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The Impact of AI-Based Chatbot Customer Service on Customer Loyalty: The Mediating Role of Customer Satisfaction, Customer Engagement, and Perceived Service Efficiency at Bank X

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Abstract: AI-based chatbot services are believed to be one of the channels that can enhance customer loyalty in the banking sector. This research aims to investigate the impact of implementing AI-based customer service chatbots at State-Owned Bank X on customer loyalty, with customer satisfaction, engagement, and perceived efficiency acting as mediating variables. This study applies a quantitative cross-sectional method by collecting both descriptive and empirical data through surveys, in which questionnaires were distributed to respondents. The research population consists of customers of State-Owned Bank X, totaling 154 million. The sample was selected using a purposive sampling technique, targeting existing customers who use the AI-based chatbot service, resulting in 430 valid responses collected between October and November 2024. The data collected were analyzed using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method. This study is expected to demonstrate that customer satisfaction, customer engagement, and perceived efficiency function as mediators in the relationship between chatbot usage and customer loyalty. The mediating roles of customer satisfaction, engagement, and perceived efficiency are anticipated to significantly contribute to improving customer loyalty through the use of AI-based chatbots. Therefore, it is essential for the company to strategically integrate and manage AI-based chatbot services, along with customer satisfaction, engagement, and perceived efficiency variables, in every chatbot implementation to achieve the goal of enhancing customer loyalty.

Keywords: Chatbot, Efficiency, Engagement, Satisfaction, Loyalty, Customer Perception

INTRODUCTION

Chatbots, or conversational agents, have developed significantly in recent years due to the advancement of Artificial Intelligence (AI) technology. The use of chatbots has now penetrated various fields, including customer service, digital assistance, product

recommendations, and more (Dale, 2016). The history of chatbots dates back to 1966, when Joseph Weizenbaum created the first functional chatbot, ELIZA, which simulated the behavior of a psychotherapist. A major development occurred in the 2010s, when chatbots began to handle more complex conversations compared to traditional rule-based methods. With continuous improvements in capabilities, researchers predict that the use of chatbots will continue to expand. According to Følstad et al. (2018), chatbot development is expected to become the main interface for various services and revolutionize the way humans communicate with machines.

In the continuously evolving digital era, artificial intelligence (AI) technology has become one of the most transformative innovations, influencing various aspects of life (Eziamaka et al., 2024), including the way companies interact with their customers. The application of AI in customer service has reshaped the landscape of customer experience, offering new opportunities to enhance efficiency, personalization, and customer satisfaction (Kumar et al., 2019).

AI-based customer services, such as chatbots and virtual assistants, are increasingly being used by companies across various industries (Kumar et al., 2019). One of the sectors that has adopted AI-based chatbot services is the banking industry. These services are believed to be one of the channels that can strengthen customer loyalty (El-Shihy et al., 2024). However, one of the state-owned banks in Indonesia has recorded the lowest Customer Loyalty Index in the banking industry at 68.5%, slightly below the 2024 industry average of 69.9% (Satisfaction Loyalty Engagement Report, 2024). One of the services that needs to be optimized to support the improvement of the Customer Loyalty Index is the chatbot. This is in line with the argument of Marketing Research Indonesia in the 2024 Satisfaction Loyalty Engagement report, which highlights that the bank's ability and speed in providing solutions when customers encounter problems are crucial to increasing customer satisfaction and loyalty at State-Owned Bank X.

This study aims to examine the impact of AI chatbot experiences on customer loyalty. Customer loyalty is a key factor in long-term business success (Rane et al., 2023). Loyal customers typically make repeat purchases, recommend products or services to others, and provide valuable feedback (Hidayatullah, 2024). Conversely, customer dissatisfaction can damage a bank's reputation and reduce its customer base. Therefore, understanding the factors that influence customer loyalty is essential for the company.

