis (1989) for perceived ease of use (PEOU) and perceived usefulness (PU), three items for trust (Gefen, 2000), five items for perceived risk (Wolfinbarger and Gilly 2003), three items for hedonic motivation (Megadewandanu, 2016), and three items for usage intention (Fishbein and Ajzen 1977).

Furthermore, this study used a non-probability sampling technique to determine the sample. This technique was chosen because of its ability to target specific populations and sample groups, which in this study is Generation Z. Generation Z is defined as individuals under 24 by Mastercard and CrescentRating (2019). Generation Z was chosen as the population by considering several things. First, Generation Z is the generation with the most extensive Internet usage, which makes this group a

potential research sample. Second, Generation Z is considered to have more activity in Internet use, especially in purchasing product and services digitally.

Purposive sampling was used to determine the sample. The specific requirements for respondents, if they want to participate in this research survey, are as follows. First, respondents must know at least one or more P2P lending service applications in Indonesia. This is because many P2P lending applications advertise to social media, such as Instagram, TikTok, and Facebook. Therefore, we believe that Generation Z, who completed this research questionnaire, knows at least one or more existing P2P lending applications. Second, respondents had one or more P2P lending applications installed on their gadgets, such as cell phones. Finally, respondents have at least one or more accessed P2P lending applications, whether to make transactions as borrowers or lenders.

The questionnaire compiled using Google Forms was distributed to various social media, such as Instagram, Facebook, Twitter, and WhatsApp. This is intended so that this study obtains respondents from Generation Z, spread across various provinces in Indonesia. Then, the question items were designed to be as detailed and as short as possible so that respondents could understand the question items directly and avoid fatigue in filling out the questions (Dörnyei and Dewaele 2022).

Using WarpPLS 7.0, data from respondents were then analyzed using partial least square structural equation modeling (PLS-SEM). PLS-SEM has many benefits. First, PLS-SEM can be used to characterize in detail every relationship between existing research variables, including mediating variables (Hair et al. 2014). Second, PLS-SEM can process data without an overwhelming amount of information (Kock 2018). Finally, PLS-SEM can give researchers confidence while working with preexisting data because it does not require a long list of assumptions or predetermined conditions (Aibinu and Al-Lawati 2010; Awang et al. 2015; Hair et al. 2019). The analysis in this study consists of several stages: first, testing the measurement model (outer model), which includes validity and reliability tests; second, testing the structural model (inner model), which includes the evaluation of model fit and quality index; and third, testing the hypothesis, which considers the results of the p-value and path analysis.

Results

Respondent's Profile

A total of 344 participants participated in this survey. However, 39 responses were discarded because they were incomplete. The final sample size was 305. Women dominate the sample (approximately 70% of the total respondents). However, the sample size of 305 fulfils the standards established by Kotrlik and Higgins (2001), who state that the minimal sample size is 118 when operationalizing continuous data. Most participants were under 20 years of age, and over half (65%) had at least a bachelor's degree. Respondents from Central Java dominated the sample despite a wide range of provincial origins. Respondents' source of income is dominated by the parental provision, with income concentrated at Rp 1,000,000 - Rp 3,000,000. This demonstrates that a sizable portion of Generation Z participants in this study do not yet have access to secure financial support. Meanwhile, the P2P lending app that many respondents knew was Investee (46%). For complete respondent profile results, refer to (Table 1).

Table 1. Respondent Profile

Demography	Frequency	(%)
Gender		
Male	91	30%
Female	214	70%
Age		
18-20 Years	178	58%
21-23 Years	127	42%
Qualifications in Education		
High School	79	26%
Diploma	17	5,5%
Bachelor	198	65%
Master	11	3,5%
Provincial Origin		
Bangka Belitung	15	5%
South Sumatera	19	6%
Lampung	4	1%
Riau	2	0,5%
Riau Island	5	1,5%
Jambi	46	15%
West Sumatera	4	1%
North Sumatera	6	2%
Aceh	5	1,5%
DKI Jakarta	21	7%
West Java	27	9%
Banten	8	2,5%
East Java	8	2,5%
Middle Java	66	22%
DI Yogyakarta	14	4,5%
Bali	5	1,5%
West Nusa Tenggara	4	1%
Papua	5	1,5%
West Kalimantan	13	4%
East Kalimantan	3	1%
South Sulawesi	2	0,5%
Southeast Sulawesi	23	7,5%
Source of Income		
From Parents	213	70%
Full Time	41	13%
Part Time	47	15%
Intern	4	2%
Income (Monthly)		
Less than Rp 1.000.000	128	42%
Rp 1.000.000 – Rp 3.000.000	138	45%
More than Rp 3.000.000	39	12%
P2P lending applications that you familiar with		
Investree	140	46%
Danamas	34	11%
AdaKami	24	9%
Amartha	34	11%
Kredit Pintar	49	14%
Julo	24	9%

The Testing of the Measurement Model

The validation of the measurement model includes two types of testing: validity and reliability tests. Validity testing uses two parameters: convergent validity, which means that each indicator matches the correct construct, and discriminant validity, which means that the loading factor value of the construct within the construct is higher than that of the construct outside the construct. Convergent validity test results were revealed using PLS-SEM analysis when the loading factor value was larger than 0.70 and the significance value was less than 0.05, as per the recommendations of Hair et al. (2014). The average variance extract (AVE) parameter can be used to determine convergent validity according to Farrell (2010), with a value of 0.50, meeting the criterion established by Koufteros (1999). All the constructions clearly resulted in AVE values greater than 0.50. This means that the convergent validity assumption met the criteria (Fornell and Larcker, 1981) despite several indicator loading factors being below 0.70, and all constructs having an AVE above 0.50. Table 2 shows that the discriminant validity tests showed that all the constructs were valid. Since all indicators passed both convergent and discriminant validity tests, we may conclude that they are all reliable.

Table 2. Validity for Discrimination Test Outcomes

	PEOU	**PU**	**TRU**	**HM**	**PR**	**INT**
PEOU	**(0.949)**	0.668	0.481	0.494	-0.263	0.309
PU	0.668	**(0.951)**	0.515	0.591	-0.259	0.422
TRU	0.481	0.515	**(0.942)**	0.762	-0.014	0.731
HM	0.494	0.591	0.762	**(0.905)**	-0.112	0.715
PR	-0.263	-0.259	-0.263	-0.112	**(0.902)**	0.002
INT	0.309	0.422	0.731	0.715	0.002	**(0.961)**
Notes: Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Trust (TRU), Hedonic Motivation (HM), Perceived Risk (PR), Intention to Use P2P Lending Applications (INT)						

Composite reliability and Cronbach's alpha were used in the PLS-SEM analysis construct reliability tests. According to Nunnally (1975) and Hulin (1987), a construct is considered reliable if it yields composite reliability and Cronbach's alpha values are better than 0.70. All research constructs had composite reliability and Cronbach's alpha ratings of more than 0.70, according to the reliability test results (Table 3), showing that all instruments were reliable. In addition, thorough collinearity testing was performed to ensure that there was no significant relationship between any construct. WarpPLS applications provide advantages over those that permit vertical collinearity checking for collinearity between predictor variables, such as full collinearity testing (Berakon et al. 2023; Rasoolimanesh et al. 2016). The full collinearity test results for all constructs were less than 3.3 (Table 3), suggesting that the research model had no collinear relationships in either the vertical or horizontal directions and did not contain any common method bias (Kock 2017).

Table 3. Testing Shows Full Collinearity, Validity, and Reliability

Construct	Number of Items	Indicators	Loading Factors	AVE	Composite Reliability	Cronbach's Alpha	Full Collinearity VIF
Perceived Ease of Use	PEOU 1	The P2P lending applications are simple to operate	0.939	0.949	0.964	0.944	1.991
	PEOU 2	The P2P lending applications require little time to master	0.963				
	PEOU 3	Operating the P2P lending applications does not need more effort	0.943				
Perceived Usefulness	PU 1	The use of P2P lending applications will support my financial plan	0.953	0.951	0.966	0.947	2.205
	PU 2	The use of P2P lending applications will make my financial plan effective	0.966				
	PU 3	The P2P lending applications will be useful for supporting development and strengthening of the financial sector	0.934				
Trust	TRU 1	The P2P lending applications are trustworthy	0.930	0.942	0.959	0.936	3.100
	TRU 2	The P2P lending applications are reliable	0.948				
	TRU 3	I believe that the P2P lending applications will fulfill my needs	0.947				
Hedonic Motivation	HM 1	Using the P2P lending applications will be fun	0.915	0.905	0.931	0.889	3.165
	HM 2	Using the P2P lending applications will be enjoyable	0.891				
	HM 3	Using the P2P lending applications will be entertaining	0.908				

Construct	Number of Items	Indicators	Loading Factors	AVE	Composite Reliability	Cronbach's Alpha	Full Collinearity VIF
Perceived Risk	PR 1	Providing personal data information online is unsafe	0.866	0.902	0.956	0.942	1.129
	PR 2	I worry about the security of sharing my personal information with a P2P lending applications	0.930				
	PR 3	Giving the P2P lending applications access to one's bank account information concerns me	0.940				
	PR 4	Personal information (including but not limited to name, address, bank information, phone number, etc.) is something I would be hesitant to give a P2P lending application	0.906				
	PR 5	I think it is risky to make a decision (such as taking selfie with ID card) provided by P2P lending applications	0.863				

Construct	Number of Items	Indicators	Loading Factors	AVE	Composite Reliability	Cronbach's Alpha	Full Collinearity VIF
Intention to Use P2P Lending Applicati-ons	INT 1	When I need money in the future, I plan to use the P2P lending applications	0.951	0.961	0.973	0.958	2.544
	INT 2	When I need money in the future, I see myself turning to the P2P lending applications	0.965				
	INT 3	When the time comes, I intend to use the P2P lending applications to get a loan	0.966				
Notes: Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Trust (TRU), Hedonic Motivation (HM), Perceived Risk (PR), Intention to Use P2P Lending Applications (INT)							

The Testing of the Structural Model

The parameters or indices used as standards for evaluating the model fit can be employed in PLS-SEM analysis to confirm the outcomes of the model fit and quality indices. Table 4 shows that the research model is soundly constructed and meets all the criteria for a good model fit. The average VIF, average R^2, and average adjusted R^2 values were all significant (less than 0.001), and the average route coefficient was also significant. The average VIF and average full collinearity VIF meet the requirements because their values are less than 3.3. Kock (2017) claims that average VIF and average full collinearity VIF are the two indicators that can detect multicollinearity. All the constructs used in this investigation were found to be valid, and there was no overlap between them (Table 4).

Table 4. Indexes of Model Fit and Quality Indices

Indexes	Value	Decission
Average path coefficient	0.250***	Accepted
Average R^2	0.514***	Accepted
Average adjusted R^2	0.510***	Accepted
Average VIF	1.982	Accepted
Average full collinearity VIF	2.356	Accepted
Notes: *** is significant at p-value < 0.01		

The Hypotheses Testing

Direct effect hypotheses and indirect impact hypotheses are the two broad categories in which the study's hypothesis testing falls. Only one of the eight hypothesized direct-effect relationships (between PU and intention) either failed to provide evidence or was not supported (Table 5). For this research, we employed the decision-making frameworks of Baron and Kenny (1986) and Kock (2011, 2013) to examine the possibility of indirect or mediated effects. To use P2P lending applications, (1) Panel A

requires significant coefficients for PEOU and PU, and (2) Panel B requires significant coefficients of PEOU and PU.

Table 5. The Findings from Direct Effect Hypothesis Testing

Proposed Hypothesis		**β**	**Decision**
H1	PEOU → PU (+)	0.67***	Accepted
H2	PEOU → Trust (+)	0.25***	Accepted
H3	PU → Trust (+)	0.35***	Accepted
H4a	PEOU → Intention (+)	0.14***	Accepted
H5a	PU → Intention (+)	0.01	Rejected
H6	Trust → Intention (+)	0.46***	Accepted
H7	Hedonic motivation → Intention (+)	0.42***	Accepted
H8	Perceived risk → Intention (–)	0.11**	Accepted
Notes: *** is significant at $p \leq 0.01$, ** is significant $p \leq 0.05$			

Including or regulating the mediating variable eliminates the need for a strong direct correlation between independent and dependent variables. Partial mediation occurs when the link between the independent and dependent variables exists, even after the mediating variable is accounted for or tested for its role as a mediator (MacKinnon et al. 2002; Baron and Kenny 1986). Table 6 presents the mediation effect test findings, showing how the mediating variable sequentially controls the link between the independent and dependent variables.

Table 6. The Results of the Tests of Hypotheses Regarding the Mediation Effects

Panel A		
Step 1: Direct Effect without Mediation		
Dependent Variables		Independent Variables Intention to use P2P lending app
PEOU		0.117**
PU		0.161***
Panel B		
Step 2: Direct Effect with Trust as a Mediation		
	Mediating Variables Trust	Independent Variables Intention to use P2P lending app
PEOU	0.254***	0.254***
PU	0.350***	0.175***
		0.459***
Panel C		
Step 3: Conclusion		
H4b: The association between PEOU and intention to use P2P applications was fully mediated by trust. H5b: The association between PU and intention to use P2P applications was fully mediated by trust. Notes: *** is significant at $p \leq 0.01$, **is significant at $p \leq 0.05$		

Panel A shows that PEOU and PU strongly predict the intention to utilize P2P lending applications before moderating factors. Two findings appear when the mediation effect is included (Panel B): there is a direct and robust association between PEOU and PU on trust and between trust and the intention to use P2P lending applications. Furthermore, there is a substantial immediate effect between PEOU and PU on the intention to use P2P lending applications. Wang et al. (2020) found that trust entirely mediates the association between PEOU and the intention to use P2P lending applications and somewhat mediates the association between PU and intention. Thus, trust supported H4b and H5b (Figure 2 and Table 6).

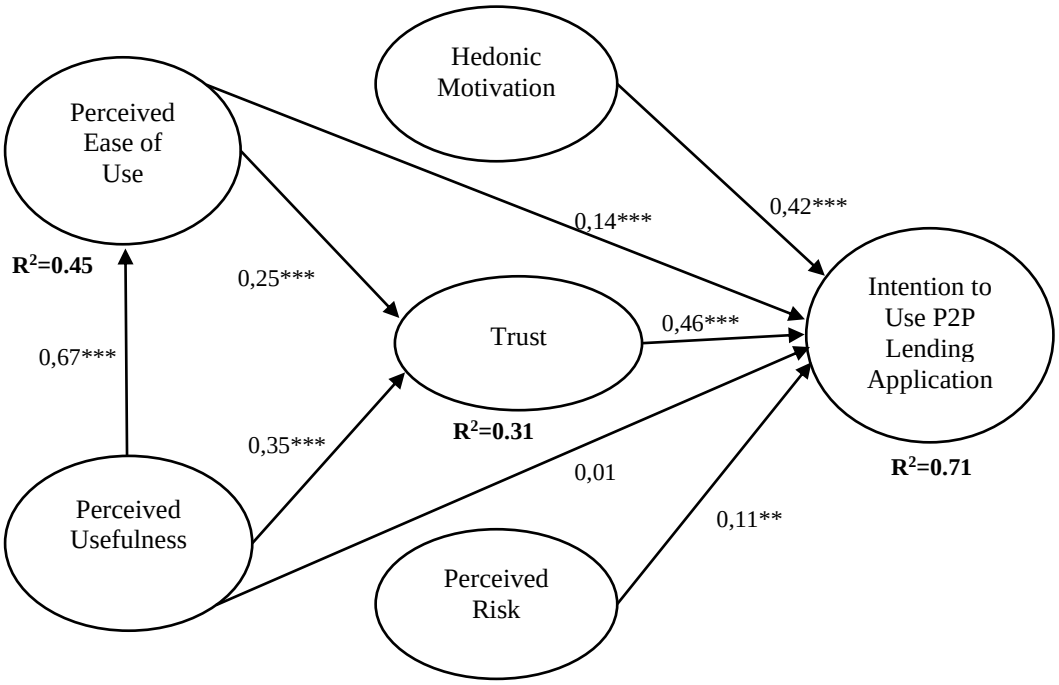

Figure 2. Empirical Findings of SEM-PLS using WarpPLS 7.0 (An Extension of Technology Acceptance Model

Discussion

This study provides important insights into the motivations behind Generation Z's increased use of P2P lending applications by using social transform theory and expanded the TAM Model. In the realm of utilizing P2P lending applications, the social transformation theory elucidates that the adoption of P2P lending applications signifies substantial technological shifts within society. This is manifested through digital technology altering the manner in which individuals access financial services. TAM expansion accurately forecasted the factors influencing people's openness to new technologies. Except for perceived usefulness, all the research model's variables positively and significantly influence Gen Z's intention to use P2P lending applications. The results also demonstrate that P2P lending applications provide a viable option for Generation Z members, who require access to rapid cash. P2P lending applications are seen as a convenient way for members of Generation Z to quickly obtain cash.

In response to these hypotheses, PEOU positively influences PU (H1 is accepted). This result adds evidence to Lavuri et al. (2023) and Liébana-Cabanillas et al. (2021) regarding impulsive online purchases and P2P mobile payments. This suggests that people are more inclined to see technology as beneficial if they believe it will help them. In addition, PEOU and PU have promising outcomes that could lead to greater trust among Generation Z members (H2 and H3 are accepted). In other words, people are more likely to trust an app if they think it would be simple to operate and would result in tangible benefits for them. Ventre and Kolbe (2020), and Usman et al. (2022) present strong scientific evidence supporting these statements.

H4a is supported by the results of the direct effects testing method, which show that PEOU is positively and significantly associated with Gen Z's intention to use P2P lending applications. This supports other

research, such as Aji et al. (2020) in the context of electronic currency, Arpaci and Basol (2020) in the context of the adoption of digital learning, and Yu and Song (2021) in the context of dating applications. However, this study showed that PU did not affect Gen Z's intention to use P2P lending applications (H4b). Generation Z may not fully understand or recognize the concrete benefits of using P2P lending applications. They may not clearly see how the app can benefit them or meet their financial needs, making perceived usefulness less relevant in forming usage intentions. Also, P2P lending applications may not provide adequate explanations or enough educational campaigns to explain how they are useful. If this information is not properly conveyed to generation Z, they may not perceive significant added value or usefulness. This is also consistent with the studies on people's intention to use electronic wallets by Abdul-Halim et al. (2022) and fitness app usage by Chiu et al. (2021).

This study also employed TAM to examine how PEOU and PU influence P2P lending applications adoption intention through trust. The findings demonstrate that trust fully mediates the relationship between PEOU and PU, thus supporting H4b and H5b. The results are also supported by Akbari et al. (2020) in the context of 5G technology acceptance in Iran and the United States. Thus, trust is one of the constructs that help explain why so many individuals are comfortable with P2P lending applications.

This study provides empirical evidence that incorporating the concept of trust and even using it as a mediating variable can account for contradictory results on the link between PEOU, PU, and Generation Z's intention to use P2P lending applications. Thus, this finding closes a gap in the literature generated by researcher's frequent omission of the trust construct in their application of the TAM. This finding is innovative and makes important contributions to advancing studies on the acceptability of technology, especially in P2P lending.

Furthermore, trust influences Generation Z's intention to use P2P lending applications (H6). Several earlier studies, including Dam (2020) on shopping intentions in Vietnam, Singh and Sinha (2020) on the prevalence of digital wallets, and Ventre and Kolbe (2020) on the same topic, find this to be the case. This study showed that Generation Z's use of P2P lending applications can be predicted by individual's degrees of trust.

The next variable to be examined with the TAM extension is hedonic motivation, which is hypothesized to positively affect Generation Z's intention to use P2P lending applications. Furthermore, it is hypothesized that perceived risk negatively affects Generation Z's intentions. It was revealed that both hedonic motivation and perceived risk played significant roles in determining Generation Z's intention to use P2P lending applications. The results of the empirical study by Indrawati et al. (2022), which found that hedonic motivation is an influential predictor of user intention to purchase online, were corroborated by the results of the present investigation, providing strong support for H7. This research shows that Generation Z's willingness to use P2P lending applications is affected by hedonic motivation.

H8 is also supported by evidence suggesting that individuals' perceived risk affects their intention to use P2P lending applications. Yi et al. (2020) found that customers worried that the expansion of the sharing economy into the tourism sector could enhance dangers, such as the spread of the Zika virus through interpersonal contact. Similarly, Rather (2021) found that many travelers still avoid popular destinations out of concern that they might get the Covid-19 pandemic virus. In addition, Han and Kim (2017) discovered that consumers' desire to buy things online is affected by social risk resulting from poor evaluations posted by other consumers on the online shopping site, Taobao.com. However, the results conclusively demonstrate that Generation Z's intention to use P2P lending applications is determined by their level of perceived risk as measured by the dimensions of privacy concerns and security risk. Thus, it can be concluded that Generation Z's intention to use the applications decreases as perceived risk increases and vice versa.

Conclusion

This study uses social transformation theory in the context of using P2P lending applications. Social transformation theory explains that the use of P2P lending applications reflects significant technological changes in society. Where digital technology has changed the way, we access financial services. Also this study extends the TAM model by incorporating components of trust, hedonic motivation, and

perceived risk perception to explain the elements that may impact Generation Z's intention to use P2P lending applications. The results reveal that the likelihood of a member of Generation Z using the P2P lending applications depends on their level of technological expertise (including simplicity of use), confidence in the quality of services supplied by vendors, enthusiasm for and comfort with technology, and perception of risk. No correlation was found between perceived usefulness and the intention to use P2P lending applications.

In addition to the TAM's theoretical contribution, this study's conclusions have significant implications for the government, particularly the Financial Services Authority (OJK), which is tasked with creating and improving the financial industry. First, we believe that OJK should provide more socialization to Generation Z regarding the safety of P2P lending applications. This study demonstrates that people are less inclined to adopt new technology when they sense a high level of danger.

Second, those who create P2P lending applications are responsible for educating users about what they stand to gain from using them. This is done to ensure that the next generation of workers have faith in the effectiveness of P2P lending applications. Third, to prevent users' private information from being sold or leaked, the financial services sector must make robust security options available for P2P lending app transactions.

Fourth, OJK should engage in socialization and education to improve the public's familiarity with legitimate P2P lending applications. Many potential borrowers are wary of using these tools due to the increasing number of illegal P2P lending services. As trust is a key aspect in promoting the adoption of P2P lending applications, all parties involved should commit to creating, sustaining, and strengthening Generation Z's trust through unique and innovative programmes.

Despite its valuable theoretical and practical contributions, this study has several limitations. First, this study only included participants from a single age group, Generation Z. Therefore, future studies should aim for a more diverse sample of respondents to address the problem of generalizing research findings. Second, PEOU, PU, trust, hedonic motivation, and perceived risk were the factors used in this research model to show Geneartion Z's intention to use P2P lending applications. Generation Z's intention to use P2P lending applications may be influenced by several other factors. Therefore, future researchers should consider other variables such as subjective norms and attitudes regarding the intention to use P2P lending applications. Third, only the dimensions of privacy concerns and security risks were used to gauge perceived risk in this investigation. As a result, future studies could divide the perceived risk variables into categories, including social risk, time risk, and monetary risk.

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Usability Evaluation and Interface Design Improvement for the Maxim Application with User-Centered Design Approach

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Abstract

The research focused on the user interface of the Maxim application, a ride-hailing service in Indonesia facing usability challenges compared to its competitors, such as Gojek, Grab, and inDrive. The study aimed to identify user issues and propose alternative interface designs to enhance usability. The User-Centered Design (UCD) approach was adopted, involving two iterative phases that yielded high-fidelity designs. Through online surveys and interviews, 77 problem categories were identified, adhering to Usability Heuristic principles, and 93 design solutions were crafted based on Shneiderman's Eight Golden Rules of Interface Design. Subsequently, the design solutions were evaluated through moderated usability testing (UT) and the System Usability Scale (SUS) questionnaire distribution. The second iteration's UT results indicated improved success rates, reduced task completion times, higher SUS scores, and positive user feedback on ease of use. In conclusion, this research improved the application's usability and offered valuable recommendations for further enhancements and future investigations.

Keywords: Ride-hailing, usability, usability evaluation

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Introduction

Transportation is essential to Indonesian society, particularly in Jakarta Metropolitan Area which includes 5 cities: Jakarta, Bogor, Depok, Tangerang, and Bekasi (known locally as Jabodetabek area). There were 49.5 million trips per day in 2018 (Badan Pengelola Transportasi Jabodetabek 2019), which increased to 88 million in 2020 (Alhikam 2020) in the Jabodetabek area. Transportation growth in Indonesia has accelerated with the emergence of mobile app-based ride-hailing services. Currently, ride-hailing services, including motorcycles and cars, are the second most popular transportation choice for Indonesian people, at approximately 34% (Mutia 2022). According to Simarmata et al. (2019), people require safe, simple, fast, and affordable transportation, which has led to the continued growth of motorcycle ride-hailing services. Additionally, car-based ride-hailing services are favored for their safety and comfort (Nugroho et al. 2020).

Maxim is a ride-hailing service provider that entered Indonesia in 2018 (Maxim 2020). Despite being a relatively new application, by 2022, Maxim had placed third position in popularity after Gojek and Grab (Ahdiat 2022). Within its two years of operation, Maxim has experienced rapid growth, completing 16 million orders (Maxim 2020). However, despite this success, Maxim has faced some challenges. The application's version 3.14.6 received a moderate rating of 3.4/5 on the App Store and 4.3/5 on the Play Store, indicating mixed opinions among users. Criticism primarily revolves around concerns regarding the user interface and feature flow, contributing to an overall less positive sentiment. Users have found it challenging to navigate the app and perform specific activities due to these perceived shortcomings. To ensure a continued positive user experience and the smooth mobility of the Indonesian community, it is crucial for Maxim to conduct a thorough examination of these limitations and make necessary improvements to enhance the usability of its application.

Usability defined as the effectiveness, efficiency, and satisfaction with which a product can be used in a specific context (International Organization for Standardization 2019). Compared to Gojek and Grab, Maxim has lower usability ratings in the components of convenience, efficiency, ease of use, and user satisfaction (Sari and Rahmizal 2021). This could pose a limitation and disadvantage for Maxim, significantly since usability issues in the application can also negatively impact business performance (Markova and Aula 2007).

The high use of ride-hailing services has attracted researchers' attention to this topic in depth. Studies focusing on ride-hailing applications in Indonesia, such as Grab and Gojek, have been conducted to assess their usability. Sukmasetya and Shalahuddin (2019) examined the usability aspect of these applications, while Widyanti and Ainizzamani (2017) improved the interface design according to the usability evaluation. These two studies show that high usability in interface design factors can improve the application's experience. However, despite the growing popularity of Maxim among users, recent research by Sari and Rahmizal (2021) indicates that Maxim's usability remains subpar, resulting in only moderate user satisfaction. In addressing this issue, usability can be improved by redesigning the interface using a user-centered approach. Research conducted by (Zahib et al. 2022) serves as an example of using User-Centered Design (UCD) methodology to enhance the usability of the Grab ride-hailing application for individuals with visual impairments through the development of design solutions. However, this methodological approach has not been applied to the Maxim application. Hence, further research is necessary to evaluate Maxim's usability and develop interface design solutions that focus on user needs by implementing UCD.

The study aimed to investigate users' perceptions of the current Maxim application's usability in the context of ride-hailing services. Furthermore, this research also identified potential improvements by proposing alternative user interface designs aligned with Usability Heuristics (Da Costa et al. 2019) and Shneiderman's Eight Golden Rules of Interface Design (Shneiderman 1997). Subsequently, the alternative design outcomes were evaluated to determine their effectiveness in improving the usability features of the Maxim application. This approach was undertaken with the intention of providing valuable insights and practical recommendations for the optimization of Maxim's ride-hailing service, ensuring its competitiveness and user-centricity in the dynamic market landscape.

Literature Review

Ride-Hailing

Ride-hailing is a service that allows individuals to book vehicle rides to reach a destination through a mobile application (Malik et al. 2021). This service connects passengers with vehicle owners in real-time (Watanabe et al. 2016), providing a convenient solution for meeting mobility needs (Septiani et al. 2017). One notable advantage of ride-hailing is eliminating haggling between passengers and drivers. Additionally, it enhances safety by providing passengers with information about the driver and vehicle they are traveling with. These benefits contribute to the increasing popularity of ride-hailing services.

In Indonesia, ride-hailing services, both for motorcycles and cars, have become the second most preferred mode of transportation, accounting for approximately 34% of the population's mobility choices (Mutia 2022). Motorcycles are particularly popular due to their accessibility and affordability, leading to substantial growth (Soehodho 2017). Simarmata et al. (2019) note that the demand for safe, fast, and cost-effective transportation fuels the continuous growth of motorcycle ride-hailing. Furthermore, car ride-hailing services are chosen by individuals seeking comfort and security (Nugroho et al. 2020). The high demand for mobility in Indonesia creates significant opportunities for the growth of ride-hailing service providers. Several applications catering to this demand include Maxim, Grab, and Gojek.

Maxim

Maxim is a ride-hailing service application that has been present in Indonesia since 2018 (Maxim 2020). Maxim's mission is to enhance user interaction and assist many individuals on their day-to-day trips. Currently, Maxim serves more than 100 cities across Indonesia (Maxim 2023) and holds the top position for both vehicle and free application categories on the Play Store as of February 2023.

Maxim offers seven types of services, namely Maxim Bike (motorcycles), Maxim Car (cars), Maxim Food (food delivery), Maxim Delivery (parcel delivery), Maxim Cargo (freight services), Maxim Life (massage, spa, and cleanliness services), and Maxim Helper (workers for lifting goods). In Indonesia, Maxim Bike and Maxim Car services dominate the application, accounting for approximately 70% and 24.5% of Maxim's bookings, respectively (Maxim 2020). One of Maxim's strengths is its affordability compared to other competitors. Despite its low fares, user reviews on the Play Store indicate that Maxim continues to provide satisfactory services. This is supported by research conducted by Setyaningsih et al. (2020), which found high satisfaction levels in service responsiveness and cost variables.

Usability

According to Weichbroth (2020), the widely accepted definition of usability is developed by ISO 9241-11 (International Organization for Standardization 2018), which states "the extent to which specified users can use a product to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use." In its application, usability has attributes for measuring the quality of an application (Huang and Benyoucef 2023). Weichbroth (2020) proposed usability attributes for mobile applications, which include: (1) efficiency; (2) satisfaction; (3) effectiveness; (4) learnability; (5) memorability; (6) cognitive load; (7) errors; (8) simplicity; and (9) ease of use. According to Huang and Benyoucef (2023), considering these aspects can enhance the utility of an application in delivering information and improving user performance when using the application.

Methods

This study adopted the User-Centered Design (UCD) that focuses on developing designs centered around users' needs to ensure that the user requirements are understood and the developed solutions will improve user utility and satisfaction (Zorzetti et al 2022). Compared to other user-centric approaches like Double Diamond and Lean UX, UCD places a more specific focus on digital processes and interfaces. Furthermore, the study will use the International Organization for Standardization (2019) approach by encompassing four key stages: (1) understanding context of use, (2) specifying user

requirements, (3) producing design solutions, and (4) evaluating against requirements. Qualitative methods, including surveys, interviews, and usability testing, were used to gain insights into user experiences, pinpoint challenges, and ensure design solutions aligned with user needs. On the other hand, quantitative methods involved surveys and the System Usability Scale (SUS) questionnaire (Brooke 2013), which has been adapted into Indonesian by Sharfina and Santoso (2016) to gain insights into application usage patterns and user experiences after adopting the newly developed alternative interface designs. The research was carried out in two iterations. In the first iteration, all four UCD stages were meticulously executed, and the evaluation results served as the foundation for proceeding to the second iteration. In the second iteration, the research commenced with stages that were tailored to address specific needs based on the evaluation results of the design (Mithun et al. 2018). Figure 1 shows the research stages, the methods used, and the outcomes produced from each stage of UCD.

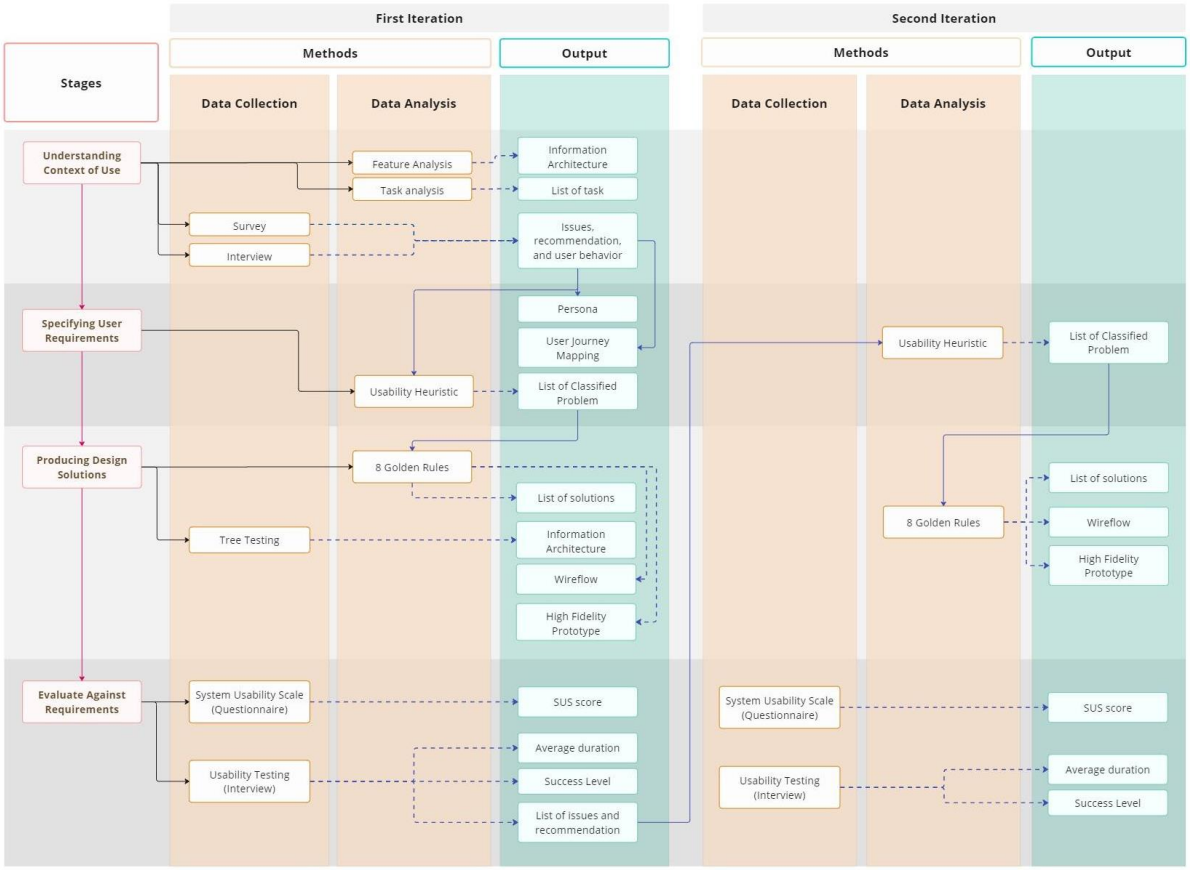

Figure 1. Two Iterative Phases of User-Centered Design Process Applied in This Study

The first stage of the User-Centered Design (UCD) development phase, known as understanding the context of use, was initiated through existing feature analysis and task analysis (Crystal & Ellington 2004) to identify the features and activities in the Maxim application. The results of this analysis were further developed into an information architecture (Ruzza et al. 2017) to facilitate understanding of feature categorization and placement. Subsequently, data collection took place through surveys (Arikunto 1992) and interviews (Badan Pusat Pengembangan dan Pembinaan Bahasa n.d.) to understand the characteristics and perceptions of Maxim's usage. The questions provided to respondents covered the entire process in Maxim application, particularly the ride-hailing services for both motorcycles and cars. The survey results were then further explored through online interviews via the Zoom application, with respondents selected from the survey participants.

In the second stage, specifying user requirements, user characteristics obtained from surveys and interviews are mapped into personas (Calde et al. 2002) and user journey mapping (Howard 2014). Subsequently, the identified issues are categorized according to 13 principles of Usability Heuristics for mobile applications, which was adapted from Nielsen (Da Costa et al. 2019)**.** Specific usability heuristics are important in evaluating mobile applications because they help quickly identify relevant

issues and ensure an ideal user experience (Othman et al. 2018). These principles include: (1) presenting the system status clearly; (2) aligning the application with real-world; (3) granting users control and freedom; (4) adhering to consistency and established standards; (5) incorporating measures for error prevention; (6) minimizing the user's memory load; (7) enabling customization and shortcuts; (8) optimizing efficiency of use and performance; (9) enabling aesthetic and minimalist design elements; (10) assisting users in recognizing, diagnosing, and recovering from errors; (11) providing help and documentation; (12) fostering pleasant and respectful interactions with the user; and (13) ensuring privacy. By leveraging these principles, designers can identify potential usability issues at an early design stage and make necessary adjustments to enhance the user experience (Saeed et al. 2019). These issues were grouped using deductive principles, a grouping based on a theory, literature, or research question (Kuckartz 2019).

Following the third stage, producing design solutions, started by systematically mapping improvement suggestions with the identified issues from the previous stage with a deductive approach guided by Shneiderman's Eight Golden Rules of Interface Design principle (Shneiderman 1997). This principle serves as guidelines for designing and improving interfaces, which consists of eight rules, such as: (1) aim for uniformity in design elements; (2) provide shortcuts for frequent users; (3) provide informative feedback to users; (4) design dialogues to result in closure; (5) implement straightforward error handling mechanisms; (6) allow for the easy reversal of actions; (7) support an internal locus of control for users; (8) minimize the cognitive load on short-term memory. Subsequently, all the identified areas for improvement were elaborated upon through the development of proposed information architecture, wireflows, and high-fidelity prototypes.

In the final stage, the interface design solutions were evaluated to validate the designs' alignment with user needs. Participants in this stage were previously involved in the understanding context of use phase. The evaluation began with usability testing (UT) to assess how effectively and satisfactorily a product can be used by users (Hertzum 2020). UT was carried out remotely using Maze (Maze n.d.) and Zoom (Zoom 2023) applications. Each research team member interacted with participants based on scenarios designed from the identified issues and needs in the specifying user requirement stages. Furthermore, the evaluation process continued with distributing a survey containing ten questions based on the System Usability Scale (SUS) through the Google Forms (Google Forms n.d.) platform. The questions were presented in the Indonesian translation by Sharfina and Santoso (2016). The SUS is adopted because it effectively supports a small sample approach for accurately assessing users' subjective perceptions of a system's usability (Vlachogianni and Tselios 2021).

Results

Understanding Context of Use (First Iteration)

The first stage began with feature analysis to understand the purpose of each Maxim feature. A total of 14 features were categorized into three groups: activities during booking, waiting for the driver's arrival, and post-journey activities accompanied by other supporting features. Subsequently, the results of the feature analysis were developed into an information architecture, as seen in Figure 2. To understand the user flow, task analysis was conducted, resulting in four activities that encompassed the entire set of features. These activities include booking a ride-hailing service, configuring travel orders, completing orders, and finding support.

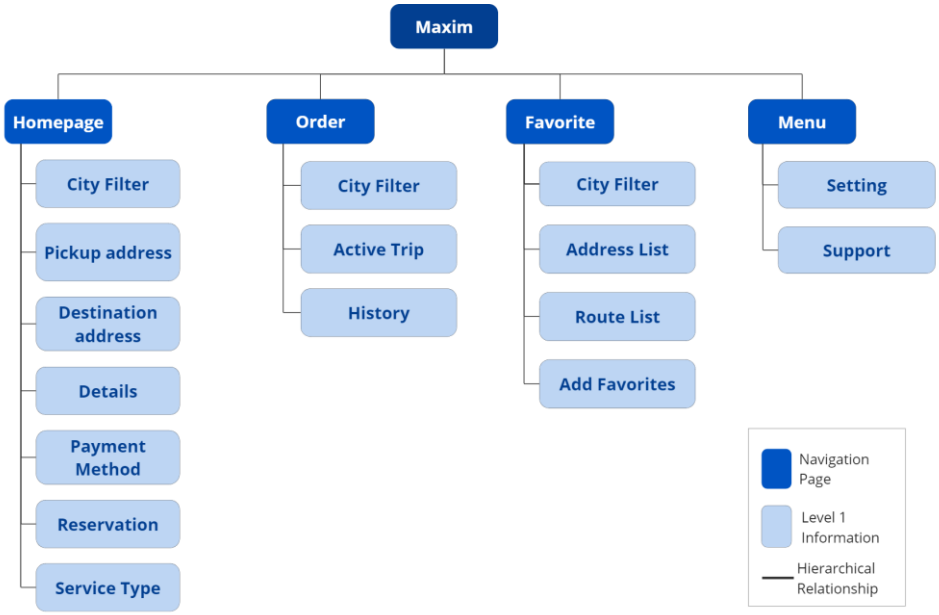

Figure 2. Existing Architecture Information of Maxim

Data collection through an online questionnaire survey was conducted from February 17, 2023, to March 18, 2023, resulting in 132 valid responses. Most of the respondents came from the 18-25 age group (82.6%), followed by those aged 26-35 (7.6%). The motorbike service emerged as the most frequently used service on the Maxim application, accounting for 90.9% of users. Respondents' motivation for booking Maxim services generally stemmed from routine needs (n = 69) and the desire for quick arrivals (n = 61). Additionally, the survey highlighted that the activity of selecting a location received the lowest ease-of-use rating, scoring 2.84 on a 1-5 scale. This low rating was attributed to challenges such as struggles to pinpoint the correct location, especially when multiple places share similar names. Through this survey, the research team gains insights into the diverse usage patterns, satisfaction levels associated with each feature, and the difficulties respondents face while using Maxim.

Furthermore, interviews were conducted online with 10 respondents to delve deeper into the survey findings, with 9 female respondents and 1 male respondent. The interviewees were selected from the survey respondents within the age range of 18-25 years, aligning with the distribution of most respondents. The respondents were categorized based on their application usage characteristics: regular users (3-5 days every week), occasional users (1-2 days every week), and novice users (less than 4 days every month). The interview results, covering respondents' habits, difficulties, and suggestions, showed consistent trends with the survey results.

Specifying User Requirements (First Iteration)

Based on the survey and interview findings, three distinct user groups were identified, differentiated by their frequency of use, specific needs, the types of features they utilize, and the challenges they encounter when using Maxim. These groupings were further developed into personas, with each persona relying on a core set of 12 features such as “Location Selection,” “Payment,” and “Safety Support.” Each persona also exhibits preferences for additional features that cater to their needs. Detailed profiles of each persona can be found in Table 1.

Table 1. List of Personas

Name	Age (years)	Application Usage Characteristics	Goal	Specific Used Features
Tiara	25	Regular	Arrive at work on time every day	Speed Up (*percepat*), Return Route (*rute kembali*)
Naya	20	Occasional	Arrive at destinations with unknown routes or without public transportation	Image Messaging (*pesan gambar*), Share Order Information (*bagikan informasi pesanan*)
Xavier	24	Novice	Discover cheaper transportation alternatives	Favorite (*favorit*)

Furthermore, Usability Heuristics served as a guide in categorizing the issues identified by respondents through the survey and interviews. The identified issues were assigned unique codes, which were then used to map them onto the proposed design improvement solutions provided by the respondents. Based on the 13 principles of Usability Heuristics, 121 issues were identified, with the three principles that appeared most frequently being correspondence between the application and the real world (n = 24), help and documentation (n = 16), and minimizing the user's memory load (n = 15). The results of this categorization and mapping served as the basis for determining needs and problems, as well as for developing design improvements. Table 2 shows certain major application features and examples of detected concerns. However, the evaluation method considers every feature and its related issues.

Table 2. List of Problems Based on Surveys and Interviews Categorized by Usability Heuristics

Feature	Rating (easiness)	Problem Code	Problem Description	Heuristics
Location Selection (*Pemilihan Lokasi*)	2.8	KLO1	Address not found	Help users recognize, diagnose, and recover from errors
		KLO2	Insufficient details regarding a specific location and its exact coordinates.	Minimize User's Memory Load
		KLO4	In a location with multiple pick-up points, the points are hard to distinguish as they are presented smaller than the main point	Minimize User's Memory Load, Consistency and standards
		KLO5	Recommendations for addresses are overly long, obstructing the map view	Aesthetic and minimalist design

Feature	**Rating (easiness)**	**Problem Code**	**Problem Description**	**Heuristics**
		KLO7	The order of history and saved addresses does not match in address recommendations	Consistency and standards
		KLO12	No shortcut for saving addresses	Customization and Shortcuts
Details **(Perincian)**	3.65	KR2	The naming and positioning of features do not accurately reflect their functions.	Correspondence between application and the real world
		KR8	Hard to understand the difference between the "Additional Information" and "Nearest Pickup Point" fields	Correspondence between application and the real world, Efficiency of use and performance
Payment (*Pembayaran*)	3.67	KBY1	There are no clear details of allocation and payment terms for each payment method	Minimize User's Memory Load
		KBY5	The presentation of information regarding payment method options is not clear	Minimize User's Memory Load
Speed Up (*Percepat*)	3.9	KC1	The costing of the “Speed Up” feature is not flexible	Customization and Shortcuts
		KC2	Hard to understand the terms of use of the "Speed Up" feature	Help and documentation
Edit Order (*Ubah Pesanan*)	3.4	KU2	There is no confirmation when changing an order	Help users recognize, diagnose, and recover from errors
		KU5	Not aware of any cost adjustments that occur	Visibility of system status

In summary, users hold positive perceptions of certain features due to their ease of use. However, these positive impressions were counterbalanced by numerous negative perceptions, primarily associated with unfamiliar and unengaging designs, complex information structures, and using terms and information uncommon to respondents. The majority of the feedback from respondents emphasized the development of clean, intuitive, and fresh design solutions, aiming to create a user interface that facilitated the utilization of Maxim's features.