In addition, this research also analyzes the mediating roles of customer satisfaction, customer engagement, and perceived efficiency in the relationship between AI chatbot experiences and customer loyalty. Customer satisfaction refers to the extent to which customers are satisfied with the products or services they receive (Suchánek & Králová, 2019). Customer engagement refers to the extent of meaningful and intensive interaction between customers and companies (Brodie et al., 2011). Meanwhile, perceived efficiency reflects customers' evaluation of how efficient and effective the services they receive are.

By understanding the relationship between AI chatbot experiences, customer satisfaction, customer engagement, perceived efficiency, and customer loyalty, companies can design more effective strategies to enhance customer experiences and build long-term relationships.

Hypothesis Development

Based on the literature review presented earlier, the following section proposes the research model. The model illustrates the relationships among the key variables and the hypotheses to be tested.

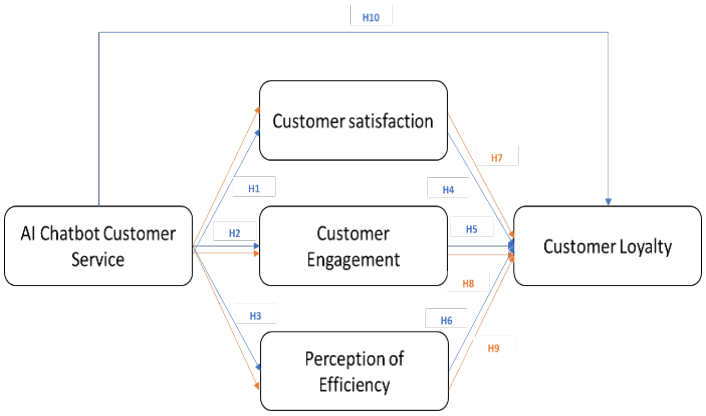

Figure 1. Research Model

Artificial Intelligence (AI), which refers to technologies that enable machines to replicate human abilities, is increasingly applied across various services and has become a major source of innovation. The use of chatbots integrated into company websites for customer service is becoming increasingly crucial, as AI significantly impacts many aspects of daily life, including the customer service sector.

Although chatbots can enhance responsiveness in customer service, there are still many challenges that need to be addressed. Common issues include the chatbot's inability to recognize the core intent of customer inquiries and its lack of flexibility in responding to more complex situations.

The development of AI-based services, such as chatbots, utilizes computer-based intelligence to simplify tasks. Chatbots help customers obtain information and receive responses to their inquiries without requiring human intervention, thus saving time and effort. The implementation of AI-based chatbots provides customers and businesses with automated solutions to address questions and meet needs. These systems offer 24/7 accessibility, improving customer service and support. Automated systems enable instant communication, provide accurate answers, and streamline processes—ensuring that businesses remain accessible at all times, which ultimately drives improvements in customer satisfaction and engagement. Customers can contact businesses using chatbots on their mobile devices anytime, from any location, and receive quick and personalized responses to their questions or problems.

This study aligns with the findings of Shaikh et al. (2023), who reported that optimal service through the implementation of AI chatbots has a significant impact on customer satisfaction. Similarly, Yun and Park (2022) found that AI-based customer service strongly influences customer satisfaction. In addition, Kim and Chang (2020) highlighted that AI-based customer service significantly affects customer satisfaction, while customer engagement in chatbot services plays an important role in influencing the intention to reuse chatbots. Satisfaction and reliability gained from chatbot services encourage customers to continue using them, particularly when the chatbot is perceived as trustworthy, thereby reinforcing the intention to reuse.

H1: AI-Based Chatbot Customer Service positively influences Customer Satisfaction.

Customer service plays a significant role in increasing customer engagement. High-quality customer service—whether through direct interaction or AI-based media such as chatbots—can create an intensive and meaningful experience for customers. Customer

engagement is defined as intensive interaction between customers and companies, often fostered through customer service or the products offered (Brodie et al., 2011). With fast, responsive, and effective customer service, customers feel that the company acknowledges their needs and provides relevant solutions promptly. This contributes to increased customer engagement, as they feel more connected to and valued by the company.