Producing Design Solutions and Evaluation Design (First Iteration)

After understanding the user context and needs, the research proceeded with developing solutions to enhance the usability aspects of the application, followed by an evaluation process to assess the effectiveness of these enhancements. In the first iteration, the identified issues and solutions were developed into the proposed information architecture, which involved organizing feature layouts, adjusting feature names, and adding shortcuts. The information architecture was then validated using Tree Testing, which resulted in an 88% correct completion rate. The development of design solutions continued with the creation of wireflows (a combination of wireframes and flowcharts) and a high-fidelity prototype based on user feedback, which was then incorporated with all of Shneiderman's Eight Golden Rules of Interface Design. A total of 94 proposed design solutions were formulated, with the "Location Selection" feature standing out as the one with the most improvements. Table 3 elaborates on the findings about issues and design solutions for the "Location Selection" feature, which is critical because it is a main feature used by users.

Table 3. Design Solution of "Location Selection" Feature (First Iteration)

Problem Code	Problem Description	Design Code	Design Proposal	Design Principal
KLO1	Address not found	DLO1	Displaying error messages	*Offer informative feedback*
KLO2	Insufficient details regarding a specific location and its exact coordinates.	DLO2	Presenting the place name, specific area, and its distance from the current location	*Reduce short-term memory load*
KLO4	In a location with multiple pick-up points, the points are hard to distinguish as they are presented smaller than the main point	DLO4	Grouping pick-up points within the main address with easily readable color selection	*Strive for consistency*
KLO5	Recommendations for addresses are overly long, obstructing the map view	DLO5	Showing complete address recommendations on a single page, with the map appearing upon user address selection	*Reduce short-term memory load*
KLO7	The order of history and saved addresses does not match in address recommendations	DLO7	Separately presenting address history and saved addresses	*Strive for consistency*
KLO12	No shortcut for saving addresses	DLO12	Providing shortcuts for inputting booking addresses	*Enable frequent users to use shortcuts*

The design proposals in Table 3 were implemented as a high-fidelity prototype accessible through the link https://ristek.link/maxim-iteration1. Design codes were used to specify the design enhancements.

An example of the high-fidelity “Address Search” page within the “Location Selection” feature can be observed in Figure 3.

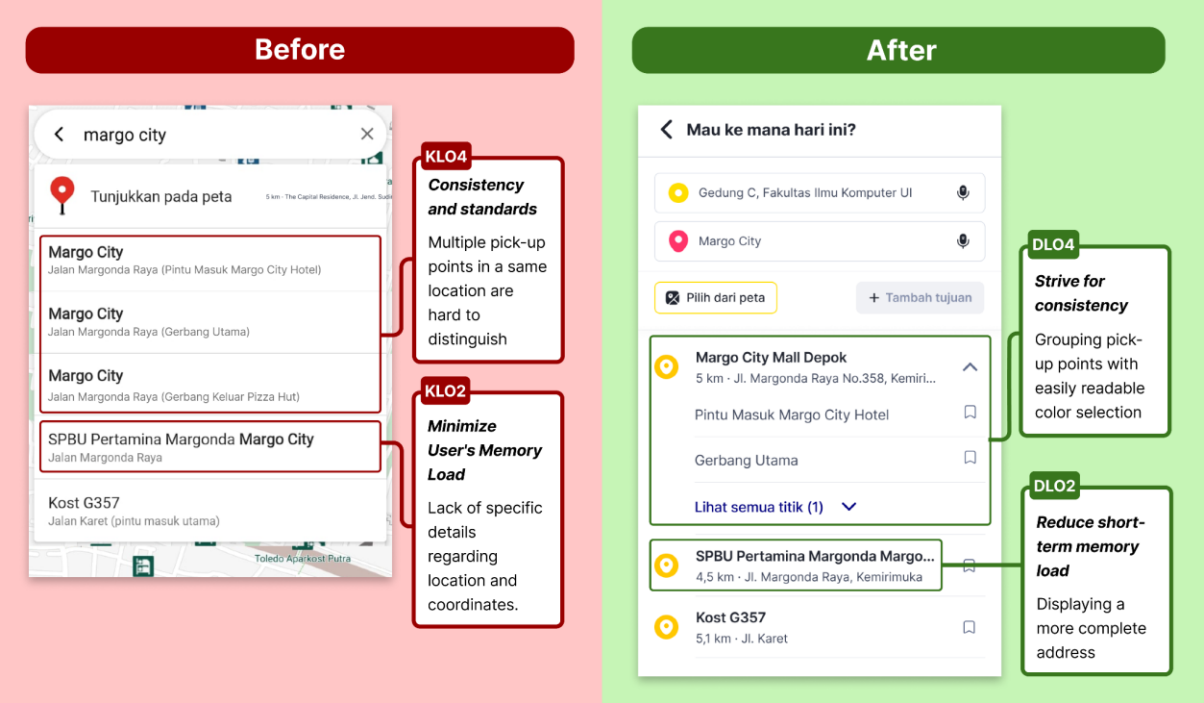

Figure 3. High-fidelity of “Location Selection” Feature (First Iteration)

Figure 3 compares two design enhancements on the location selection page after users input the destination address, contrasting the initial design (highlighted in red) and the first iteration (highlighted in green). Each identified issue and its respective solution is denoted by codes corresponding to Table 4. As an illustration, KLO4 addresses users' challenges in distinguishing multiple locations within the same area, adhering to the usability heuristic principle of consistency and standards. This concern is effectively tackled through an alternative design labelled DLO4, which involves grouping destinations in the same area with distinct colors for better differentiation. This adjustment aligns with the "strive for consistency" principle, as it consistently applies color hierarchy and components across each design.

After the design solutions were developed, the process proceeded to the evaluation stage using UT and SUS surveys. Fifteen participants, who had previously undergone the "understand the context of use" stage, took part in the UT. A total of 22 scenarios were crafted based on previously identified issues and tailored to match the characteristics of each persona. For instance, building upon the "Location Selection" feature, three scenarios were designed for participants representing each persona, as illustrated in Table 4.

The evaluation results from the first iteration of design solutions development indicated that the design had achieved a high level of usability. This was evidenced by the success rates in the UT results, which generally leaned towards “complete success” (64.24%) and “success with minor issues” (25.15%). Additionally, respondent assessments gathered from 33 participants in the SUS survey supported the positive usability findings with a score of 76. This score falls within the “good” and “acceptable” categories, according to (Brooke 2013).

However, this high level of usability was not consistently achieved in every scenario or perceived by every respondent. Some scenarios in the UT were found to either fail to be completed (1.21%) or completed with significant issues (9.39%). The UT also revealed varying completion times due to respondent anxiety and exploration. The average completion duration of all scenarios was 41.25 seconds, with completion times ranging from 11.3 seconds to 109.5 seconds. Additionally, the SUS scores have the potential for improvement, especially regarding respondents’ need to familiarize themselves before using the system. Therefore, the research continued to the second iteration for specific features that need improvement following the issues and suggestions provided by respondents.

This second iteration development aims to increase the success rate, reduce the scenarios' completion duration, and enhance respondent assessments of the final Maxim application design outcomes.

Table 4. Usability Testing Scenario of "Location Selection" Feature

No	Scenario	Success Indicators	Follow-up Questions
1	You want to select the destination location to the Main Gate of Margo City Mall. How do you do it?	Type in the destination location column.	What is your opinion after completing this task?
2	Next, you want to add the second destination address to Stasiun Pondok Cina in the recommended address history. How do you do it?	Locate the "Add Destination" button; and Select the saved address or history address through the recommended address suggestions.	Is the arrangement of information and display of saved addresses or history of addresses easier to understand?
3	You work at Venus Karaoke & Billiards, located near Margo City. You want to find the closest pickup point at Margo City to your office and decide to save that address for future use. How do you do it?	Choose the nearest location from Venus Karaoke & Billiard; and Click the shortcut button for saving the address.	Is the display informative enough when the address is not found?; and Are the differences in pickup points easier to understand?

Specifying User Requirements (Second Iteration)

The development of design solutions continues in the second iteration based on the results of the design evaluation and potential improvements from the first iteration's evaluation. To enhance the usability of the Maxim application, a second iteration was conducted based on the identified issues and recommendations provided in the first iteration. The insights gathered were then mapped into Usability Heuristics, as illustrated in Table 5.

Table 5. List of Problems Found in The Second Iteration

Feature	Success Rate (Iteration 1)	Problem Code	Problem Description	Heuristics
Location Selection (*Pemilihan Lokasi*)	51.5%	MULO1	Difficult to discern the active column.	*Visibility of system status*
		MULO2	Challenging to select points on the map due to insufficiently contrasting point colors.	*Aesthetic and minimalist design*
		MULO3	The shortcut for saving addresses is not clearly visible.	*Minimize User's Memory Load*
Details (*Perincian*)	73.3%	MUR1	The feature "Add Another Contact" is less familiar to beginners.	*Correspondence between*

Feature	Success Rate (Iteration 1)	Problem Code	Problem Description	Heuristics
				application and the real world
		MUR2	Locating the “Cash Split” (*pecahan uang tunai*) feature proves challenging due to the absence of guidance	*Help and documentation*
Payment (*Pembayaran*)	40.0%	MUBY1	Filtering payment method options are difficult due to the dense information provided	*Aesthetic and minimalist design*
		MUBY2	The placement of Maxipay is somewhat overshadowed by the “Cash Split” feature.	*Aesthetic and minimalist design*
Speed Up (*Percepat*)	50%	MUC1	Sempat sulit menemukan ikon "Percepat" akibat warnanya yang kurang kontras	*Consistency and standards*
Edit Order (*Ubah Pesanan*)	66.7%	MUU1	The text on the "Edit Order" button is challenging to discern.	*Consistency and standards*
		MUU3	Assuming direct access to the "Edit Order" page from each information column on the "Order Details."	*Pleasant and respectful interaction with the user*

Based on the findings of the Usability Testing, user perceptions were generally positive, with a decrease in the number of usability issues for the first iteration’s design. However, some challenges persist for users when locating information and features. The conducted mapping revealed that most user difficulties in terms of usability are related to the principle of minimizing user memory load (n = 11). These usability problems will then be used as input for producing design solutions.

Producing Design Solutions and Evaluation Design (Second Iteration)

After identifying and categorizing the issue of the last iteration, the development progressed to enhancing the usability of interface design. The solutions are devised according to mapped issues and recommendations for improvements with Shneiderman’s Eight Golden Rules of Interface Design. For example, the results of issue mapping and improvement for the “Location Selection” feature can be seen in Table 6.

Table 6. Design Solution of "Location Selection" Feature (Second Iteration)

Problem Code	Design Code	Design Proposal	Design Principal
MULO1	D2LO1	Providing distinct icons for pick-up and drop-off points by using different colors for the active column	Strive for consistency
MULO2	D2LO2	Applying color to the main address area and using more contrasting colors for points	Strive for consistency
MULO3	D2LO3	Including tooltips with bookmark function information	Reduce short-term memory load

Table 6, shows that the problems found were related to readability, consistency and color selection. Therefore, improvements were made to the "Address Recommendation," "Add More Destinations," and map display pages by applying Shneiderman's Eight Golden Rules of Interface Design. Furthermore, the proposed design in Table 6 is implemented as a high-fidelity prototype, which can be accessed via the link https://s.id/maxim-iterasi2. A design comparison of this feature can be seen in Figure 4.

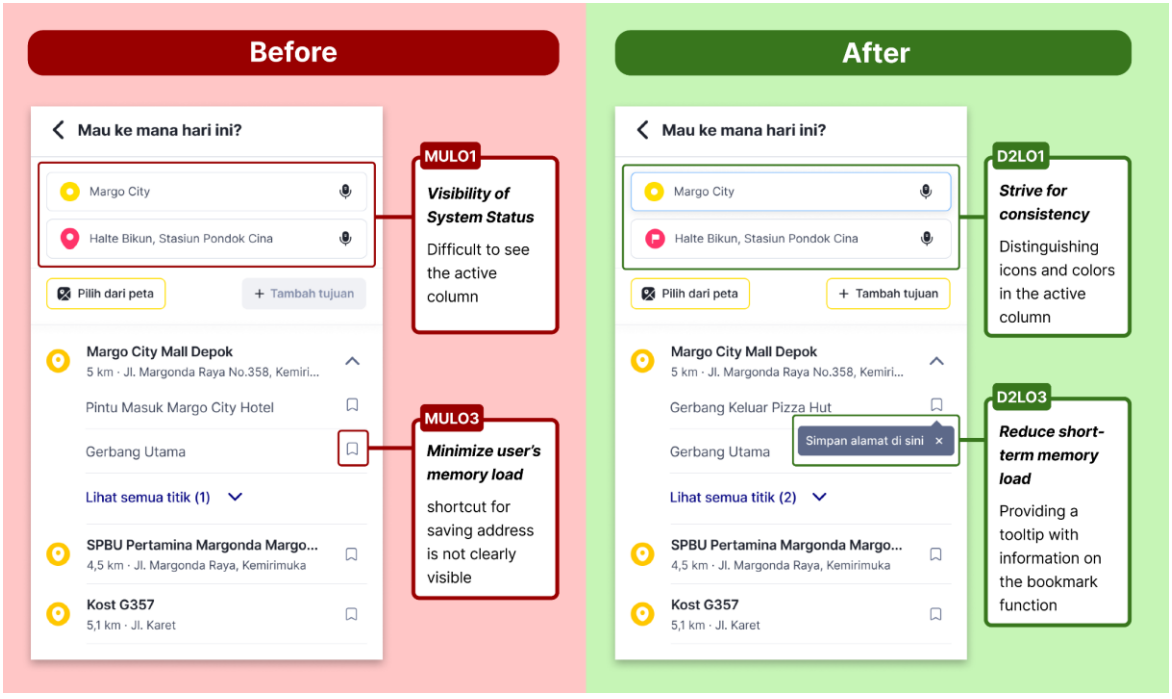

Figure 4. High-fidelity of "Location Selection" Feature (Second Iteration)

In Figure 4, a comparison of two design improvements on the location selection page after the user has entered the destination address is depicted between the first iteration (highlighted in red) and the second iteration (highlighted in green). Each problem and solution refer to codes corresponding to Table 6. For example, MUL01 represents an issue related to users having difficulty distinguishing the active column, in line with the Usability Heuristic principle of visibility of system status. This issue is addressed through an alternative design with the code D2LO1, involving the differentiation of icons and colors for the active column, aligning with the strive for consistency principle in Shneiderman's Eight Golden Rules of Interface Design.

The improvements in the second design iteration were evaluated using the same methods and tools as the first iteration. The evaluation process began with usability testing (UT) involving 15 respondents with scenarios design as in the first iteration. However, only 14 scenarios were included in the second UT, specifically those with low success levels or significant issues identified in the previous testing phase that required improvement. Based on the results of the UT implementation, most participants could complete scenarios without any problems, achieving "complete success" (90.48%). Furthermore, the average time required by respondents to complete scenarios decreased to 26.69 seconds. These results were supported by the SUS score obtained from 34 respondents, which increased to 88.97, equivalent to an "excellent" and "acceptable" satisfaction level based on research by Brooke (2013). These positive evaluation results indicated that the development had successfully enhanced the user experience for Maxim application users in utilizing the features related to ride-hailing services. Additionally, mapping improvement recommendations and solutions derived from identified issues could serve as a reference for future research concerning the development of the Maxim application design. Moreover, mapping the improvement recommendations and solutions derived from identified issues could serve as a reference for further research regarding the development of the Maxim application design.

Discussion

In the first iteration, 121 issues were identified and grouped into 77 problems based on their similarities. These problem groups were mapped to the principles of mobile usability heuristics, with the "correspondence between application and the real world" principle being the most commonly encountered problem (n = 24). Subsequently, these identified issues were addressed by developing solutions based on user feedback and Shneiderman's Eight Golden Rules of Interface Design principle. A total of 92 proposed design solutions were then evaluated to ensure their effectiveness in improving the usability aspects of the application using usability testing (UT) and the distribution of the SUS survey. Some scenarios in UT were successfully finished with "complete success" (64.24%) and "success with minor issues" (25.15%). However, these results were not consistently achieved in every scenario or perceived by every respondent. Additionally, the obtained SUS score of 76 (good and acceptable) indicated potential for improvement, particularly regarding respondents' need to familiarize themselves before using the system. Therefore, the research proceeded to the second iteration to address specific features that needed improvement.

The second iteration evaluation results of 43 design solutions that were developed to address 42 issues demonstrated a significant improvement, with 90.48% of UT scenarios finished perfectly and an enhanced SUS score of 88.97 (excellent and acceptable to users). Moreover, the increase in positive feedback and the absence of previously identified negative sentiments, as observed in the first iteration and the current application, indicate an improvement and enhancement in the usability aspect of the design in the second iteration.

Design Implications

Previous studies by Widyanti and Ainizzamani (2017), Sukmasetya and Shalahuddin (2020), Sari and Rahmizal (2021), and Astuti et al. (2021), highlighted various aspects of usability and user satisfaction in the context of ride-hailing apps. However, none of these studies specifically delved into the systematic development of alternative user interface designs and their impact on the app's usability for Maxim Application using user-centered design (UCD) methodology. This study applies to each UCD stage, involving respondents at each step and utilizing several techniques of data collection (survey, interview), data analysis (feature analysis, task analysis, Usability Heuristics, & Shneiderman's Eight Golden Rules of Interface Design), and evaluation (SUS & UT). Additionally, the study is conducted through two iterations, making it more comprehensive and ensuring the best results from the Maxim application design development process.

This research implied that user interface development using user-centered design (UCD) could substantially enhance the Maxim ride-hailing app's usability. The application of the Usability Heuristic, a key principle in the study, has proven effective in identifying usability issues and improving the

overall user experience. This aligned with the principles of the Usability Heuristic as presented by Salazar et al. (2013) and Saeed et al. (2019), as well as its utilization in research (Widyanti and Ainizzamani 2017). In addition, the positive impact on the app's usability through iterative design development is in line with the findings of Sukmasetya and Shalahuddin (2020).

In practical terms, these findings will offer valuable implications for Maxim company and future research in the realms of interface design and the usability of the Maxim application. Maxim can leverage these findings by integrating UCD methodologies into their development processes to enhance overall usability, guided by the identified usability issues and the success of iterative design changes. This study provides actionable guidance for Maxim, providing specific recommendations based on identified usability issues and iterative design improvements. Furthermore, the research suggests future endeavors should expand the geographical scope of studies, ensuring usability improvements cater to diverse user needs. Additionally, competitor analysis is recommended to gain strategic insights for enhancing the overall user experience.

Conclusion

This research was conducted to identify user issues and develop alternative interface designs to enhance the usability aspects of the Maxim application using UCD. The identification of context and user needs through surveys and interviews revealed both positive and negative perceptions regarding the utilized features. However, these positive impressions were counterbalanced by numerous negative perceptions. In total, 121 issues were identified and grouped into 77 problems based on their similarities. These problem groups were then mapped to the principles of mobile Usability Heuristic, with the "correspondence between application and the real world" principle being the most commonly encountered problem (n = 24).

After two development iterations, the “complete success” rate significantly increased to 90.48%, a marked improvement from the initial 64.24%. Respondents demonstrated a reduced average completion time of 26.69 seconds in the second iteration, compared to the varied durations ranging from 11.3 to 109.5 seconds observed in the first iteration. Moreover, the SUS score ascended from 76 to 88.97 in the second iteration, indicating an “excellent” and “acceptable” satisfaction level. The refinement process was guided by Shneiderman’s Eight Golden Rules of Interface Design principles, ensuring effective user need fulfillment. Finally, improvement and enhancement in the usability aspect of the second iteration are evident, as reflected by the rise in positive feedback and the absence of previously identified negative sentiments observed both in the initial phase and the current application.

In summary, the insights obtained from these findings are expected to provide valuable information for Maxim company and future research in interface design and Maxim application usability. Nevertheless, it is crucial to recognize the study's limitations, as it focused exclusively on the Jakarta Metropolitan Area, potentially restricting the generalizability of the results to other geographical areas. To address this limitation in future research, it is advisable to broaden the scope of Maxim application development by investigating a more diverse user demographic and enhancing user experience through additional aspects or methodologies, such as competitor analysis.

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Designing Indonesian Maternal and Child Health Mobile Applications using User-Centered Design

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Abstract

The high maternal mortality rate in Indonesia has led the Indonesian government to develop a mobile application for maternal and child health (MCH). However, this application received a bad rating on the applications distribution platform, and even some of its features could not function properly. Therefore, this study aims to design the MCH application. This study used the user-centered design (UCD) methodology with three iterations and applied Shneiderman's eight golden rules. Participants involved in the data collection and evaluation process were health workers, health experts, and pregnant women. The first iteration's evaluation will produce a low-fidelity prototype (wireframe), whereas the second and third iteration's evaluations will produce a refined high-fidelity clickable prototype. The resulting prototype has several major features, including notes entry, information and education, reminders, a blood supplement tablet tracker, and monitoring of fetal development. Evaluation in the first iteration utilized interviews to validate the wireframe, whereas the second and third iterations utilized usability testing and system usability scale (SUS). In the second iteration, the final SUS score was 71.2, or "good," while in the third iteration, the final SUS score was 85.4, or "excellent." This research is expected to contribute to two areas: serving as a reference for pregnancy application interface designs, especially for MCH applications, as well as the improvement and development of pregnancy health applications using the UCD methodology.