AI-based chatbot customer service enables customers to quickly obtain information and solutions without long waiting times, thereby enhancing their perception of efficiency and encouraging deeper engagement (George et al., 2024). Such responsive service also fosters a positive perception of the company and influences customers' decisions to continue using the service. Research by Shaikh et al. (2023) stated that efficient customer service significantly influences customer engagement, as successful and satisfying interactions motivate customers to engage further with the company.

In a study by Gao and Huang (2021), customer engagement was identified as a key factor mediated by the quality of omnichannel integration in strengthening customer loyalty. Consistent and high-quality customer service across both physical and digital platforms encourages customers to engage more deeply with the company. This hypothesis emphasizes that high-quality customer service—delivered through both in-store and digital platforms—facilitates customer engagement both psychologically and behaviorally.

H2: AI-Based Chatbot Customer Service positively influences Customer Engagement.

The relationship between perceived service efficiency and customer satisfaction in the context of AI-powered customer service is evident. Customer satisfaction is influenced by their perception of how efficiently AI systems resolve problems and provide relevant support (Kumar et al., 2024). On the other hand, engaging and satisfying interactions with AI systems reinforce customers' perceptions of their effectiveness. Perceived efficiency and customer satisfaction are both critical factors in building loyalty through the development of trust, the fulfillment of expectations, and the formation of a positive brand image.

This argument is supported by the findings of Singh and Singh (2024), who stated that AI chatbot implementation in customer service significantly impacts customers' perception of service efficiency. Similarly, Tsai et al. (2024) also found that customer service through AI chatbot implementation has a significant effect on perceived service efficiency.

H3: AI-Based Chatbot Customer Service positively influences Perceived Service Efficiency.

Customer satisfaction encourages the formation of customer loyalty, which in turn can lead to repeat purchase decisions. When customers trust a particular product or service, their satisfaction reinforces their belief in the company. Satisfied customers are more likely to trust the company and recommend its services to others. From the consumer's perspective, the perception of a product or service's reliability is shaped by their experiences and how well the performance aligns with their expectations. Companies gain significant benefits when they achieve high levels of both customer satisfaction and loyalty.

This argument is supported by the findings of Azizan and Yusr (2019), who stated that customer satisfaction significantly influences customer loyalty. Similarly, studies by Almohaimmeed (2019) and Nguyen et al. (2020) also confirmed that customer satisfaction has a significant impact on customer loyalty.

H4: Customer Satisfaction positively influences Customer Loyalty.

Customer engagement refers to the active interaction between customers and a brand or company, which can be both emotional and rational in nature. According to Zaid and Patwayati (2021), customer engagement can take the form of recommendations, customer-to-

customer interactions, and participation in company-related activities. Customer loyalty, on the other hand, is a long-term commitment developed by customers toward a brand or service provider, built upon positive experiences and outcomes. Zaid and Patwayati (2021) further explain that actively engaged customers tend to exhibit higher loyalty, including a stronger willingness to make repeat purchases and recommend the brand to others. This is consistent with research by Hapsari et al. (2020), which shows that customer engagement directly increases customer loyalty.

H5: Customer Engagement positively influences Customer Loyalty.

Perceived service efficiency plays an important role in building customer trust, fulfilling expectations, and shaping a positive brand image—all of which contribute to the development of customer loyalty. Customers' perceptions of efficiency are driven primarily by how well AI systems fulfill their needs quickly and accurately. The speed, effectiveness, and reliability of AI systems collectively strengthen customers' perceptions of efficiency. Moreover, perceived efficiency has a cascading effect on customer satisfaction, which ultimately shapes customers' evaluations of the services, brands, and overall experiences they receive.

This view is supported by Rane et al. (2023b), who found that perceived service efficiency significantly mediates the relationship with customer loyalty. Similarly, Sanny et al. (2020) also reported that perceived efficiency plays a significant role in influencing customer loyalty.

H6: Perceived Service Efficiency positively influences Customer Loyalty.