Keywords: maternal health, prenatal care, user-centered design, telemedicine, Indonesia

Introduction

Maternal death, or maternal mortality, is a major global problem and has existed for a long time (Ngwenya et al. 2022). One of the Sustainable Development Goals (SDGs) is to reduce maternal mortality (United Nations 2023). Maternal mortality is measured using the Maternal Mortality Ratio

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(MMR) (WHO n.d.). MMR is the number of maternal deaths per 100,000 live births (WHO, 2019). SDG 3.1 aims to reduce the global MMR to 70 per 100,000 live births by 2030, with no country having an MMR of more than double this global target (Ngwenya et al. 2022). The World Health Organization (WHO) year 1996 launched a global consensus on the main strategy for reducing the MMR (Ngwenya et al. 2022). This consensus includes (1) family planning that is equipped with health services, (2) guaranteed care during pregnancy and childbirth, (3) timely emergency treatment of pregnancy, and (4) immediate postnatal care (World Health Organization 2016). Based on the WHO (2019), 94% of maternal deaths occur in low- and lower-middle-income countries. The MMR in Indonesia is quite alarming. The Central Statistics Agency (2023) records that MMR in Indonesia reaches 189 deaths per 100,000 live births.

With the progress of e-health in recent years, Indonesia's Ministry of Health launched various e-health applications, starting from PeduliLindungi, SehatPedia, and the Indonesia Health Facility Finder (IHEFF). Recently, Indonesia's Ministry of Health launched a mobile application named Mobile KIA, a digital form of the maternal and child health handbook. Electronic health, commonly referred to as "e-health," is defined as the use of information and communication technology (ICT) to support human needs in the health sector and for more effective, efficient, and safe health services (da Fonseca et al. 2021). E-health has shown rapid development in Indonesia. Nuryadi et al. (2022) shows the potential for the development of the valuation value of the e-health industry from USD 85 million in 2017 to USD 973 million by the end of 2022.

The Mobile KIA application acts as a note-entry tool and a medium of communication, information, and education for pregnant women (Ministry of Health 2020). However, based on our observations, the application has received poor user ratings on the application distribution platform, namely 3.5 out of 5 on the Play Store and 1.0 out of 5 on the App Store. Not only did the application receive negative user feedback, but several features of the Mobile KIA application also didn't function properly.

There is research on policies and actions to reduce the MMR in Nepal (Karkee et al. 2021). Nepal made impressive progress in reducing maternal mortality by 2015 (Karkee et al. 2021). The implementation of several interventions, such as a national program to increase the number of skilled birth attendants (SDAs) and maternity facilities, free maternity care, and enhanced birth preparedness and complication preparedness programs, aided this progress (Karkee et al. 2021). According to Liu and Wang (2021), the use of smart mobile terminals in the management of maternal health care outside of hospitals not only enables medical staff to provide timely personalized media services for pregnant women, but also enables pregnant women to learn about health care through a variety of channels, enhance the quality of health management for pregnant women at home, and significantly improve pregnancy outcomes. Moreover, Kabongo et al. (2021) described that m-health significantly associated with maternal and child healthcare (MCH) outcomes. Then, Venkataramanan et al. (2022) found that m-health interventions can improve access to MCH. Although Liu and Wang (2021) as well as Ilozumba et al. (2018) have discussed mobile applications in supporting maternal health, both of which did not discuss the user interface (UI) and user experience (UX) of mobile applications. Therefore, this study aims to fill this research gap by designing the pregnancy features on the MCH mobile application (mKIA) that suits the needs of pregnant women in Indonesia and provides a better experience using user-centered design (UCD) approach. This research is expected to be a reference for providers and developers of maternal health applications.

Literature Review

Antenatal Care

WHO (2018) defines antenatal care (ANC) as care provided to pregnant women during pregnancy by skilled healthcare providers, often in first-level health facilities (Bryce et al. 2021). In addition to the WHO definition, there is another definition from the Republic of Indonesia's Ministry of Health. The Ministry of Health (2020) defines ANC as "a series of activities that are carried out from the time of conception until before the start of the delivery process that are comprehensive and of good quality and are given to all pregnant women." The general goal of ANC is that all pregnant women can undergo pregnancy and childbirth with positive experiences and give birth to healthy and quality babies

(Ministry of Health 2020). In addition, ANC also aims to monitor and maintain the health and safety of the mother and fetus, detect all pregnancy complications, and take necessary actions, respond to complaints, prepare for birth, and promote a healthy lifestyle (Laksono et al. 2020). Stakeholders involved in antenatal care are pregnant women and their partners, as well as health workers, such as obstetricians and gynecologists, general practitioners, midwives, nurses, and so on.

Antenatal care provides an opportunity for pregnant women to identify risk factors for pregnancy through screening, prevent and manage diseases (both pre-existing and pregnancy-related), and provide education and health promotion (Bryce et al. 2021). In addition, ANC also plays a role in reducing perinatal morbidity and mortality by detecting and treating prenatal complications and identifying women who are classified as high risk to ensure delivery takes place in skilled settings (Atukunda et al. 2021). Good quality ANC has been associated with higher rates of facility deliveries (Bryce et al. 2021).

Electronic Health

E-health is the application of information and communication technologies through the internet to empower or improve health services that contribute to a person's quality of life (da Fonseca et al. 2021; Wynn et al. 2020). E-health involves mHealth and telehealth practices that use electronic technology to provide resources, services, and information regarding health care (da Fonseca et al. 2021). The Global Observatory for eHealth defines mHealth as medical and public health practices supported by mobile devices, such as cell phones, patient monitoring devices, personal digital assistance, and other wireless devices (Bradway et al. 2017). Meanwhile, telehealth is the use of telecommunications technology to promote the care and education of patients and professionals working in the area (da Fonseca et al. 2021).

Mobile health, often known as mHealth, enables users to obtain health services electronically, use applications to verify information, and manage or monitor health care or problems (da Fonseca et al. 2021). MHealth provides opportunities to improve healthcare delivery and clinical outcomes (Kabongo et al. 2021, McCurdie et al. 2012). In addition, the mHealth application can increase the interaction between users and the health care system (Kabongo et al. 2021). The consumer health domain is one of the most significant opportunities offered by mHealth as it allows patients to be actively involved in and self-manage their health conditions (Kabongo et al. 2021, McCurdie et al. 2012).

Rhodes et al. (2020) shows that mHealth for maternal health can improve maternal health services. In addition, from the mother's side, it provides greater control for mothers in choosing and utilizing health services during pregnancy (Deave et al. 2022). Similarly, a study conducted in Switzerland showed that the use of mHealth applications for recording related to maternal health can help patient communication with health workers in ANC examination session (Klaic et al. 2022). Another study that conducted in Madagascar, shows that the mHealth system for maternal health can improve the quality of ANC even through minimal intervention (Benski 2020). Apart from that, mHealth can also help patients to get standardized ANC care and has been proven to increase patient compliance (Benski 2020).

Methodology

Data collection and analysis methods

This research uses mixed methods—a combination of quantitative and qualitative methods. User-centered design (UCD), which involves four stages—understanding the context of usage, defining user requirements, designing solutions, and assessing them against requirements (McCurdie et al. 2012)—is the design development methodology employed in this study. Understanding the context of use is the first stage in the user-centered design process. This stage is carried out to understand the behavior of target users by knowing the difficulties experienced based on their experiences and user needs for a product (Sharp, et al. 2019). During this stage, researchers only use quantitative data collection techniques, which were done by conducting design evaluations, online interviews, and content analysis. During the stage of specifying user requirements, a synthesis of user needs will be carried out based on the results of interviews identifying the needs and behavior of pregnant women. The results will be summarized using content analysis. Determination of user needs is also carried out after going through

a process of independent observation of the mKIA application and heuristic analysis using Shneiderman's 8 Golden Rules to gain context of the current condition of the application. Heuristic analysis is essential in the early stage as it is a broad guideline or principle that designers and evaluators can use to identify potential usability issues in the system we will evaluate (Sharp et al. 2019).

This research implements the user-centered design process in three iterations. A low-fidelity prototype will be created on the first iteration and validated by research participants throughout subsequent interview sessions. During the second iteration, a high-fidelity prototype will be created using input from the first iteration. SUS is one of the most used questionnaires to assess the usability of a product and according to Brooke (1995), SUS has proven to be a valuable, powerful, and reliable evaluation tool. In general, SUS is used after respondents have had the opportunity to use the product or system being evaluated. The researchers will then conduct usability testing and give the SUS questionnaire to participants to gather feedback and suggestions for the third iteration. Lastly, the high-fidelity prototype will be modified during the third iteration depending on the input and feedback from the second iteration. Furthermore, usability testing and distribution of the final SUS questionnaire will be carried out to evaluate the usability of the interface design that has been developed.

Research instruments

In designing interview questions, the research team created several categories of questions for each respondent. Questions for pregnant women and women who have given birth design to take more look at the design of the mKIA application from the user's point of view. These questions will be divided into three categories of questions, namely regarding the antenatal care (ANC) process and the use of the MCH handbook, pain points or constraints experienced by participants during pregnancy and goals that participants want to achieve. Based on these three categories, interview questions for pregnant women and women who have given birth are described in more detail in Appendix A.

Results

First Iteration: Gathering User Requirements and Making a Low Fidelity Design

In the first iteration, four stages will be carried out in the UCD process, namely understanding the context of use, specifying user requirements, designing solutions, and evaluating against requirements. The respondents' criteria are mothers who are pregnant or have given birth in the past year and health workers. The result of the first iteration is the application interface design framework and evaluation results to be applied in the next iteration. We conducted online interviews to find out and learn more about the user's experiences regarding the constraints, motivations, and expectations of users in using the MCH handbook during pregnancy and using maternal health applications during pregnancy. The interview process was conducted online using the Google Meet application platform. The interview questions given to the users were divided into several segments to explore the participants' behavior in using the MCH handbook and pregnancy application during use. The online interview involved fifteen participants of different ages and backgrounds (Table 1 and Table 2). Twelve of them are mothers who are pregnant or have given birth in the past year, while the other three are public health experts and health workers consisting of general practitioners and midwives.

Table 1. Summary of Respondents' Demographics of Pregnant Women and Mothers Who Have Given Birth

No.	Respondents' Name	Age (years)	Domicile	Current or Latest Pregnancy
1.	Respondent 1	25	Jember	First
2.	Respondent 2	30	Madura	Second
3.	Respondent 3	29	Bekasi	First
4.	Respondent 4	28	Bekasi	First
5.	Respondent 5	32	Jember	Third
6.	Respondent 6	25	DKI Jakarta	First
7.	Respondent 7	30	DKI Jakarta	Second
8.	Respondent 8	29	Jember	Fourth
9.	Respondent 9	32	Jember	Third
10.	Respondent 10	41	Yogyakarta	Third
11.	Respondent 11	30	Jember	First
12.	Respondent 12	31	Jember	First

Table 2. Summary of Respondents' Demographics of Health Practitioner

No.	Respondents' Name	Age (years)	Occupation
1.	AN	31	Midwife
2.	PS	34	General Practitioner
3.	SA	43	Public Health Expertise

Based on the results of the content analysis, we able to synthesize and identify the pain points felt by pregnant women. The process of synthesis and identification of pain points is carried out by grouping pain points that have the same topic and giving names to each group or category that has been formed. We obtained three categories of pain points, namely pain points related to using the MCH handbook, using maternal health applications, and while undergoing antenatal care (ANC). We identified eight pain points related to the use of the MCH handbook, four related to the use of maternal health applications, and three related to the implementation of ANC. Figure 1 displays a mind map diagram of pain points felt by pregnant women.

In addition, based on content analysis, we also synthesized and identified goals that pregnant women wanted to achieve. The process of synthesis and identification of goals is carried out by grouping goals that have the same topic and giving a name to each group or category that has been formed. We got three categories of goals, namely, goals related to information, recording, and reminders. We identified three goals related to providing information, two goals related to recording, and two goals related to

reminders. The other four goals cannot be grouped into any category. Figure 2 displays the identified mind map goals.

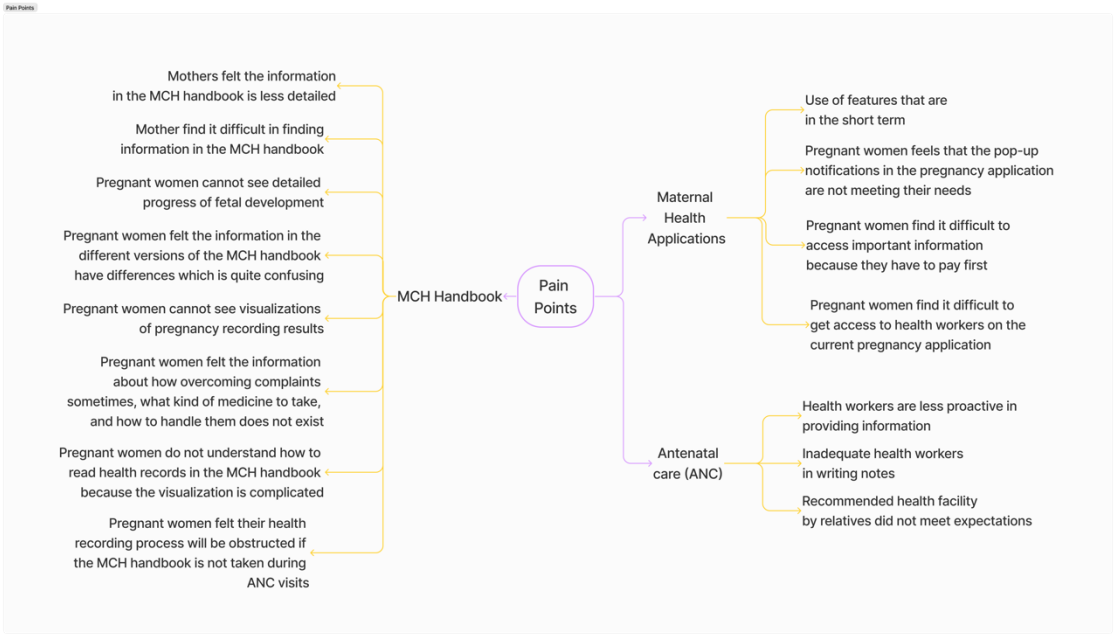

Figure 1. Pain Points Mind Map Diagram

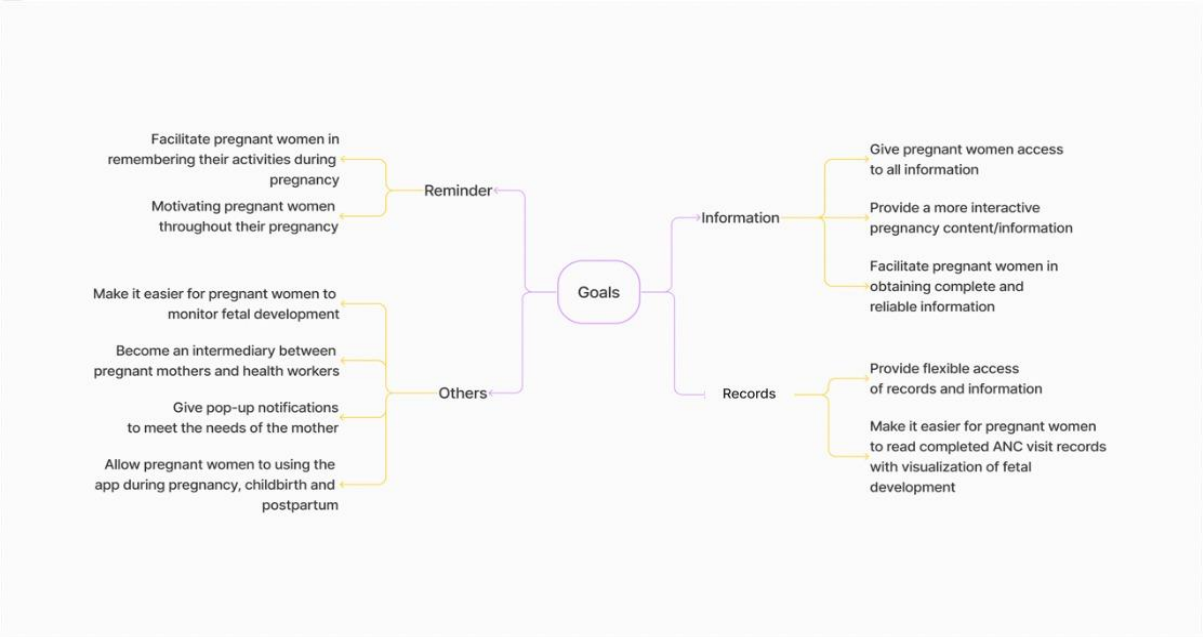

Figure 2 Goals Mind Map Diagram

We created two personas that represent the two types of pregnant women, each with different characteristics and motivations for undergoing pregnancy. These personas were created to help us create the best solution for our targeted user. Through these personas, it will help us to give features constraint and prioritization mapping (Siika-aho 2016). The first persona is the type of pregnant woman who is active in seeking information and exercising, while the second persona is the opposite. The first persona represents pregnant women who are active in seeking information about the health of the mother and fetus during pregnancy. The first persona also regularly exercises by taking a morning walk to maintain her body fitness. In the first persona, it is told that a housewife named Amira is undergoing her first pregnancy. Amira knows the importance of light exercise, so she often goes for her morning walks. In addition, during pregnancy, Amira educated herself by using MCH books and maternal health

applications. Amira also didn't hesitate to ask the doctor either personally or via telemedicine.

In carrying out her pregnancy, Amira has a goal to monitor the development of the fetus every week. In addition, Amira wants to have a trusted source of information that discusses complaints in pregnancy in a complete and clear manner. Lastly, Amira wants to get information that is appropriate for her gestational age. Despite Amira's being active in educating herself and moving her body during pregnancy, she also experienced difficulties. When Amira has a complaint, she cannot find a specific solution in the MCH handbook regarding how to handle the complaint. In addition, sometimes Amira finds it difficult to understand the recording in the MCH book.

The second persona represents pregnant women who are less active in seeking information about the health of the mother and fetus during pregnancy. This persona is also not motivated to actively move its body. This is because this type of user feels busy with her daily life as a career woman. In the second persona, it is said that a state-owned enterprises employee named Nabila is undergoing her second pregnancy. During her pregnancy, Nabila used the Ministry of Health and hospital versions of the MCH handbook as a source of education, information, and record keeping.

In carrying out her second pregnancy, Nabila has a goal of remembering routine activities that must be carried out during pregnancy, such as taking vitamins, taking iron tablets (TTD), or attending antenatal care (ANC) visits. Nabila also wants to have a trusted source of information that is complete, easy to access, and provides audio-visual content. Lastly, Nabila wants to be able to consult with health workers through maternal health applications. During her pregnancy, Nabila experienced difficulties, as she felt that the explanations contained in the MCH handbook were incomplete. In addition, her busy life as a career woman makes Nabila often unable to remember and less motivated to carry out her routine activities.

In the process of thinking about potential solutions, the researcher team conducted benchmarking and design reviews on similar applications, especially those that were frequently used by pregnant women, which we found during the online interview stage. We also compare all the features that already exist in the current mKIA application to ensure the completeness of the features in the application design. From the results of the problem-solution mapping, we found several new feature solutions that previously did not exist in the mKIA application namely monitoring of fetal development, reminder and notification, ANC note entry and telemedicine.

In addition to new features, we also formulated solutions that are design improvements to the current mKIA application interface. This design improvement aims to increase the motivation of pregnant women to use the application when they need information about pregnancy. The proposed solution is to provide personalized information with an interactive display. Personalized information aims to adjust information to accommodate the needs of users at a certain gestational age, while interactive displays aim to increase the motivation of pregnant women to read and obtain information, increase engagement, and provide a good overall experience.

The information architecture (IA) is designed to map information systems to applications. From IA, we can see what pages need to be designed in the application, as well as what information is contained on those pages. The hierarchy on the page will also be visible based on the color of the components. The IA created with Figma will be used as a guide for creating user flow, design, and prototypes at a later stage. Figures 3, Figure 4, and Figure 5 illustrate the IA of the mKIA application to be designed.

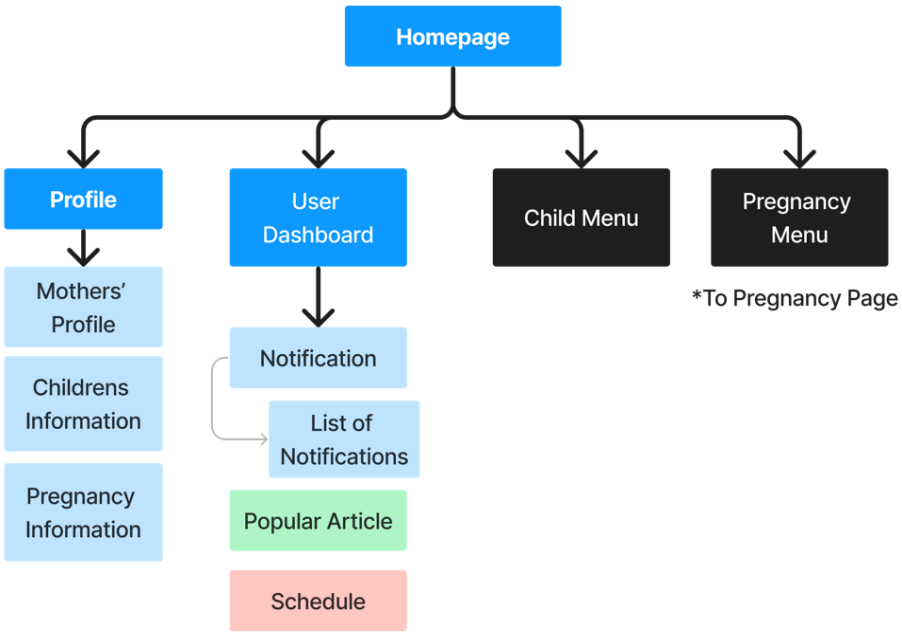

Figure 3. Information Architecture Homepage

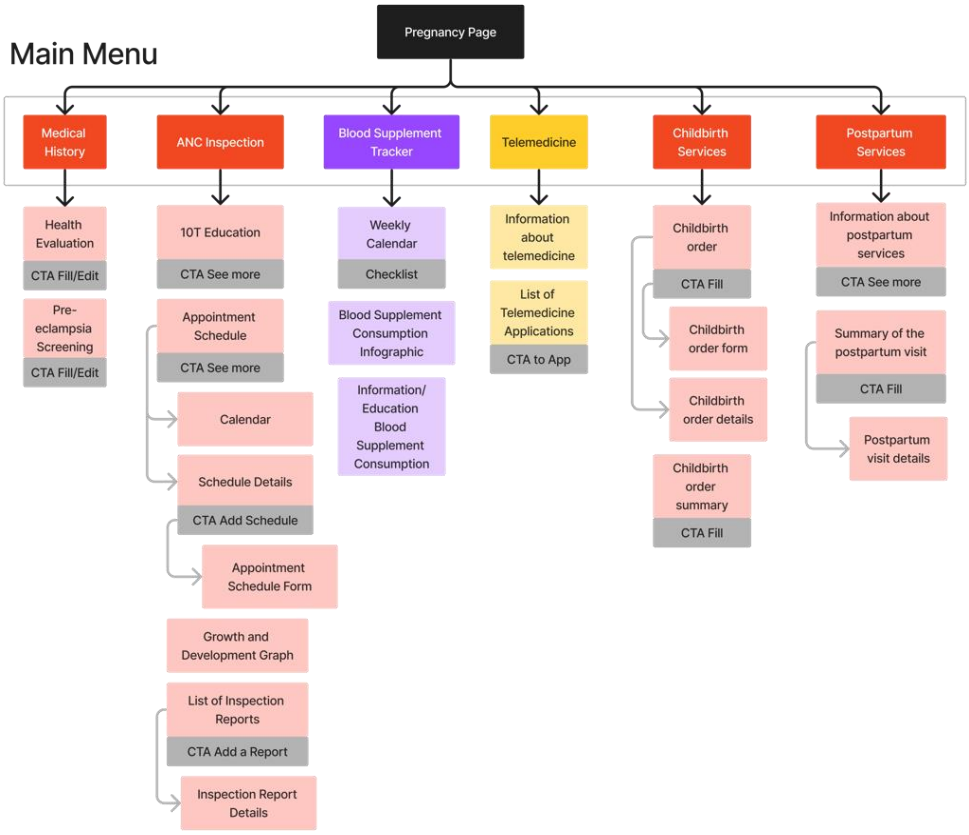

Figure 4. Information Architecture Main Menu for Pregnancy Page

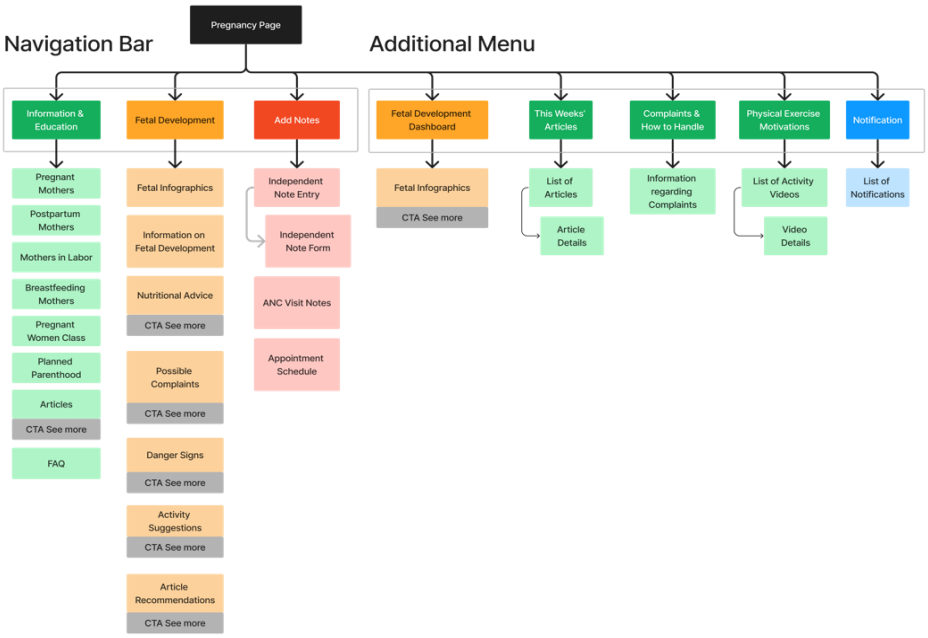

Figure 5. Information Architecture Navigation Bar and Additional Menu in the Pregnancy Page

The homepage is displayed after the user has successfully authenticated. On this page there is a user dashboard, a pregnancy menu, a children's menu, articles, and profiles. There are two menus that are branching points for this application, namely the pregnancy menu for users who are pregnant women and the child or toddler menu for users who have given birth or are already parents. The user dashboard will contain information regarding gestational age, namely if the user is a pregnant woman, and/or information regarding the number of children and their ages, namely if the user has given birth. In addition to these two menus, the researcher team has also included a shortcut menu for popular articles to make the information accessible to users who only want to do light reading. Furthermore, a list of notifications and reminders can be accessed on the homepage. This is because the homepage is the first page that the user will see when opening the application, so the user can be immediately informed if there is an urgent reminder or notification. All the information contained on the homepage is sourced from both the pregnancy and children's menus.

The red component indicates that the page contains the recording feature. In the IA designed, pages with recording features are the ANC examination pages, the health history pages, the delivery services pages, and the postpartum services pages. The ANC examination page contains a schedule of ANC visits where users can schedule and view ANC visit schedules in each trimester, graphs of the progress of each component of the 10T examination recorded at each visit along with normal and abnormal indicators, and a form for entering 10T examination data at ANC visits. Furthermore, users are also given a shortcut to add their notes from the navigation bar located on the homepage. This shortcut gives the user the option to add ANC visit records or independent records.

The green component indicates that the page contains informational and educational features. The sources of information that the researcher team plans to use are, of course, MCH books and third-party organizations in the health sector that work closely with the Indonesian Ministry of Health to ensure that all information provided is credible. In IA, which we designed, information and education pages consist of health articles for pregnant women, symptoms and risks for pregnant women, exercise motivation for pregnant women, nutrition and nutrition, information during pregnancy, information during childbirth, information on breastfeeding, and family planning. Information sourced from the MCH handbook includes information on pregnancy, puerperium, childbirth, breastfeeding, and family planning. The researcher team plans to collect other information from a collection of Indonesian third-party organizations in the health sector.

The components in orange are the pages for fetal development and gestational age. This page is also

included in the information and education category, but due to the large amount of information on that page, the researcher team decided to separate this page from the educational information page. Fetal development will display, among other things, visualizations of the fetus such as analogies and descriptions of their sizes, counters for pregnant women's gestational age, information on changes that occur in pregnant women at that gestational age, nutritional advice for pregnant women at that gestational age, activity suggestions, symptoms that may occur, as well as health articles that can be read.

The next component is the purple one, which is the iron supplement tracker page. Iron supplements are one of the nutritional services provided during ANC visits. The consumption of iron tablets is important to meet the iron needs of the fetus and placenta during pregnancy. The iron supplement tracker will remember every day the consumption of iron supplements by pregnant women. Then, at the end of the week, pregnant women can see the completeness of their iron supplement consumption.

The last component is the one in yellow, which is telemedicine. This page contains a feature where pregnant women can consult with health workers through third-party applications in the health sector and in collaboration with the Indonesian Ministry of Health. The system will take the user to a health application where they can consult about their pregnancy. Wireframes are created to provide a rough overview and structure related to the interface design being developed. Figure 6 shows the examples of wireframe of pregnancy page.

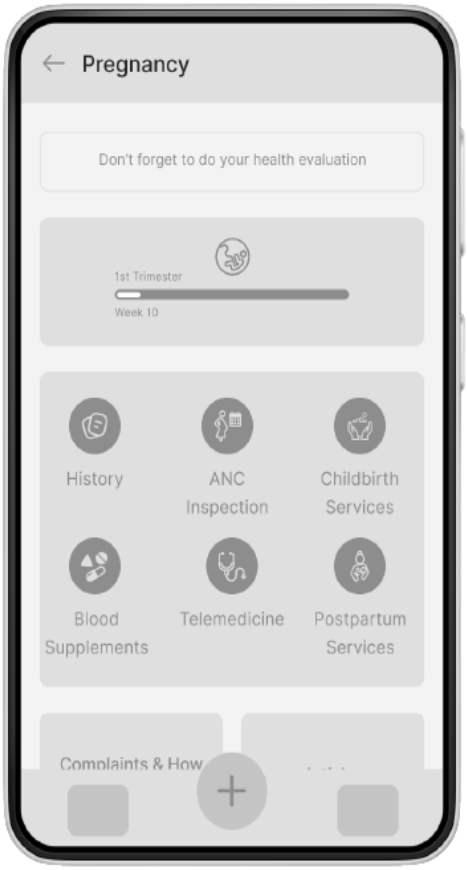

Figure 6. Wireframe Pregnancy Page

Second Iteration: Development of High-Fidelity Design

In the second iteration, a high-fidelity design will be made to continue and refine the application design in the previous iteration (Figure 7). The result of the second iteration is a high-fidelity application design, and evaluation results will be implemented in the next iteration. The main high-fidelity design gives coloring to the wireframe development using the primary color pink, which refers to the basic

color of the MCH book, which is the book's trademark. The uniqueness of the primary color of the KIA book also makes its users call this book the 'pink book,' which is then used as the primary color in the mKIA application. The use of this color is in line with one of the rules of Shneiderman's 8 Golden Rules for the strive for consistency rule where the use of pink will remind the user of the MCH handbook and increase the user's familiarity with the mKIA system so that it can build sufficient context for the user. In addition, the neutral purple secondary color chosen was intended to provide contrast to the primary color, which is used for several components that require more attention, such as buttons and alerts. Apart from adding colors and improving the features of the low-fidelity phase, there are additional pages on prerequisites features that are not included in the low-fidelity design. The page additions include a splash screen, login page, and onboarding page. In addition, a sub-feature is added to the fetal development feature, namely, recording the fetal heart rate.

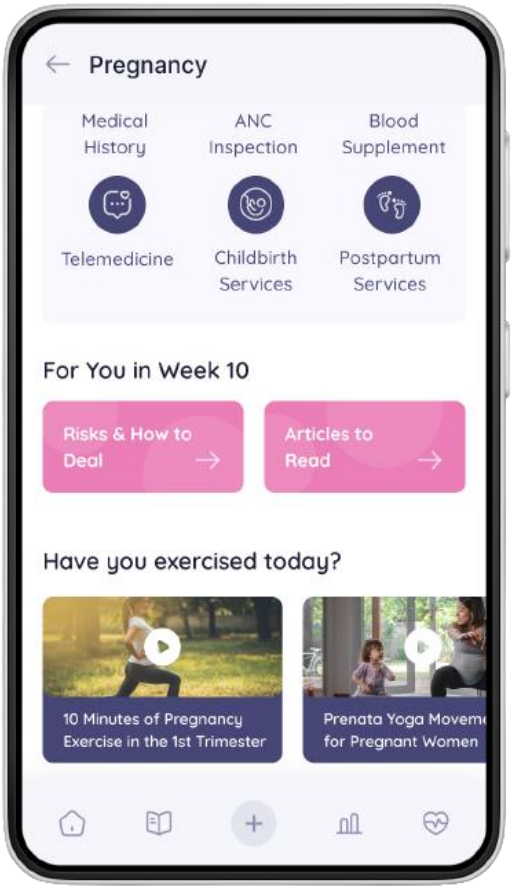

Figure 7. Homepage Feature

During this stage, the research team conducted usability testing and distributed the System Usability Scale (SUS) questionnaire. Usability testing is a qualitative evaluation method by observing user behavior when using an application and gathering feedback about usability issues or user insights. Meanwhile, SUS is used to measure the usability of applications at the design evaluation stage.

The quantitative evaluation method used by the research team is the System Usability Scale (SUS). Data is collected through the online questionnaire, which is given to each usability testing participant (Table 3). Participants are asked to fill out the SUS form when the UT session is over. The SUS questionnaire consists of ten statements that UT participants will respond to measure their perceptions of the usability of the designed application. The SUS overall score can be calculated by responding to each question with a rating of 1 to 5 how strongly they agree or disagree with the statement, the SUS overall score can be calculated. In addition, there is one qualitative question in the SUS questionnaire which aims to get overall feedback for the application interface design. Quantitative evaluation using SUS was carried out twice, namely in the first and second iterations. The UT session was held in three weeks with 6 participants from the previous session. The evaluation was carried out twice in this

iteration and the upcoming iteration to see the difference in SUS scores when the prototype was refined after the first usability testing session.

Table 3. Summary of Respondents' Demographics of Pregnant Women and Mothers Who Have Given Birth

No.	Respondents' Name	Pregnancy Status	Type of Persona
1.	Respondent 1	Have given birth	First Persona
2.	Respondent 2	Ongoing pregnancy	
3.	Respondent 3	Have given birth	
4.	Respondent 4	Have given birth	Second Persona
5.	Respondent 5	Ongoing pregnancy	
6.	Respondent 6	Ongoing pregnancy	

Based on the SUS evaluation, a score of 72.1 was obtained, where the interpretation indicated that the application interface design could be grade B with an adjective rating of 'Good' (Bangor et al. 2009). Hence, there is still some room for improvement for the next iteration. The target score is to get a score of 85, which is a minimum score for grade A, and an adjective rating of 'Excellent' in the next iteration.

Third Iteration: Finalization of High-Fidelity Design

In the third iteration, improvements to the high-fidelity design will be carried out based on input and feedback in the second iteration. The result of the third iteration is the final high-fidelity application design and the final evaluation results of the application (Figure 8). Improvements to the high-fidelity design were carried out based on the feedback that the research team received in the usability testing session in the second iteration. Improvements are grouped based on core features, and the designed solutions are selected based on suggestions from participants in usability testing and by benchmarking on pregnancy applications that are often mentioned by participants.

We used the system usability scale (SUS) questionnaire to measure the usability aspects of the application in evaluating the design in the third iteration. Like the second iteration process, we distributed online the SUS questionnaire to each UT participant. The final SUS score in the third iteration was 85.4. Therefore, we achieved the target SUS score of 85 which can be categorized into the highest adjective rating, namely excellence (Bangor et al. 2009). This indicates that the design improvements made in the third iteration have almost entirely met the needs and expectations of users. Other usability aspects such as usability, efficiency, effectiveness, satisfaction, ability to learn, and ease of access are also fulfilled.

Figure 8. High-Fidelity Design Refinement for Note Entry Feature

Discussion

Research conducted by Stevenson and Oscarsson (2021) discusses application development, specifically regarding the development of maternal health applications for immigrant pregnant women who have difficulty communicating with health workers in Sweden. Stevenson and Oscarsson (2021) develops a system that can facilitate pregnant women's communication during antenatal care and helps pregnant women get health facilities in remote areas that apply a user-centered design process. The application developed in Stevenson and Oscarsson (2021) focuses on providing applications for note-entry and communication media between health workers and Arabic Speaking Women patients. Thus, this study can fill the gap in the research conducted by Stevenson and Oscarsson (2021) by carrying out three UCD iterations complemented by a heuristic evaluation of Shneiderman's 8's Golden Rules (Shneiderman and Plaisant 2005). The mKIA that is designed in this research also answers a research gap conducted by Haddad et al. (2019) regarding the development of applications that must be based on user needs and compliance with applicable health regulations.

In the end, this research was able to achieve the expected goals, i.e., producing a mKIA design with a better user experience while maintaining the function of the MCH handbook. This research is expected to be able to provide theoretical benefits in the form of enriching the literature regarding the development of mobile applications for maternal health with the UCD approach. In addition, this research is also expected to provide practical benefits by becoming a reference that can be used by maternal health application developers, especially the Ministry of Health as the Mobile KIA application developer.

The research conducted by Haddad et al. (2022) and da Foncesca et al. (2021), which discussed the review of maternal health application development, are too focused on technology utilization and sometimes still disregards applicable health guidelines and the experience of pregnant women as users. Therefore, this research is expected to contribute to the research topic of developing maternal health

applications through designing interface designs that put the user at the center. This research made a theoretical contribution by redesigning the Mobile KIA application while maintaining the function of the MCH handbook as a medium for note entry, communication, information, and education. In addition, this research used the interaction design heuristics as a guideline to ensure that the usability aspect of the redesigned application is achieved. Thus, this research contributes by increasing knowledge about the application of heuristics that can be carried out in maternal applications using the user-centered design method.

This research is expected to provide practical benefits by providing a reference for the implementation of designs for providers and developers of maternal health applications using a user-centered design approach. It is hoped that application developers can find out the mechanism for implementing features contained in maternal health applications that can meet existing health standards, as well as address the problems experienced by pregnant women during their pregnancy. The expectancy is that maternal health application developers can develop features that suit the needs of pregnant women and pay more attention to user experience in their implementation. Thus, this research is expected to assist developers in developing appropriate maternal health applications and be the first step in advancing maternal health in Indonesia.

Conclusion

The redesign process shows that many functionalities from the MCH guidebook can be synergized in mKIA. These added functionalities were aligned with the Ministry of Health's mission to reduce maternal death. The design results of the mKIA application received good feedback from users. The features of mKIA application include maternal information, education, record keeping, pregnancy growth and development charts, fetal development progress, and recording of fetal movements. This study can also play a role as a pregnancy support application and complement the MCH handbook especially in developing countries. Further studies need to pay more attention to the potential user in rural areas. Finally, further studies should also be creating a design solution for health workers regarding antenatal care.

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Appendix A. Interview Questions for Pregnant Women and Mothers Who Have Given Birth

Category	Interview Question
Demographic Question	Please tell us a little about yourself (name, age, domicile, and occupation).
	Is the current pregnancy the first pregnancy? If not, how many times are you currently pregnant?
	During the pregnancy process, did you ever use the MCH handbook? If so, can you state which version?
	During the pregnancy process, have you ever used a pregnancy app? If so, can you state the name of the application?
Process of Antenatal Care (ANC) and Use of the MCH Handbook	What do you know about antenatal care?
	How often do you make antenatal care visits?
	Under what circumstances and conditions did you attend the antenatal care session, and did anyone remind you to attend?
	Please tell us about your experience when doing antenatal care visits, including travel, waiting time, and the facilities and treatment you received.
	How long have you been using the MCH handbook?
	How do you use the MCH handbook?
	What parts of the MCH handbook have you used?
	In your opinion, how has the experience of using the MCH handbook been so far?
	How complete is the information in the MCH handbook?
	[If the xth pregnancy (x> 1)] Are you quite familiar with the use of the MCH handbook?
	[If the x-th pregnancy (x> 1)] Do you still use the MCH handbook as a reference for information on your last pregnancy?
Pain Points	So far, have you experienced any problems when searching for information in the MCH handbook?
	Can you tell me how often you experience this problem?
	What problems do you often experience during pregnancy, both health problems and other problems?
	Do you use the MCH handbook as a reference in finding solutions to the problems mentioned?
	How do you find solutions to the problems you experienced during pregnancy?
Goals	In your opinion, is the utilization of the MCH handbook sufficiently optimal in terms of information, method of delivery, and how to use it?
	In your opinion, is the information in the MCH handbook enough to meet your needs as a father or a pregnant woman? Why?
	Have you ever looked for or obtained an alternative to the current MCH handbook (in terms of delivery and use)?
	What are the solutions or alternatives?
	How has the process of recording information in the MCH handbook when visiting health facilities been so far? Is the recording process

Category	Interview Question
	running effectively?
	Do you use pregnancy apps to support the pregnancy process? If yes, what application did you use, and why did you choose the application?
	How can this application support your pregnancy?
	What do you get from the application?
	What features need to be developed for the application?
	Is the application a substitute for the MCH handbook or a complement to the MCH handbook?
	In your opinion, what things from the MCH handbook can be replaced by the MCH app?
	Would you suggest other pregnant women use the pregnancy app instead of the MCH handbook? Why?
	What information do you need during pregnancy, and how do you find it?
	Did you keep an independent health record during pregnancy? If yes, why and how did you do the self-recording?
	Do you have a regular daily or weekly health-related activity during pregnancy? If yes, how do you remember the activity?
	How do you determine which health facility to choose during pregnancy? Do you plan to or have time to change health facilities during your pregnancy?
	Do you often use digital content for activities during pregnancy? If so, where did it come from?
	Do you feel that providing information in the form of audio is more helpful for certain conditions?
	If there is an application that carries features from the MCH handbook, what features do you hope to have?

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Onboarding Model to Integrate Newcomers into Scrum Team at an Insurance Company

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Abstract

The average IT employee turnover rate at Company XYZ between 2020 and 2022 was 14.5%. When a new employee is hired, the company needs to help them learn the system development process used at the company. Company XYZ's IT division uses the Scrum framework to meet user demands quickly, but they don't have a specific onboarding process to help new employees adapt to Scrum and integrate new employees into the Scrum team without disrupting the ongoing projects. Therefore, our study aims to develop an onboarding model that will enable new team members to achieve successful onboarding and effectively integrate into their new team. This research used a qualitative approach by conducting interviews to gather in-depth and personal insights from the members of a hybrid working Scrum team. The interview data was thematically analyzed using a model derived from Peggy Gregory's onboarding theory because it has a useful set of meta-level categories for our study. Our study adjusts existing theory to fit the case study, the adjustments are within onboarding activities and newcomer adjustment category. A practical guide is also provided to improve successful onboarding for the newcomers into the Scrum team.

Keywords: onboarding activities, onboarding model for agile, onboarding adjustments, scrum; new employee

Introduction

Scrum is a framework that helps people solve complex and adaptive problems productively and creatively while producing products of the highest value (Schwaber and Sutherland 2020). It has been

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used since the early 1990s to manage work on complex products and to produce valuable products with well-distributed teams (Manteli et al. 2014). Scrum is not a standardized process where people follow a prescribed set of activities to create products in a timely and cost-effective manner. Rather, it is a framework for managing and organizing agile work.

The unavailability of an onboarding mechanism for implementing Scrum has presented several challenges. New team members encounter difficulties adapting to Scrum and the tools used for system development. Furthermore, the capacity and capability of new members are often overlooked when assigning workload, resulting in incomplete backlog targets at the end of sprints. Consequently, it is important to establish an onboarding model for the agile team at Company XYZ to suit the conditions and environment. This initiative will not only enhance the company's system development process but also increase the likelihood of successful onboarding for new members.

Company XYZ has experienced an average turnover rate of 14.5% for its information technology employees from 2020 to 2022. This means that every three months, there are team members who leave or join the team. The reasons for turnover include the completion of work contracts, employee resignations, and employees who do not pass probation. A turnover rate above 10% is considered high, and the company needs to aim for a turnover rate of less than 10% to maintain workforce stability (Pavlou 2023). The high turnover has resulted in the need for the company to recruit new employees to meet workforce needs and fulfill reduced resources due to employees leaving. Each new employee must be supported in adapting to the Scrum method used for the company's system development process.

The onboarding process at Company XYZ is currently quite general and traditional. It involves explaining company regulations, which are detailed in the standard operating procedure documents for each division, and providing insurance information, which is explained in the new employee orientation program document (NEOP). However, the information technology division at Company XYZ does not have a specific onboarding method to help new employees adapt to the implementation of Scrum.

In the context of new employee assimilation, companies need to conduct effective recruitment and selection with strategic orientation to maximize employee performance. Orientation, also called organizational socialization, is the process through which new employees acquire the knowledge, skills, and behaviors required to become effective organizational members (Bauer 2010). As highlighted by Bauer and Erdogan (2011), new employees typically have a probationary period of approximately 90 days to demonstrate their capabilities in their new role.