Customer satisfaction strongly influences customer loyalty. When customers are not sufficiently satisfied with their transaction experiences involving a product or service, they tend to share negative experiences, which can lead to the spread of unfavorable word-of-mouth and potentially damage loyalty toward the product or company. Conversely, satisfied customers are more likely to feel comfortable, share positive experiences, and strengthen their loyalty to the product or service.

This argument is supported by the findings of Yudani and Yasa (2024), who reported that customer satisfaction significantly mediates the relationship with customer loyalty. Similarly, Sudarso et al. (2023) confirmed that customer satisfaction plays a mediating role in enhancing customer loyalty.

H7: Customer Satisfaction mediates the influence of AI-Based Chatbot Customer Service on Customer Loyalty.

Customer engagement creates stronger emotional bonds between customers and companies. This contributes to increased loyalty, as engaged customers tend to use the same service more frequently, recommend the company to others, and remain committed to the brand (Brodie et al., 2011). Research also shows that customer service delivered through AI-based chatbots can drive intensive engagement and, in turn, enhance customer loyalty (George et al., 2024).

Customer engagement acts as a significant mediator because customer service can create a deeply engaging and satisfying experience. As a result, the impact on loyalty becomes stronger. Engagement derived from efficient and responsive service builds customer trust, ultimately encouraging them to continue using the company's services sustainably (Shaikh et al., 2023).

Furthermore, customer engagement has also been proven to positively influence the acceptance of omnichannel programs, which in turn strengthens customer loyalty. Gao and Huang (2021) emphasized that customer engagement—both psychological and behavioral—is

a critical factor that enables omnichannel retailers to build strong, sustainable interactions that enhance customer loyalty.

H8: Customer Engagement mediates the influence of AI-Based Chatbot Customer Service on Customer Loyalty.

Customers' perceptions of service efficiency in AI-based chatbots play a key role in shaping customer satisfaction (Hsu & Lin, 2023). The speed, accuracy, and ability of chatbots to handle routine inquiries all contribute to perceived efficiency. Customers who view chatbots as efficient in delivering services are more likely to experience higher satisfaction levels. Singh and Singh (2024) also found that AI-based customer service has a positive and significant impact on perceived efficiency, which subsequently influences satisfaction and ultimately fosters customer loyalty.

Perceived efficiency and customer satisfaction together can build trust, fulfill expectations, and create a positive brand image, all of which strengthen customer loyalty. This perspective aligns with Rane et al. (2023b), who reported that perceived efficiency mediates the relationship with customer loyalty. Similarly, Sanny et al. (2020) also confirmed that perceived efficiency serves as a mediating factor in customer loyalty.

H9: Perceived Service Efficiency mediates the influence of AI-Based Chatbot Customer Service on Customer Loyalty.

Chatbots offer several advantages, including 24/7 availability, quick responses, time efficiency, reduced human error, and support for businesses in enhancing customer loyalty. Their adaptability further demonstrates their ability to keep up with evolving customer needs (Tulcanaza-Prieto et al., 2023). One of the key dimensions of chatbot service quality is the ability to deliver accurate, relevant, and valuable information to customers at the right time.

This view is supported by El-Shihy et al. (2024), who found that customer service delivered through AI chatbot implementation significantly impacts customer loyalty. Similarly, Supriyanto et al. (2021) emphasized that AI chatbot-based customer service has a substantial influence on customer loyalty. In the same vein, Rane et al. (2023a) reported that the implementation of AI chatbots in customer service contributes significantly to enhancing loyalty.

H10: AI-Based Chatbot Customer Service positively influences Customer Loyalty.

According to Widiaswara and Sutopo (2021), when consumers experience satisfaction, they will continuously use the product regardless of the price offered by the company or services provided by other parties. Similarly, Agiesta et al. (2021) stated that customer loyalty can generate business profits without requiring additional promotional costs to attract new users. Therefore, customer satisfaction is an important factor in supporting the formation of customer loyalty.

METHOD

This study adopted a quantitative causal research design, grounded in the positivism paradigm, to investigate the proposed relationships. The sample was obtained through non-probability purposive sampling, using contact and email databases provided by State-Owned Bank X. Data were collected with structured research instruments and analyzed using statistical techniques to test the predetermined hypotheses.