The purpose of this study is to create a comprehensive onboarding process for integrating new members into the Scrum team at Company XYZ. This is necessary as the company has implemented a hybrid working style, combining collocated and remote working environments, in response to the COVID-19 pandemic. The baseline model for this study is adapted from the onboarding model proposed by Gregory et al. (2022), which provides a framework of categories and activities suitable for this research. Adjustments have been made to the onboarding model to align with the specific conditions at Company XYZ. The findings of this research can serve as a foundation for helping newcomers efficiently adapt to Scrum in our unique context. It is expected this study can enhance practitioners' understanding of onboarding support in Scrum teams by presenting effective practices identified by team members. These contributions are anticipated to improve onboarding, enhance newcomer satisfaction, and boost team productivity.

Literature Review

Research conducted by Sharma and Stol (2020) established a theoretical model that outlines the relationship between onboarding activities (such as orientation, training, and support), onboarding success, organizational fit (job satisfaction and quality of workplace relationships), and turnover intentions. A noteworthy discovery was that orientation and support had a strong correlation with onboarding success. Dagenais et al. (2010) identified three key factors that help new developers integrate into software projects. These factors are early experimentation, internalization of different structures and cultures, and frequent validation of progress. The study involved 18 developers who

had recently joined an ongoing project. Despite most of the respondents being experienced developers and working on agile teams, the focus of the study was not specifically on agility in agile teams. The only Agile practice highlighted as helpful and effective during orientation was the daily Scrum meeting. Yates et al. (2020) investigates how new software developers comprehend the code base of existing systems. The study examines the various types of information conveyed from internal experts to new team members during the onboarding process. The findings suggest that mentoring new members can offer four perspectives of a program (temporal, structural, algorithmic, and rationale), and each perspective is valuable for onboarding into software development projects. Britto et al. (2020) emphasizes a single case study to enhance our understanding of onboarding processes in large, globally distributed software projects. The study revealed that successful onboarding was influenced by factors such as proximity to mentoring and formal training, adaptation to sociocultural backgrounds, task allocation, and team stability. Although the research investigated agile teams, the primary focus was on onboarding within globally distributed projects rather than agile teams. Gregory et al. (2022) identified a unique onboarding model designed specifically for agile software development. The study delves into the onboarding process by analyzing a case study of an agile team working in a co-located environment. It explores the perspectives of all team members, including both new and established members, and examines the evolution of onboarding within the team over time. This approach provides a more comprehensive understanding of the phenomenon compared to a simple interview study involving participants from different organizations. The study focuses on how the team utilizes and customizes agile practices to create effective onboarding techniques. Finally, the findings are aligned with existing onboarding literature from Bauer (2010) to create a model of onboarding within the agile context.

Methodology

An overview of this research methodology is shown in Figure 1. The first step of the research is to identify the problem faced within the case study to get the gap between reality and expectations, the identification is conducted by interviewing the Scrum team's product owner and scrum master to gather an overview of the situation. The second step is to conduct a root cause analysis by identifying the main issue that is creating the gap between reality and expectation, one key factor causing the issue is because there is no agile onboarding method currently to help newcomers integrate into the Scrum team. The third step is carried out by searching the theories and previous research related to this research, the theories mainly about agile onboarding activities, agile methodology, and Scrum. The fourth stage is to build the theoretical framework based on the literature review; the main theory used as a baseline for this study is an onboarding model by Gregory et al. (2022).

The initial step involves identifying the problem within the case study to address the gap between reality and expectations. This is identified by interviewing the Scrum team's product owner and Scrum master to gain insight into the situation. The second step is to conduct a root cause analysis to pinpoint the main issue contributing to the gap between reality and expectations, one significant factor contributing to this issue is the absence of an agile onboarding method to assist new members in integrating into the Scrum team. The third step involves exploring theories and previous research related to this topic, with a focus on agile onboarding activities, agile methodology, and Scrum. The fourth stage is to construct the theoretical framework based on Gregory et al. (2022). The fifth stage of this research involved preparing research instruments, which were formed from the onboarding framework and agile onboarding model. In-depth interviews were conducted with team members using probing questions to gather detailed insights and personal perspectives. The focus of the interviews was to gather information about the implementation of Scrum, onboarding experiences, work atmosphere, and other relevant insights. Finally, the conclusions are made based on the data analysis findings.

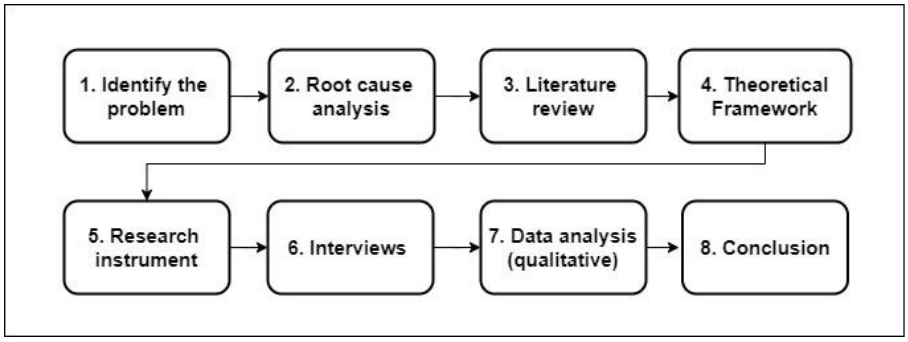

Figure 1. Flow of the Research Methodology

This study utilized an onboarding model developed by Gregory et al. (2022) as the basis or baseline for examining onboarding activities. This model is comprised of three main categories: onboarding activities, newcomer adjustment, and workplace adjustment as can be seen in Figure 2. Onboarding activities consist of 27 codes organized into six sub-categories, newcomer adjustment comprises six codes grouped into five sub-categories, and workplace adjustment includes four codes grouped into three sub-categories.

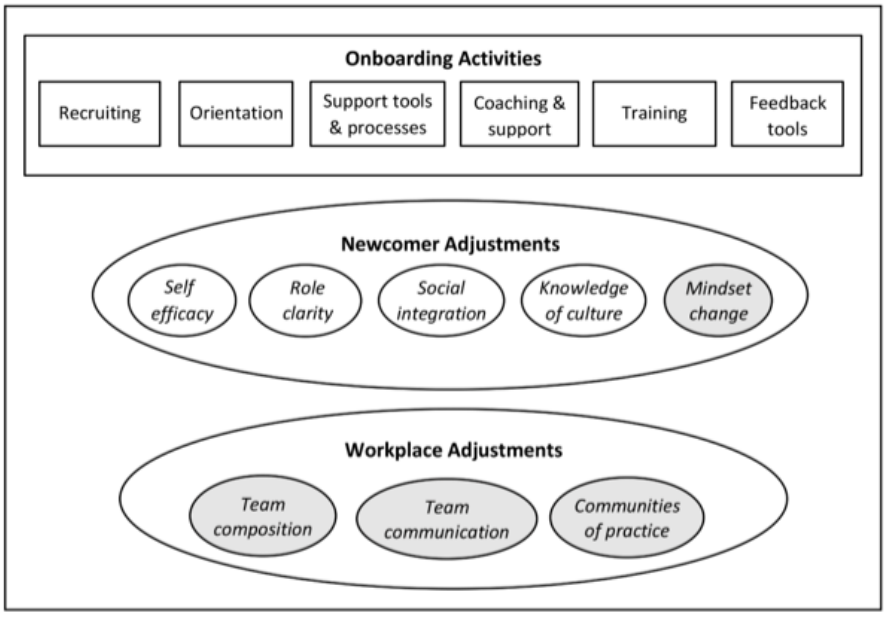

Figure 2. Peggy Gregory Onboarding Model

The researchers utilized the onboarding model as an analytical framework due to its comprehensive categories and activities that aligned with the research objectives in the case study. This method, known as elaborative coding, involves using existing theoretical categories or themes to guide the analysis of the current research (Saldana 2015). Since this research is a qualitative case study, the researchers did not quantify the frequency of each code provided by participants. Instead, the study used relevant or verbatim quotations to illustrate the conveyed code and made sure to include at least one quotation from each participant (Saldana 2015). Elaborative coding was employed to identify codes not present in previous theories, thereby enhancing the understanding of the case studies. The stages for the data analysis are shown in Figure 3.

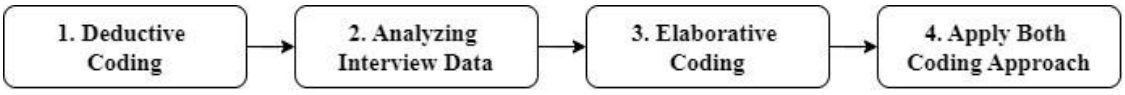

Figure 3. Stages of the Data Analysis

The initial stage involves deductive coding, where pre-established codes from the onboarding model by Gregory et al. (2022) are applied to create a coding scheme outlining the research themes. The second stage involves analyzing interview data by familiarizing with the codes from Gregory et al. (2022) and examining the data. Similar sections are tagged with existing codes, and verbatim quotations are included to illustrate or support the coded themes. The third phase includes conducting elaborative coding to explore additional themes or patterns that arise from the data. This involves a thorough exploration of the data to discover new concepts or insights that go beyond the initial coding scheme. The last step involves integrating all the codes obtained from both coding methods by combining the findings from both deductive and elaborative coding to create a comprehensive understanding of the data.

Result and Discussion

This study takes the perspective of a team that incorporates a hybrid way of working, with four days of remote work and one day of co-located work. The team is made up of nine members, including a scrum master, four quality assurance or system testers, and four software developers who utilize the scrum framework for software development (Table 1). The team operates on a one-week sprint cycle and consists of both new and established members. New members are defined as employees who have been with the project team for less than a year, while established members have been on the team for a year or more. New members share their experiences as newcomers, while established members offer broader insights based on their own experiences and observations of others during the onboarding process.

Table 1. Team Member Profiles for Interviews

Role and Code	**Experience at Company XYZ**	**Previous Agile Experience**
Scrum Master [SM]	4 years	1 year
Software Developer Team Leader [DEV1]	6 years	4 months
Quality Assurance Team Leader [QA1]	6 years	7 months
Software Developer Team Member [DEV2]	2 years	1 year
Software Developer Team Member [DEV3]	1 year	4 months
Quality Assurance Team Member [QA2]	2 years	7 months
Quality Assurance Team Member [QA3]	1 year	3 years
Software Developer Newcomer [NC1]	4 months	4 years
Quality Assurance Newcomer [NC2]	7 months	none

The interview took place in a semi-structured virtual mode using Microsoft Teams. The interviewer remained open to new ideas and sought further information related to the topic. Participants provided consent for audio recording of the interviews, which were then transcribed for analysis. The onboarding model for Scrum teams, developed from this research, is shown in Figure 4. The shaded portion indicates an adjustment within that specific area in this case study. The term "adjustment" implies a change or addition to the code from the Gregory et al. (2022) onboarding model as identified in this study.

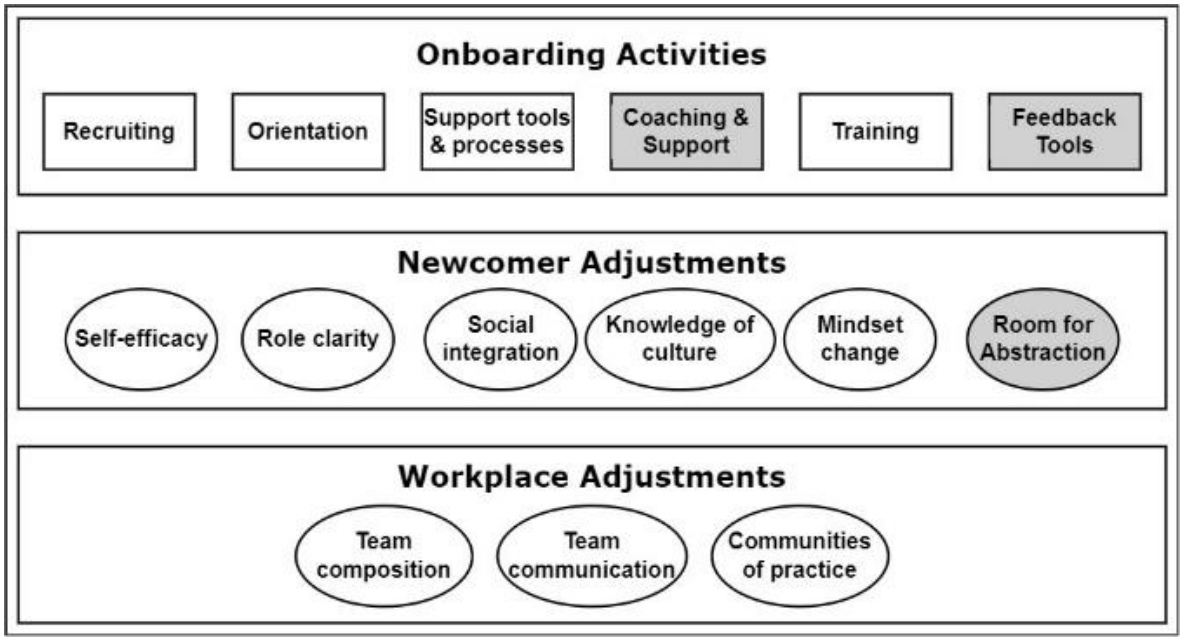

Figure 4. Onboarding model for the Scrum Team at Company XYZ Adopted from Gregory et al. (2022)

Onboarding Activities

For the sub-categories of recruiting, orientation, support tools and processes, and training, there are no code adjustments because the application more or less matches the case study and the existing theory research. For the coaching & support category, there is a code adjustment which is the addition of the pair testing code because it was found that the application of pair testing in the case study was to help team members in daily work, there is a code adjustment from previously co-location to hybrid working because team members work in a hybrid manner, which is one day co-located at the office and four days of working remotely, there was also an adjustment to the code from previously ceremonies to become Scrum events because in the case study the entire Scrum events is a methodology to help team members in providing support to each other and also provides coaching. For the feedback tools category, there are adjustments to the retrospective code, sprint reviews, and sprint refinements which have been moved into the Scrum events code because this series of activities is included in the Scrum events. Onboarding activities are divided into six sub-categories and 23 codes describing the factors that play a role in onboarding, as seen in Table 2.

Recruiting

The recruitment process is carried out formally and has its operational standards. The initial stage of the recruitment process is that applicants register through the company's job posting, and then an administrative selection process is carried out, after that the applicants will be invited for an interview, and in the interview technical and non-technical evaluations are carried out to assess the applicant's suitability. When applicants have joined, they will be assigned to a team and will be given orientation.

Long-Term Recruitment Strategy: The unit has a long-term recruitment strategy (Bauer and Erdogan 2011), specifically recruiting students who are still studying or doing internships at the company while completing their studies. Once the interns complete their studies, they can become permanent employees. This strategy means that these employees require minimal orientation because they are already assigned to a suitable team, understand the team goals, products, and technology used by the Scrum team: *"Because students who do internships can become a permanent employee at Company XYZ after completing college and after being evaluated by human capital and superiors"* [NC2].

Onboarding During Recruitment: During the recruitment process, knowledge gaps of the candidate are identified (Bauer & Erdogan 2011): *"To find out how experienced they are with Scrum, so we can*

predict their needs when they joined in" [DEV1], *"So that we can measure the ability of the candidate to implement Scrum, but we still accept candidates who have never applied Scrum, most of them are fresh graduates"* [QA1]. By understanding new members' knowledge gaps, the team can predict the needs of new members to help them adapt to agile methods.

Table 2. Onboarding Activities with Sub-Category and Codes

Category	Sub-category	Code	Adjustment
Onboarding Activities	Recruiting	Long-term recruitment strategy	-
		Onboarding during recruitment	-
	Orientation	New staff pack	-
		Working with the client pack	-
		Agile method pack	-
		Socializing	-
	Support tools & processes	Information radiator	-
		Communication tools	-
	Coaching & support	Mentoring	-
		Role modeling	-
		Pair programming	-
		Pair Testing	✓
		Scrum Events	*
		Hybrid Working	✓
	Training	Immersion	-
		Self-study	-
	Feedback tools	One-to-ones	-
		Immediate feedback	-
		Code reviews	-
		Small tasks	-

Symbol – indicates no adjustment from Gregory (2022) onboarding model, ***** indicates an adjustment from Gregory (2022), ✓ indicates new adjustment identified in this study.

Orientation

Orientation has a social role, helping new members feel welcome by introducing them to coworkers and other individuals in the organization (Bauer, 2010).

New Staff Pack: New members are given a file called the NEOP, which in general is a document explaining and describing standard procedures, laws, and business processes that apply in the company. Providing this file is a general orientation process for case studies.

How Our Team Works with the Client Pack: This document provides examples of how the team works with users, such as before-after conditions for a feature, how to document testing scripts, and administration of document signing by users. This helps new members to get an idea of how to work together with users.

Agile Method Pack: Documents such as The Scrum Guide (Schwaber and Sutherland 2020) help new members learn about agile and how to apply it to agile teams (Gregory et al. 2022). The company

must be able to provide a summary of how the Scrum implementation is expected from new members, so that new members will get an idea of the company's expectations and standards for implementing Scrum.

Socializing: Team members always make an effort to socialize and get to know each other, because this helps new and established members build trust, and makes new members more confident in interacting and communicating with others, *"I really enjoy working here because the team is very positive and supportive. "The team here also often holds events outside the office, so I get closer to others and it's not awkward to chat when WFO (work from the office)"* [NC2]. For new members, this is the beginning of adjusting to the team and building trust with other team members, which is an important part of new member orientation, therefore new members need to constantly socialize to increase trust in each other.

Support tools and processes

The team uses a variety of tools for communication and coordination which new members have to learn.

Information radiator: a tool that is a physical object such as a whiteboard, to provide a summary of the team's work progress and is always clearly visible. This tool is commonly used in agile teams to coordinate work (Cockburn 2006). The team has a large whiteboard and also has a virtual board, specifically using the Jira application, where the team can track and see how many tasks they have completed from the previous day, *"When we are working from home, we do a daily standup to discuss what each personnel did for that day, then we discuss the burndown chart to remind how much more work needs to be completed. The team thinks that these tools are also useful for new members, "we write each member's task on the whiteboard as a reminder, because usually there is a work dependency between team members."* [SM]. When team members see an overview of the team's work, they will remember what tasks are related to each other between team members: *"By reminding other members of their tasks that are related to ours, we learn time management, teamwork, and communication. Because those things are important for the quality of the team"* [QA2]. This tool can guide new members to monitor in general how the task process is carried out from time to time.

Communication tools: The team uses several applications for communication such as Microsoft Teams, WhatsApp, Zimbra, and Microsoft Outlook. Communication tools are frequently used in co-located agile teams (Calefato et al. 2020), the team always uses communication tools when the team is working remotely or virtually: *"When I first started, I always paid attention to how team members did Scrum planning, daily standup, coordination via chat or email, and used Jira so that it could be used as an example."* [DEV2]. Communication tools are also very helpful for team members to be able to monitor the work status of team members and can notify indirectly if a team member is busy and focused on doing something: *"Usually I don't reply to their chats if I'm busy, I will also put busy status on teams."* [QA3]. New members must be able to adapt and utilize the communication tools used by the team.

Coaching and support

Many aspects of implementing agile provide support for newcomers, such as agile ceremonies, self-organizing teams, pair-programming, pair-testing, role-modeling, and sprint velocity. All team members encourage a positive and supportive work atmosphere, established members understand how to support new members to adapt to the team because they have also experienced being new members. Buchan et al. (2019) explains that mentoring is the activity that most contributes to increasing successful onboarding.

Mentoring: Mentoring helps new employees learn the ins and outs of the company. A mentor can teach new employees about the organization, provide advice, and assist with work instructions. New employees may come to their mentors with questions they were afraid to ask their superiors for fear of appearing incompetent (Bauer 2010). However, Company XYZ has not implemented a mentoring method for new members, therefore mentoring should be implemented to help new members integrate into the team.

Role Modelling: Team members stated that role modeling is beneficial for newcomers. This is very important to convey the importance of honesty and transparency in work, *"I often ask questions in groups for discussion or directly to the team when I'm in the office because I don't know how to do the task. Because usually, I see the scrum master often invites team members to discuss when they are confused."* [QA3]. Team members understand that they will encounter obstacles that they cannot overcome themself, they can imitate the way the scrum master coordinates to solve these obstacles.

Pair Programming: A technique in which two programmers work side by side to complete a task. This technique is seen as an effective way to get to know code that is already running, and how to create code in a team context, and is useful for getting to know other team members (Buchan et al. 2019): *"From my experience, the best way to learn was pair programming, I was paired with a senior team to solve complex algorithms, and from here I also learned how to become open to new ideas"* [DEV3].

Pair Testing: A collaborative system testing technique where individuals work together to test a product or application, this is done to improve communication and provide a new perspective for conducting system testing: *"I often ask for opinions or points of view from other co-workers when testing, because other people may have different ways"* [QA2].

Scrum Events: Scrum has four ceremonies or events, they are sprint planning, daily stand-up, sprint review, and sprint retrospective (Schwaber and Sutherland 2020). The four activities in Scrum are briefly explained to new members, then new members will be directly involved in the series of activities so that they better understand what the practices are like in the team: *"Each person will explain what they are working on that day, then they will also tell you if there are any obstacles that they have not been able to resolve.", "Sprint reviews are usually held on Tuesdays and will be attended by users, product owners, and department heads from each role. Then explain what the team has done in the week's sprint. The superiors will provide input on what the next job will be like."* [NC1]. Scrum activities help new members understand what the expected results are for the team.

Hybrid Working: Hybrid work practices are practices that implement co-location and remote work. Working co-located or in the same room makes it easier for team members to understand the team situation and ask questions directly, *"WFO helps colleagues to coordinate directly, usually if someone is confused, they immediately ask the person next to them, sometimes the person next to them helps answer the question. listen to it"* [SM]. Working remotely can provide flexibility to team members, reduce distractions, strengthen the use of technology, and increase trust in each other, *"WFH improves work-life balance because it reduces time spent traveling to the office. If someone is sick, they can also rest more and reduce the spread of the virus. And the most important thing is to increase trust in each other because we believe that each member can be given ownership of their tasks and they will provide results independently without us having to ask them repeatedly"* [SM].

Encouraging teamwork: Old team members often share knowledge and provide mutual support within the team, especially towards new members. Working as a team and building trust is critical to implementing agile, *"Asking team members, we are encouraged not to be afraid or embarrassed to ask others if we have difficulties or are confused about work or things outside of work."* [NC1].

Encouraging learning: Learning related to company norms and improving the quality of work helps new members adapt during the initial period after joining the team, also has a positive impact on the employee's desire to stay in the organization and increases job satisfaction (Bauer 2010): *"Sometimes we get feedback to improve the implementation of the SOLID principle so that our code is easy for other people to read and understand. This feedback encourages us to improve our performance and quality of work."* [NC1].