The sample size was determined using the 10-times rule (Memon et al., 2020), yielding 340 respondents based on 34 measurement indicators (10 × 34). This number exceeds the

minimum requirement for Structural Equation Modeling (SEM), which is generally 100–150 participants (Hair et al., 2017).

This study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) as the data analysis method, which enables the assessment of both direct and indirect effects within the specified mediation model. Mediation analysis was conducted to examine whether perceived service efficiency and customer satisfaction mediate the relationship between AI-based customer service chatbots and customer loyalty. In addition, the measurement indicators for each research variable were adapted from previous studies, as outlined below.

Table 1. Operationalization Variables Study

Variables	Indicator
Customer service refers to activities across all business sectors aimed at integrating the ordering process, processing, and delivery of services through communication, in order to strengthen relationships with consumers. In this study, it is implemented through AI-based chatbot services (Lupiyoadi, 2006).	Speed of Response (LPC1)
	Effectiveness (LPC2)
	Comfort (LPC3)
	Service Reliability (LPC4)
	Technological Perception (LPC5)
	Positive Experience (LPC6)
Customer satisfaction is defined as the positive emotional response of customers toward their experience with a company's products or services (Kencana, 2022).	Service Satisfaction (KEP1)
	Fulfillment of Service Expectations (KEP2)
	Improvement in Satisfaction (KEP3)
	Positive Impression (KEP4)
	Customer Recommendation (KEP5)
	Contribution of Services to the Company (KEP6)
	Interaction Satisfaction (KEP7)
	Overall Service Satisfaction Level (KEP8)
Perceived efficiency is defined as the customer's evaluation of how effective and efficient a company is in fulfilling their needs and expectations (Lee & Park, 2019).	Efficiency (PEL1)
	Timely Response (PEL2)
	Quality of Interaction (PEL3)
	Problem Resolution (PEL4)
	Service Accuracy (PEL5)
	Service Effectiveness (PEL6)
	Service Efficiency (PEL7)
Customer loyalty is a set of harmonious attitudes reflected in consistent purchase behaviors that are systematically beneficial to one entity compared to its competitors (Watson et al., 2015).	Customer Loyalty (LOP1)
	Brand Loyalty (LOP2)
	Influence on Decision-Making (LOP3)
	Customer Trends (LOP4)
	Customer Commitment (LOP5)
	Brand Preference (LOP6)
	Long-Term Commitment (LOP7)
	Product Loyalty (LOP8)
Customer engagement is defined as intensive and meaningful interaction between customers and companies, often occurring through customer service or product usage (Brodie et al., 2011).	Adaptability (KTP1)
	User Experience (KTP2)
	Accessibility (KTP3)
	Feature Superiority (KTP4)
	Service Recommendation Quality (KTP5)
	Information Exchange (KTP6)

RESULTS AND DISCUSSION

Summary of Respondents' Characteristics

The characteristics of respondents in this study describe the profile of customers who use the chatbot service at State-Owned Bank X. The descriptions include gender, age, education, and occupation.

Gender

Differences in consumer behavior, including responses to messages delivered through mass media, may be influenced by factors such gender, region, socioeconomic class, and other factors (Adler & Rodman, 2009). Among these, gender is often a key determinant of consumers' purchasing or product usage decisions. The distribution of respondents by gender is presented in the following table.

Table 2. Percentage of Respondents by Gender

Gender	Frequency	Percentage (%)
Female	206	60,59
Male	134	39,41
Total	340	100

The results show that the respondents consisted of 134 men (39%) and 206 women (61%). This suggests that users of the State-Owned Bank X chatbot are predominantly female. These findings are consistent with Sofyan et al. (2024), who reported notable gender differences in chatbot usage decisions, with women demonstrating greater influence in choosing to adopt banking products.

Age

Individuals in younger age groups generally demonstrate stronger abilities to interact and actively seek information from others. Consistent with Abdillah et al. (2020), millennials (young adults) are regarded as being more adept at using technology, including chatbots, to support product-related services. Moreover, educational attainment and the capacity to acquire new information also serve as reinforcing factors in this context.