Empathy: Because established members still remember what the onboarding experience was like, they stated that these memories helped them to sympathize and understand what kind of obstacles new members faced, *"Teach them with step by step or stage by stage, because in my experience when I first joined there were a lot of things to learn and it felt like I couldn't handle all of them because it was too much."* [DEV2].

Training

Training is to improve employee skills in terms of hard skills and soft skills. This training can illustrate to new members how to proactively help them acclimate thereby encouraging successful onboarding (Bauer 2010). The training carried out in the case study was to invite new members to work together with the established team members while diving directly into the work. This is very effective in speeding up new members' understanding of technical and non-technical aspects.

Immersion: Experimental learning techniques for new members, they dive straight into tasks on their first day and most of their training is achieved by becoming productive members of the team. This technique is aligned with agile methods, where teams work to deliver value as quickly as possible, *"Involve them directly in every teamwork activity, so that they are hands-on on the task they choose, provide documentation of existing work, and direct them to ask questions if they are confused or in doubt about something."* [DEV1]; *"And new members have similar experiences as the development team leader said involved in meetings, even if only listening."* [NC1].

Self-study: New members will increase their onboarding success if they can learn independently regarding material or aspects that support their work, *"I just study independently from the source code used, or usually I ask other experienced members"* [DEV1]; *"With online courses, read the literature and immediately practice agile"* [DEV3].

Feedback tools

New members receive informal feedback or input regarding their work when working in pairs because they work on minor or small tasks. More formal feedback is received during sprint reviews, code reviews, and sprint retrospectives. This is very useful for newcomers to help them adapt to the team.

One-to-Ones: All new members have regular face-to-face meeting sessions approximately every week, with the team leader (Klein and Beth 2012). This method allows them to get guidance on technical issues and reflect on their work practices.

Immediate feedback: New members will get feedback on their work relatively quickly, as the team uses one-week sprint phases. Feedback is important for new members (Bauer 2010). A new member shared his experience when his work was being tested, *"We often get feedback when the QA team is testing, for example, something like this 'for this process it seems better and easier to understand if it's like this... for rich colors, it's not pleasing to the eye but that's what I think, maybe it can be done. discussed together.' That's more or less the input."* [NC1].

Code reviews: Informal code reviews where a group of developers read and review a section of code. This technique is used to provide feedback and help learning for all members, including new members. This technique helps new members to learn by listening and listening to the whole group discussing detailed points about coding practices and problem-solving, *"a code review is carried out to review the code that we have written so that we can find more efficient ways for development"* [DEV3].

Small tasks: Agile methods often break user stories or epics into small tasks or what can be called a backlog so that developers can create code and test it in the next few days. This practice is important to ensure that estimates and sprint planning are carried out as accurately as possible (Buchan et al. 2019). This is useful for the team to be able to give small and simple tasks to new members for the initial stage, *"Often given minor but large tasks, don't give complex tasks even a few"* [NC1].

Newcomer Adjustments

For the sub-categories of self-efficacy, role clarity, social integration, knowledge of culture, and mindset change there are no code adjustments because their application is necessary and appropriate for research case studies. There is an additional sub-category called room for abstraction with two codes because there are obstacles that new members must face when onboarding virtually in the case study.

Newcomer adjustments are divided into 6 sub-categories and 8 codes describing the internal factors that play a role in onboarding, as seen in Table 3.

Table 3. Newcomer Adjustment with Sub-Category and Codes

Category	Sub-category	Code	Adjustment
Newcomer Adjustments	Self-efficacy	Empowerment	-
	Role clarity	Reimagining	-
	Social integration	Joining a team	-
	Knowledge of culture	Knowledge of agility	-
	Mindset change	Tackling problems	-
		Becoming agile	-
	Room for Abstraction	Clarity on Expectations	✓
		Personal Interaction	✓

Symbol – indicates no adjustment from Gregory (2022) onboarding model, * indicates an adjustment from Gregory (2022), ✓ indicates new adjustment identified in this study.

Self-efficacy

Self-efficacy can be interpreted as an individual's belief in his ability to complete a task given to them (Britto et al. 2017). Self-efficacy is related to workload delegation because confidence in one's ability to complete a task is the origin of the ability to work independently to achieve that task. Working in agile teams assumes that team members are empowered and can organize themselves to complete the tasks they undertake, either by working alone or in collaboration with other team members.

Empowerment: A process that allows individuals or groups to gain control, make decisions, take action, and self-confidence in their professional lives, *"I also sometimes appoint new members to work on something they have never held before, so they can learn a lot from it"* [SM].

Role clarity

New members need to understand their role on the team. For example, a developer has special skills such as front-end or back-end roles. Agile team members must be ready to take on various types of tasks and should not only work based on their specialty. Team leaders support new members to find their place. One technique used is reimagining to help staff reimagine themselves into new roles (Gregory et al. 2022).

Reimagining: team leads use one-to-ones to discuss how to work with new members to help them reimagine themselves in their new roles. This helps them make the transition, *"I also ask if they can learn something new outside of what they already know, so they can fill the workforce if needed"* [DEV1]. This process needs to be carried out to help new members reimagine their abilities in the role given to them.

Social integration

Social integration helps newcomers become part of an agile team because team members work together as a unit.

Joining a Team: New members shared that they felt comfortable and easy to integrate into the team, as there was a positive atmosphere in the workplace; *"I feel very cool working here because the whole*

team has a good attitude and supports each other, making it easier for us to interact with each other, when WFH or WFO" [NC2]. This positive atmosphere helps new members integrate into the team.

Knowledge of culture

The team working culture is context-oriented at several levels that influence how things are done. Team members shared that the best way to help new members learn their work culture is through experiential learning within the team.

Knowledge of agility: Gregory et al. (2022) imply that the main problem of onboarding is integrating inexperienced newcomers with knowledge of agile ways of working into a team that has a strong agile culture. An introduction process regarding agile work culture is needed for new members to broaden their horizons regarding its application.

Mindset change

Mindset change is important for agile team members because research has found that this is an important concept that is an essential part of agility (Mordi and Schoop, 2020). A mindset refers to a person's attitude or way of thinking and is therefore different from knowledge of culture. Mordi and Schoop (2020) uses theory literature and primary data to define the agile mindset as "a mindset based on the values and principles of the Agile Manifesto, whose main characteristics are trust, responsibility and ownership, continuous improvement, a willingness to learn, openness, and a willingness to continually adapt and grow". In their study, the five aspects with the highest levels were: finding solutions to problems, being motivated, helping each other, listening to each other, and focusing on achieving common goals.

Tackling problems: For the fresh graduates in this team, this is their first work experience in the information technology sector, they have no previous experience in working on application development which is crucial from a business perspective in companies. This learning needs to begin with new members during their first few months on the job (Gregory et al. 2022).

Becoming agile: Team members, especially new members, find it difficult to maintain the process of implementing an agile mindset without following the example of the team leader or Scrum Master. Following a series of Scrum events can help new members move towards a change in mindset.

Room for Abstraction

New members may experience various abstractions or challenges when onboarding virtually, the company needs to address the challenges because it is essential for creating a positive and effective onboarding experience that sets new members up for success in their roles, improves engagement, retention, and strengthens organizational culture in a hybrid working environment.

Clarity on Expectations: New members need clarity regarding team expectations to meet the team's criteria. Onboarding online or virtually can create ambiguity regarding job responsibilities, performance expectations, and organizational processes. Without direct supervision, new members may struggle to fully understand the roles and responsibilities they are required to perform.

It is important to provide new team members with clear guidance on team expectations to ensure they meet the criteria set by the team. Onboarding virtually can create confusion around job responsibilities, performance expectations, and organizational processes. Without direct supervision, new members may struggle to fully grasp their roles and responsibilities. Consequently, new team members are advised to engage with existing members to gain clarity about the team's expectations.

Personal Interaction: In remote or online onboarding, the absence of in-person interactions with colleagues or managers can pose a challenge for new employees in forming personal connections and fostering positive relationships with their team. The lack of face-to-face contact may impede the development of relationships and integration into the company culture. It requires bravery for new team members to initiate conversations and seek guidance from other team members: *"We sometimes*

could not sure if they understand with the instruction I gave to them, because we could not see their reaction, so we need to ask a couple more times to ensure" [SM].

Workplace Adjustments

There is no code adjustment for this category because its application is necessary and appropriate for the research case study. Work environment adjustments are divided into 3 sub-categories and 4 codes describing work environment factors that play a role in onboarding, as seen in Table 4.

Table 4. Workplace Adjustment with Sub-Category and Codes

Category	Sub-category	Code	Adjustment
Workplace Adjustments	Team composition	Adjusting the team	-
		Mentor availability	-
	Team communication	Accommodating newcomers	-
	Communities of practice	Agile community of practice	-

Symbol – indicates no adjustment from Gregory (2022) onboarding model, * indicates an adjustment from Gregory (2022), ✓ indicates new adjustment identified in this study.

Team composition

The team composition in an agile development team is very important in the progress of development because agile teams are required to be able to carry out tasks quickly. When there are new members in an agile team, the team composition will change and adjustments will need to be made to accommodate the new team configuration. Ideally, an agile team should have more permanent employees than contract or internal employees. This can avoid changing team composition too often. The Scrum Team at Company XYZ has a 50:50 ratio between permanent and non-permanent employees, non-permanent employees contribute to a high turnover rate in the team. Due to the high employee turnover rate causing frequent changes in team composition, this can result in sprint targets not being achieved which results in a setback in the project timeline.

Adjusting the team: As time goes by, the team members consist of many permanent employees so they have fewer non-permanent members. This balance increases the team's ability to continue to develop because the dynamics of team change can be minimized (Gregory et al. 2022). Therefore, the Scrum team in the company must be able to maintain its composition to remain stable.

Mentor availability: New members need guidance in their first period of work, so they need a mentor who can guide them during their work adjustment period. The role of mentor is best carried out by the team leader, but often they are busy and do not have free time to accompany the new member. Apart from that, there was never a handover of work between the old team members who were leaving and the new team members: *"The recruitment process often takes a very long time, so even though the established members who are leaving have done a one-month notice or have been notified one month beforehand, they still cannot hand over their jobs to the new team. This is because the replacement only arrived several months later."* [SM]. This makes knowledge transfer and handover impossible. Therefore, experienced team members need to be willing to serve as mentors to newcomers.

Team communication

Agile teams aim to be well-integrated and have effective ways of communicating. When new members join a team, existing members need to change their way of communicating to explain to newcomers in simpler language so that new members can better understand.

Accommodating Newcomers: Communication is an important thing in adjusting the work environment. Often the problems faced by agile teams are lack of communication, poor

communication, and lack of documentation in discussions. This needs to be avoided because to be able to support new members during their adjustment period, it is by using good communication in simple language that is generally understood by everyone and this should be done by all team members.

Communities of practice

The IT division at PT XYZ consists of 14 agile teams that develop different applications. Even though one agile team has carried out its duties effectively, this may not necessarily be the case for the other team. Therefore, it is necessary to create a community of practice. A community of practice is a group of people who share information and experience about something they do and learn how to do it better when they interact regularly.

Agile community of practice: It is necessary to create a community of practice that is specific to the topic of agile. This community consists of several agile teams who share information and experiences in doing their work. There needs to be regular discussions in the community at least once a month. This can open up new perspectives in doing work, especially for new members who are adapting.

Conclusion

This research explained how an onboarding model is well-suited for integrating new members into Scrum teams within the information technology division of an insurance company, particularly those adopting a hybrid working approach (a combination of co-located and remote work settings). We primarily focused on the onboarding activities and newcomer adjustment categories, tailored to fit the specific context of the case study. This adjustment was prompted by the onset of the COVID-19 pandemic and the subsequent adoption of a hybrid working model within the study case to accommodate the evolving work environment.

Implementing the onboarding model in the study case can improve the onboarding experience for newcomers. This can lead to smoother integration of newcomers into the Scrum team, resulting in increased productivity, better team cohesion, faster adaptation to the hybrid working environment, and increased contribution to overall organizational effectiveness. A practical way to help new members is by implementing important practices from the onboarding model to increase the chances of successful onboarding into a Scrum team, such as:

1. Onboarding activities: the company can implement mentoring in the company, have newcomers imitate other team members who are viewed as role models, engage in pair programming or pair testing, participate in the entire series of Scrum events, immerse themselves in tasks that fit their roles, conduct one-on-one sessions, pursue career-support learning independently, and consider the feedback provided by other team members.

2. Newcomer adjustments: new team members should feel confident in their ability to complete tasks, understand their roles and responsibilities, adapt to the team's work culture, and embrace agile thinking. They should also work on aligning their expectations with those of other team members.

3. Workplace adjustments: the team needs to ensure stability by managing the team composition, preparing mentors for new members, and adjusting communication methods when interacting with new team members.

The adaptation of the onboarding model to suit a hybrid working environment provides valuable insights into the dynamically increasing team and organizational change management. This study highlights the importance of flexibility and adjustment in applying theoretical frameworks to real-world contexts. This theoretical implication highlights the need for ongoing research and development in human resource management strategies to keep pace with changes in the modern workplace.

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Analyst's Perception on the Use of AI-based Tools in the Software Development Life Cycle

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Abstract

Artificial Intelligence (AI) integration has been the goal in many industries, including in the software development industry. One example of this integration comes in the form of integrating AI in the Software Development Lifecycle (SDLC). To date, the difficulties of incorporating AI-based tools into particular phases of SDLC have not received much attention in research. Using qualitative approach, this study aims to discover the perception on the use of AI-based tools and challenges in integrating them in the analysis phase of SDLC. The study finds out that analyst have positive perception about integrating this technology in their field of work but there are some challenges while integrating this technology such as familiarity of the tools, output quality, dependency, and data security and privacy concern. This study also discovers some key factors of why some analysts adopt or refuse this technology namely related to time, urgency, and budget.

Keywords: artificial intelligence, sdlc, integration, challenge, key factor

Introduction

Software engineers have been creating techniques and standards since the beginning of software development to turn the process into a methodical one that can guarantee particular standards of quality. The rules outlined in the Software Development Lifecycle (SDLC) have been the appropriate methodology to follow by the practitioners since these rules guide them in developing a high quality of software products (Acharya and Sahu 2020; Moreschini et al. 2023; Pargaonkar 2023). Due to the ever-

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changing development of technology and demands from the market, this methodology is adapted to the changes that occur, resulting in breakthroughs in the use of the technology as well as action taken in the process (Adanna and Nonyelum 2020; Banerjee et al. 2020). An example of the changes that are occurring is the application of technology, including artificial intelligence, or AI. AI technology is well known to have a significant impact on a variety of industries, including transportation, agriculture, health, and others, in addition to the technological sectors (Kuang et al. 2021; Panda et al. 2019). This phenomenon triggered researchers to conduct studies to explore this technology.

There are several studies related to the integration of AI in the technology industry, specifically related to SDLC. A notable study examines how AI techniques can be used in software development (Stavridis and Drugge 2023). The study's primary findings include the possibility that AI tools could offer developers intelligent assistance in the form of innovative feedback and task automation. Concerns were raised, meanwhile, regarding the organization's potential impacts as well as the requirement to adjust to AI tools. The study highlights how crucial it is to consider how the introduction of AI may alter system development processes and how crucial it is for developers to successfully work with and adjust to AI tools.

Another study investigates the use of ChatGPT and other AI tools in different stages of software development (Waseem et al. 2023). According to the study, ChatGPT is helpful in expediting the initial stages of software development, enhancing accuracy and efficiency. ChatGPT remained a useful tool during development, optimizing workflows and offering insightful data. The study also emphasizes how AI technologies may be used to simulate the function of an architect in Architectural Collaborative Software Engineering (ACSE) by efficiently and effectively producing software requirements. To improve requirement quality, the research also highlights the importance of human oversight and the value of human feedback.

Another study explaining the challenges of integrating AI (in this case ML) (Laato, Mäntymäki et al. 2022). The study examines the challenges of incorporating SDLC concepts with machine learning (ML) development. To investigate how four distinct archetypal SDLC models promote ML development, the study performed a series of expert interviews. Redefining the prescribed roles and responsibilities within development work, using the SDLC as a framework for management, customers, and software development teams to commit to a common understanding, and method tailoring are the three high-level trends in ML systems development that the research found to emerge from the analysis. The study emphasizes the issues associated with managing the development of ML models as part of the full SDLC and the need for additional research on whether and how to incorporate data scientists' work into SDLC models.

There are also similar studies that try to explore the integration of AI in other fields of studies, such as pathology (Drogt et al. 2022). The study aims to learn about the views of experts on the shift to digital pathology and the possible benefits of AI-based image analysis, the researchers conducted interviews with 24 professionals (15 pathologists, 7 lab workers, and 2 computer scientists). The advantages and difficulties of digital pathology were spoken about, along with the aspirations and expectations of the respondents regarding AI in pathology. The Researchers thought AI may help with more sophisticated diagnoses and improve the efficiency of their workflows, especially for repetitive and routine chores. The significance of keeping a realistic perspective on AI's prospective benefits and the necessity of practical viability for successful AI research were other topics covered by the respondents. Lastly, the respondents also saw AI fulfilling a variety of roles and duties in the diagnostic process, such as advisor, instructor, and additional expert.

Another study comes from the agricultural industry, which explains the possible benefits and challenges of using smart farming technologies in the agricultural industry (Jerhamre et al. 2022). According to the study, farmers are generally in favor of smart farming and think it will save money and time on tasks like fertilizing and irrigation, which will benefit workers' working conditions. Farmers, on the other hand, might not always see the need for investments in smart farming and instead think of them as something stylish and modern.

Based on the literature research conducted by own researcher, many AI integration processes have been incorporated into the SDLC phases, but there has not been much focus on the analysis phase of software

development, specifically related to the challenges of this integration. Therefore, qualitative study is required to explore the challenges in integrating AI into the SDLC's analysis phase. The objective of this study is to learn what analysts think about integrating AI into the analysis phase of the software development life cycle (SDLC) and what obstacles they may encounter while integrating this technology. Thus, several questions arise from the objectives of this research: (1) What is the analyst's perception of using AI-based tools in the analysis phase of the SDLC? (2) What are the main challenges that analysts may face regarding the use of AI-based tools to support the analysis stage of the SDLC? (3) What are the key factors that influence an analyst's decision regarding the use of AI-based tools in the analysis phase of the SDLC?

The remainder of this paper is structured as follows. The next section provides a brief description of related literatures and followed by the methodology used in this study. Then, we present the result of this study as well as the discussion, conclusion, implication, limitation, and suggestion for further research.

Literature Review

Artificial Intelligence

The terms Artificial Intelligence, or known as AI, is used to describe how a system or machine can imitate human intelligence. The system that builds by the principal of AI is capable of various cognitive processes such as understanding, thinking, learning, predicting, planning, and others (Xu et al. 2021). The main idea of AI is to create a smart machine that can provide solutions and solve problems related to human intelligence (Goralski and Tan 2020). According to (Sarker 2022), techniques in the field of AI potentially can be divided into 10 major parts: (1) machine learning; (2) neural networks and deep learning; (3) data mining, knowledge discovery and advanced analytics; (4) rule-based modeling and decision-making; (5) fuzzy logic-based approach; (6) knowledge representation, uncertainty reasoning, and expert system modeling; (7) case-based reasoning; (8) text mining and natural language processing; (9) visual analytics, computer vision and pattern recognition; (10) hybrid approach, searching and optimization.

In industry 4.0, AI is recognized as the key driver behind the technological advancements. AI is transforming various industries, which is causing the existing industry to grow very swiftly (Cioffi et al. 2020; Mohammed et al. 2021; Nortje and Grobbelaar 2020). Many companies invest in AI because they perceive it as an opportunity in the current industrial competition. However, many of them still find it difficult to take advantage of its benefits (Enholm et al. 2022). Although AI technology has the potential to greatly benefit humanity and society, some people are concerned about the possibility that AI will eventually replace human labor in the workforce (Vorobeva et al. 2022; Vrontis et al. 2022).

Software Development Life Cycle

The term Software Development Life Cycle (SDLC) refers to a set of organized tasks that are used as a guide for developing information systems. This methodology helps the development team to control every activity that occurs in the software development cycle, which makes this methodology essential for software development (Okesola et al. 2020). SDLC consists of several primary phases in its application, namely requirement analysis, design, implementation, testing, and maintenance (Saravanan et al. 2020). In another study, the phases in SDLC are divided into six phases consisting of planning, defining requirements (requirement analysis and software requirement specification), designing and software architecture, building or developing the product, testing, and deployment as well as maintenance (Gupta et al. 2021). Although some researchers may explain the SDLC phases different from the others, the overall explanation still revolves around the same main idea.

There are two primary categories of SDLC methodology, namely heavy-weight methodology and light-weight methodology (Ben-Zahia and Jaluta 2014; Yas et al. 2023). In the heavy-weight methodology, prior to beginning the development process, this approach greatly emphasis on documentation, long-term planning, and design. In contrast to the heavy-weight methodology, the light-weight methodology, also referred as agile development, prioritize more on the user involvement during the cycle as well as

shorter and more efficient process (Al-Saqqa et al. 2020; Ben-Zahia and Jaluta 2014). Both approaches have different SDLC models. Some examples of SDLC models that are categorized as heavy include waterfall, spiral, and incremental models. Meanwhile, SDLC models such as prototyping, Rapid Application Development (RAD), and Agile (Scrum, Lean, and Extreme Programming) are categorized as the lightweight (Ben-Zahia and Jaluta 2014). Each of these models certainly has its own advantages and disadvantages and given the growth of the technology and current industries, it is not completely ruled out that the number of SDLC models might keep increasing in the future.

The Current State of AI Technique Application in SDLC

Prior to conducting this study, researchers conducted a literature review to gain a broad understanding of the phenomenon of utilizing AI technology in SDLC. This is brought about by circumstances where advancements in technology keep evolving and their applications continue to be utilized in various industrial sectors. From this phenomenon, the literature review study aims to gain a comprehensive understanding of the trends in the application of AI technology in assisting the development of a software system as well as the challenges or obstacles encountered while doing so. The literature review study was carried out systematically by adopting the Kitchenham method (Kitchenham and Charters, 2007). From the systematic literature review, researchers were able to comprehend the trends and challenges of using AI technology related to each phase of the SDLC which helps the work of the software development team.

The findings of the literature review demonstrate that, among the many techniques falling under the scope of AI, ML, deep learning (DL), and natural language processing (NLP) methods are the ones most frequently employed to assist software system development activities. AI techniques such as DL can be used in the planning phase of SDLC to help predict which SDLC models are suitable for usage (Dhami et al. 2021) and to improve function Point-Based Software Size estimation (Zhang et al. 2021). Related to the analysis phase, ML techniques can help with software requirement specifications (Akshatha Nayak et al. 2022; Quba et al. 2021) and can also be used to predict software vulnerabilities (Imtiaz et al., 2021). Related to the design phase, various AI techniques can be used, such as ML which is used to assist in predicting software bug (Delphine Immaculate et al. 2019) and automate the assumption identification process (Li et al. 2019), NLP to create DFDs (Cheema et al. 2023) and used for voice-driven modeling software (Black et al. 2021), Artificial Neural Network (ANN) for software bug prediction (P and Kambli 2020), as well as the use of tools based on intelligence decision support systems used in risk management software (Asif and Ahmed 2020). Related to the fourth phase of SDLC, implementation, ML techniques can be u can be applied for a variety of purposes. these include assisting in the identification of weak points in source code (Sonnekalb 2019) and helping to predict defects in software (Ahmed et al. 2020; Pradhan and Nanniyur 2021; Shrimankar et al. 2022), generating code using generative AI (Sun et al. 2022), and other techniques such as NLP which is used to classifying bugs (Picus and Serban 2022) and the use of tools such as ChatGPT which helps in code analysis (Ozturk et al. 2023). Regarding the testing phase, several forms of this application are the use of DL techniques which are used to automate the process of generating test case scenarios (Roy et al. 2021), the test case classification process by utilizing a combination of NLP and ML techniques (Tahvili et al. 2020), as well as the use of NLP to provide solutions and automate fixing in the source code (Chi et al. 2023). Related to the last SDLC phase, maintenance, ML techniques can be used to assist the development team in detecting and analyzing technical debt (Khan and Uddin 2022; Tsoukalas et al. 2022) and DL techniques are used to assist in Software Maintainability Metrics Prediction (Jha et al. 2019).

The application of AI to fulfill different requirements for software system development activities is undoubtedly related to potential challenges. Prior study has focused more on the difficulties experienced by researchers testing AI techniques than by real users of these tools. These difficulties are related to the requirement for tools that are helpful in the development of software systems. In general, the challenges faced in most SDLC phases are related to the datasets used to test these AI techniques, such as limited dataset availability and low dataset quality (Chi et al. 2023; Dhami et al. 2021; Laato, Birkstedt et al. 2022; Sonnekalb 2019). Apart from that, several challenges were also identified in various cases which may be related to certain phases in the SDLC such as chances of error (Sun et al.

2022), high costs (Sonnekalb 2019), security concerns (Ozturk et al. 2023; Sonnekalb 2019), inconsistent results (Ozturk et al. 2023), and inaccurate result (Malhotra et al. 2022) which is related to the implementation phase, there is concern about human error and the complexity of the model used (Chi et al. 2023), which is related to the testing phase, as well as challenges related to the maintenance phase such as imbalance class in determining the model used to test the equipment (Tsoukalas et al. 2022). Even though the study to examine the current condition of the use of AI in SDLC has been carried out, challenges, especially in the analysis phase related to the use of AI in SDLC, still remain unexplored.

Methodology

This study uses a qualitative approach, which is an approach that aims to study and understand the meaning given by a particular individual or group regarding specific problems (Creswell and Creswell 2018). The qualitative approach was chosen because this approach allows researchers to have in-depth information regarding how an analyst perceives the use of AI-based tools, especially for the requirement analysis phase in SDLC.

Data Collection

In the process of data collection, this study used a semi-structured interview method. This method allows researchers to delve into a particular topic through the opinions of informants related to the topics being asked. The data collection process was carried out from December 4, 2023, to December 11, 2023. For the method of determining the study sample, this study adopted a purposive sampling method with selection criteria, namely people who have worked or are still working as an analyst, whether as business analysts, system analysts, or others and have been involved in the development cycle of a software system, especially involved in the analysis phase. The use of this sampling method allows researchers to explore the perceptions of a particular group on a particular research topic, which is in accordance with the initial objectives of this research. Apart from that, the sample selection was also carried out only on people who have worked or are still working as an analyst because the researchers assumes that they are the people who have experience in the field related to the development of a software system, especially at the analysis stage.

In the data collection process, interviews were conducted with five participants with each role as business analyst and system analyst. This research only involved five participants because the results obtained already addressed previously formulated research questions by providing several important insights related to the use of AI-based tools in the analysis phase in SDLC. The diversity of roles allows researchers to obtain more varied information related to an analyst's perception of the use of AI-based tools at the analysis stage in the SDLC phase. Apart from that, the variety of industries sectors of each participant also allows this research to gain a broader understanding, especially regarding the background, regulations, and culture of each company. The profiles of the participant of the interview from this study can be seen in Table 1.

Table 1. Profile of the Interview Participant

No.	Role	Age (years)	Working Experience (years)	Industry Sector
1.	Assistant Manager of Business Analyst	27	5+	Finance and Insurance
2.	Business Analyst	24	3	Information Technology
3.	System Analyst	31	5+	Government and Public Administration
4.	System Analyst	23	2	Education
5.	Business Analyst	26	3	Finance and Insurance

Interviews were carried out online via the Microsoft Teams platform and recorded via the same platform and recording tools from the local computer. Based on the literature research conducted by the researchers, these interview questions consist of open-ended questions which are intended to explore the answers from the informant. The interview questions are divided into several parts: to find out the informant's background, to find out the informant's personal opinions regarding the use of AI-based tools, to find out the positive and negative points of view of the informant regarding the use of AI-based tools, and to find out their opinion regarding the development of the analyst role in the AI development.

Data Analysis

In this study, data analysis was carried out by adopting the thematic analysis method. Thematic analysis is a technique used to evaluate qualitative data which involves searching for recurring patterns in a dataset and reporting the results. This method is a way to explain data, where in the process of code selection and theme creation, interpretation is also used (Kiger and Varpio 2020).

In this study, the steps for conducting the thematic analysis consist of six parts (Kiger and Varpio 2020). In the first step, the researchers transcribed the audio interviews that had been conducted previously. This process was carried out to help the researcher to see all the data that had been collected. In addition, in this first step, the process of data translation to English was also carried out because the interviews were conducted using Indonesian. The next step continues with the initial coding process. The initial code was formed to facilitate the process of compiling and collecting similar data. Then, in the third step, the theme searching process is carried out. In this process, data that has been grouped based on its code is re-evaluated to look for potential themes that can be developed. Next, in the fourth step, the potential themes that have been formed are reviewed again to see their suitability to the codes they describe. Next, in the fifth step, the names of the themes are determined, where in this research the themes are adjusted to the research questions. Finally, in the sixth step, the results of the findings that have been analyzed are presented in sentence. The entire thematic analysis process in this research was carried out manually using Microsoft Word and Microsoft Excel tools. In addition, this process also uses the researcher's personal interpretation skills.

Results

Analysts Perception Regarding the Use of AI-based Tools in the Analysis Phase of SDLC

Convenience and Efficiency of the Work Processes

It is well-recognized that the use of AI-based tools can facilitate human work. These tools can be used to do a variety of tasks, from easy ones to time-consuming, complex ones. As a result, new opportunities can be created to improve the convenience and efficiency of the job to be done, such as in software development projects. This AI-based tool's fast data processing and analysis capabilities may provide users valuable insight that helps them work better, particularly when it relates to the requirements analysis process that analysts carry out when creating a software system. Some analysts argue:

(*"When it comes to using AI when designing a system, for example requirements analysis, I think it's quite helpful, because first it can simplify the requirements gathering process, so the assumption is that general or minor requirements can already be provided with AI. So, from our side, we only need to be concerned with the deeper, or more technical parts"* – Participant 1)

(*"So, my current project has various modules. When I am assigned to a module, before I carry out requirements gathering with users and stakeholders, first I need to understand what the best practices that are likely to be obtained from that module are. That's why AI really helps me to keep me on the right track, so I don't need to be confused about determining best practice."* – Participant 2)

Increased Productivity and Time Savings

Undoubtedly, it is hard to separate the efficiency that AI-based products provide to work from productivity. When using AI-based tools, particularly during requirements analysis in the software system development cycle, employees can work more productively because some of these tools can provide suggestions, which allows them to make decisions more quickly and eventually complete their tasks. As mentioned by several analysts:

(*"While there are a few teams who have already started using AI, such as OCR or optical character recognition, it's most likely that the technology is still in its early stages of implementation at my workplace. This is useful during the requirements stage because the user provides data in the form of files (PDF files, maybe) or images. It might take a while to manually convert it to text, so perhaps we can use the OCR feature to extract the text data from, like, an image or a PDF file so that it can be processed again for the requirements process."* – Participant 4)

(*"…but from my personal side, I feel that, if for example there were AI tools that could help with every SDLC process from planning, collection, requirements, etc., so that every design already had a to-do list, we could calculate how much manpower it would have, and estimate the time based on the requirements with just one or two statements of our needs until finally it can also suggest the type of database to use, that's actually quite helpful."* – Participant 3)

Enthusiasm

The presence of new technology in a company is often a topic that sparks enthusiasm among employees, especially if the technology provides ease in employee tasks, where employees can directly feel the impact of using the technology. one analyst said:

(*"Maybe it hasn't been used in our company now, but in my own opinion, maybe later it will be needed for the data analysis process, because if we use AI, maybe the data source will be completer and more varied. But for the moment, because we haven't used it yet, we haven't tried it or applied it."* – Participant 5)

Possible Challenges in Using AI-Based Tools to Support Analysis in SDLC

Familiarity and Training for Using the Tools

Using new tools or technology, such as AI, often requires adequate training because not everyone is familiar with the technology. This is necessary to understand how the technology works effectively to maximize the potential of the tool in supporting the work being undertaken. As the analysts said:

(*"Maybe for the start, because I have never used AI tools before, the first thing that I must do is to adapt and learn more to understand the AI tools that I will use if I must use them."* – Participant 1)

(*"... maybe the first thing is how to use it, because I've never tried it directly, I'm only used to seeing on share screens how to use it and from the information I know, for example, to use OCR, it requires quite a long training, and some training may not be free."* – Participant 4)

(*"Because I'm not very familiar with it, I've never used it. so, training or knowledge transfer is needed first for things like this So I can get used to it and maybe understand better how to use it."* – Participant 5)

Quality and Credibility of the Data Produced

Feelings of anxiety and doubt are common reactions that some people may feel when they are faced with something new. Similarly, with AI technology, some people who are not familiar with the innovation of the technology, especially in their working environment, will certainly have some questions such as how credible and accurate the results given from the technology are.

(*"As for the risks themselves, what I can think of now is that maybe the results are invalid. I mean like, it's human-made too. Maybe when it's used for the first time, it might produce data that doesn't match*

what we want. So, maybe my concern is more about the results that don't match what we need." – Participant 1)

(*"... what I'm more worried about is the result of AI. If it is wrong, if we are not aware, it can have quite fatal consequences. So, the humans themselves must be smarter in filtering the results generated by AI."* – Participant 2)

(*"So first, it's the credibility of the AI because there are many new AIs operating, the data dictionary from AI may be limited. So, the accuracy of the information we need may not be what we expect."* – Participant 3)

Excessive Tool Dependency

The excessive use of technology is one of the things that needs to be considered in this continuously evolving digital era. The advancement of technology such as AI can lead to over-dependence on the technology given the many things that can be solved using AI-based tools. This may indirectly affect the abilities of its users, such as the decay of critical thinking skills and adaptability when faced with new or unexpected situations, as stated by one of the following analysts:

(*"... So, when we encounter problems with different users or for example with different systems, we are worried that if we depend too much on AI, AI will not be a supporting tool, but instead will be the main character. In our system, if in the future we were transferred to another office, we might be unable to adapt to the standards of the new office."* – Participant 3).

Data Security and Privacy

Concerns about data security and privacy are something that needs to be underlined especially when using AI-based tools. Some users feel anxious when they process data on these tools because it is possible that the tools they use are vulnerable to misuse or privacy violations which will have a negative impact on the company where they work. This was stated by several analysts:

(*"... maybe for the paid tools it is safe because maybe when purchasing the license there is a statement that the data will be safe. Now maybe for the tools that are used for free, we don't know whether the data can also be accessed by other people who use the same tools."* – Participant 4).

(*"the biggest risk is probably back to data security. So, if for example, when we collect from various sources using AI, if the security is not secure, it could turn back to the company."* – Participant 5)

Key Factors that Influence Analysts Decisions in Using AI-Based Tools in the Analysis Phase in SDLC

Time Efficiency

AI-based tools are known to be able to create efficiency in various work processes. For example, some AI-based tools can be used to process and analyze a large number of text documents in a short time, which previously would have taken a long time if done manually. Another example, some AI tools can be utilized for faster decision-making due to their ability to provide suggestions that may be valuable to the user. Several analysts explained their needs in using these AI-based tools, especially when it comes to time issues:

(*"Why do I use the tools themselves because it can cut quite a lot of time. So, for example, in analogy, I usually need 4 hours to determine the best practice, but with a matter of minutes or seconds, depending on how fast I click, I can get the best practice."* – Participant 2)

(*"... we are racing against time while the requests from users are many and sometimes change."* – Participant 3).

No Requirement from the Company

The use of a new technology or breakthrough within the company often requires a strict approval process. Generally, when a company is going to adopt new technology, the company needs to first evaluate both the urgency or need from internal and external sides, the benefits obtained, the risks of implementing the technology, the availability of resources, and other factors. This time-consuming process can make some companies reluctant to adopt new technology. One analyst explained:

(*"Until now, we haven't, because our company itself does not require us to use AI. It seems that there are no decisions or others related to AI, so now we are still manual. Personally, I want to try it, it's just because in a professional environment, we must raise the issue if we want to propose a new method for using AI and it must be approved by many parties. So, from my own side, it is constrained because the IT department itself has no intention of using AI."* – Participant 1).

Inadequate Budget

Adequate budget allocation is necessary for the successful implementation or use of new technologies, including AI, in companies and organizations. However, each team and division within the Company may not be provided with an adequate budget to adopt these technologies. This can be a roadblock for teams and divisions in implementing such technologies that enable improvements in the effectiveness, efficiency, and productivity of their work, as explained by one of the analysts:

(*"... each division and team are given a budget. Well, maybe it's not enough to include the budget for implementing AI."* – Participant 4).

Not required by the users and internal

The use of technology such as AI is not always an absolute necessity for users or internal parties of a company. Any decision to adopt something that may affect operations or projects needs to be evaluated first. Sometimes, a simpler solution may be enough to meet the user's needs and expected goals. Some analysts argue:

(*"My team has never used it, because maybe my users are more internal, so it doesn't need much analysis, because it just affects the internal parties. Maybe if it's for another team that goes to students, maybe it is necessary to use Ai."* – Participant 4).

("*At the moment, maybe our company does not need it and the requirements of the users themselves do not need it. And for data analysis our company also has another team such as data analytics which usually handles data needs. For example, for certain needs, they who usually collect data and those who are the ones who handle the analysis*" – Participant 5).

Discussion

The results of this study show that most analysts see a positive impact of using AI-based tools, especially in the analysis stage of software development activities. The benefits identified include an increase in efficiency as well as ease in the work process. In addition, an increase in productivity and savings in time to complete a task were also advantages highlighted by analysts. For some analysts who have never used these tools, the adoption of these tools in their work process, especially for the analysis process in software development activities is something to look forward to in the future given some of the advantages offered by the tool. The results of this study are similar to study conducted (Job 2021) which shows that the application of AI techniques has a significant impact on various stages in software development activities, especially in the testing stage. The study states that the use of AI tools allows automation in the software testing process which helps to increase the overall scope of testing and ensure the quality produced through the testing process and error detection with a relatively faster time when compared to the testing process carried out manually. In addition, AI tools are also expected to be able to test with fewer possible errors so that the results provided can be more accurate.

Although the use of AI tools is considered to have a positive influence on software system development activities, this is certainly inseparable from the obstacles and challenges that may be faced by users of

these tools. The first possible challenge faced from the use of AI-based tools for analysis needs in software development relates to the familiarity of the tools used. Some companies or organizations that have been running for a long time may see AI-based tools as something new to be adopted in their environment. This leads to a lack of familiarity with and understanding of how to use these tools among their employees. In addition, adequate training is also required for companies that intend to adopt such technology. This finding is in line with the result of other study (Shang et al. 2023) which explains that lack of knowledge on AI technologies and applications and lack of skilled and trained employees are two of several other barriers to the adoption of AI in the scope of project management. This is due to the use of AI systems that are still relatively new in their industry where familiarity with the use of AI itself is still lacking. Then, the next possible challenge relates to the results provided by these tools. Although AI is considered capable of completing a variety of tasks, some analysts think that the results provided by these tools are not 100% accurate and credible, which hinders the use of these tools in supporting their work. This finding is in line with the results obtained in other study (Fui-Hoon Nah et al. 2023) which explains that there are several challenges in using generative AI-based tools, specifically regarding to the output produced. The obstacles referred to in the study are the accuracy of the results generated and the explainability of the results provided which may make it difficult for users to understand the results they get which can lead to a sense of distrust of the tools. The third possible challenge identified in this research is over-reliance. The growing capabilities of AI-based tools cause some people to focus too much on using the tools, rather than their "real" work. This result is in line with the findings of study conducted (Bird et al. 2022) which explains that the use of AI-based tools involved in software development tasks makes developers spend too much time focusing on the results obtained from these tools compared to the completion of the tasks they should be doing. The last possible challenge identified in this research relates to data security and privacy. Data processed through AI-based tools raises concerns for some parties regarding the risk of misuse and violation of the privacy of the data they provide. Similar findings were also presented in the study (Murdoch 2021) which highlighted concerns about the misuse of personal data that needs to be protected, such as medical information. In the context of software development activities, especially when conducting analysis, some analysts share the same concerns about the misuse of company data provided when they use AI-based tools.

With some consideration of the positive and negative impacts, as well as the possible challenges faced in its implementation, this study successfully identified several key factors that influence the use of AI-based tools, especially during the analysis phase of a software system development activity. These factors are divided into two main aspects, namely internal and external considerations. From the internal perspective, the time factor was identified to encourage the use of AI technology. This is due to the ability of AI that can complete complex and dynamic tasks in a relatively faster time when compared to completing these tasks manually. This finding is consistent with the results of other study conducted (Barenkamp et al. 2020) which explains that the use of AI in various phases of the SDLC allows time savings in these phases and can help improve the quality of the output provided. This is possible with AI's ability to provide valuable suggestions and automate the work of certain tasks.

From the external side, the key factors identified are more directed towards the factors that influence analysts' decisions not to use the tools. The first factor relates to the absence of Company requirements to use the technology. Adopting a new technology that has never been used in the operational activities certainly requires many considerations. The lack of support from top management makes the adoption of these technologies low. Then, the second factor that influences the analyst's decision not to use this technology is that there is no urgency either from the user or internal side to use this technology. This is due to the requirement of each of these parties, which does not require complex technology and is sufficient to be completed with existing technological resources. These two factors are in line with the findings of a study (Shang et al. 2023) where the study showed that the lack of need for adoption and lack of support from project stakeholders are several things that become obstacles in the adoption of AI technology in the scope of project management. The last factor influencing the decision to use this technology is the limited resources available, specifically financial resources. This result is consistent with the findings in the study (Alsheiabni et al. 2019) which shows that lack of funding is one of the hindrances faced in the adoption of AI within the organizational scope. Lack of funding is one of the crucial factors in the successful implementation of new technologies in companies and organizations.

However, in many cases, each team or division is not necessarily provided with an adequate budget to adopt the technology.

Conclusion

This research was conducted to explore the understanding regarding the use of AI-based tools in the context of SDLC, particularly in the analysis process. To support the objectives of this study, the researchers conducted qualitative study by exploring the perceptions of analysts through semi-structured interviews. Based on the results of the interviews conducted, there were several findings related to the research questions.

First, all analysts have a positive perception of the use of AI-based tools in the analysis process in SDLC. This is supported by the availability of various AI tools such as Chat GPT or other AI-based tools that can summarize PDF files and provide valuable suggestions for analysts. Additionally, several benefits of integrating AI-based tools in the analysis process, particularly in requirements gathering, have been identified, including that AI-based tools can simplify the requirements gathering process, especially for general or small requirements, thereby allowing analysts to focus on more important things, such as technical aspect. AI can also help the analysis process become faster and more efficient because it can save time in the requirements gathering process. For analysts who have never directly used these tools, this is something they are enthusiastic about and hope to use in the future.

For the second finding, it can be concluded that some of the main challenges that an analyst may face when using AI-based tools are related to familiarity and how to use the tools, the quality and credibility of the data produced, dependence on tools that can reduce user skills, and there are concerns about data security and privacy.

For the latest findings, there are several factors that influence analysts' decisions in using AI-based tools, especially for conducting analysis. The time factor is known to be the main factor influencing analysts' decisions in using the help of this AI-based tool. This is because these tools can help cut a lot of time from the process carried out. In addition to the factors that influence use, there are also factors that influence an analyst's decision not to use these tools. Some of these factors include the absence of company necessity for adopting these technologies, insufficient funding for their adoption, and lack of need from users or internal parties for their use.

Implication

This study makes several contributions, both theoretically and practically. From a theoretical perspective, this study contributes to the literature in the context of AI integration in SDLC, specifically highlighting the analysis phase. This study shed lights on the perceptions, possible challenges, and key factors that influence the adoption of AI-based tools by analysts in software development activities. The insights provided broaden the understanding of the SDLC by incorporating the potential role and impact of AI technologies and offer a different perspective on how AI can enhance software development practices. In addition, this study also provides a strong foundation for future research in technology adoption, particularly in the fields of AI and software development by highlighting the theoretical discourse on technological resistance and facilitation in organizational settings.

From a practical perspective, this study contributes by providing insights to software development teams, organizational and project leaders, and AI-based tool developers on what can be addressed to emphasize the use of AI in the SDLC. By understanding user perceptions, benefits, challenges, and key factors affecting the adoption of AI-based tools in organizations, stakeholders can create appropriate strategies regarding the adoption and use of AI in software development. This study emphasizes the importance of a comprehensive training program to address the issues of employee familiarity and adaptation to AI-based tools if companies want to adopt AI technology in their work process. Furthermore, the study also underscores the need for a strategic approach to resource allocation and policy design to encourage the integration of AI in software development activities.

Limitation and Future Work

Although this study provides valuable insights into how analysts perceive the use of AI-based tools in SDLC, this study has certain limitations. This study only focused on a relatively small group of participants, involving only business and system analysts, thus limiting the generalizability of the findings to the various roles involved in SDLC and various industry sectors. Future research can broaden the scope of roles of participants and industries represented to ensure that the findings can be more generalized to the population studied. Furthermore, this study only involved qualitative methods in the process. Future research is expected to conduct quantitative research to complement and validate the findings in this study. In addition, longitudinal studies can be carried out to observe how the perception and development of integrating AI-based tools in the SDLC change over time.

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