Table 3. Percentage of Respondents by Age

Age (Years)	Frequency	Percentage (%)
<25	38	11,18
25-35	122	35,88
35-45	180	52,94
Total	340	100

The results indicate that more than half of the respondents (53%) are in the productive age group of 35–45 years. Age has long been recognized as an important factor influencing physical capacity and openness to innovation, where younger people are generally more responsive and physically stronger than older ones (Suratiyah, 2015). Consistent with prior studies (Polama et al., 2020; Iski et al., 2015; Nguyen & Luu, 2013), age significantly shapes access to and use of technology. In the context of this study, it also affects both the adoption rate and frequency of chatbot utilization.

Education

Slamet (2003) defines education as an effort to bring about changes in human behavior, while Soeitoe (1982) describes it as an organized process designed to achieve observable behavioral changes. Education is also regarded as an indicator of human resource quality.

In this study, education refers to the formal educational levels completed by respondents who use the State-Owned Bank X chatbot. Respondents' educational attainment is classified into three categories: Elementary School (SD), Secondary School (Junior High School/Senior High School), and Higher Education (University/College). The distribution of respondents by educational background is presented in the following table.

Table 4. Percentage of Respondents by Education Level

Level of education	Frequency	Percentage (%)
Elementary School (SD)	4	1,18
Junior High School (SMP)	67	19,71
Senior High School (SMA)	89	26,18
Higher Education (PT)	180	52,94
Total	340	100

The findings indicate that more than half of the respondents (53%) have a higher education background. This is consistent with Lestari et al. (2022), who observed that bank customers are largely drawn from communities with a bachelor's degree, and with Latifah et al. (2020), who reported that 94% of e-commerce users possess higher education qualifications.

Individuals with higher education are typically more receptive to technological change, particularly in adopting online banking services. They are generally more confident in using digital products and face fewer barriers when conducting online transactions. As emphasized by Rakasyifa and Mukti (2020), education is a critical factor influencing decision-making, including the choice to adopt chatbot-based services.

Occupation

Occupation plays a significant role in daily life as it enables individuals to meet their needs. In this study, occupation refers to the primary profession of the respondents. The distribution of respondents' occupations is presented in the following table.

Table 5. Percentage of Respondents by Occupation

Occupation	Frequency	Percentage (%)
SOE/Civil Servant (BUMN/PNS)	117	34,41
Private Sector Employee	136	40,00
Other	87	25,59
Total	340	100

The results indicate that the largest proportion of respondents are private-sector employees, representing 40% (136 individuals), followed by state-owned enterprise (SOE) and civil servant employees at 34%. The variety of occupational backgrounds including students, civil servants, private-sector employees, and entrepreneurs shows that banking chatbot users come from diverse professional groups. This suggests that chatbot adoption is not limited to a particular occupation. These findings are consistent with Lestari et al. (2022), who found that most chatbot users are employed in the private sector.

The Influence of AI-Based Chatbot Customer Service on Customer Loyalty at State-Owned Bank X

The influence of AI-based chatbot services on customer loyalty was analyzed using a structural model developed through Structural Equation Modeling (SEM) with the Partial Least Squares (PLS) approach. This method provides a systematic framework for examining correlations and their effects, whether positive or negative, and assessing their level of significance. The analysis in this section focuses on the significance of these effects, both individually (partial) and collectively (simultaneous).

The evaluation of the measurement model involved tests of individual item reliability, internal consistency (composite reliability), average variance extracted (AVE), and discriminant validity. The first three criteria are grouped under convergent validity. Item reliability, or indicator validity, was assessed using the loading factor value (standardized loading), which reflects the strength of the correlation between each indicator and its construct. A loading factor above 0.7 is considered ideal, indicating that the indicator reliably measures

the construct. Nevertheless, values above 0.5 are still acceptable, whereas indicators with values below 0.5 should be removed (Chin, 1998).

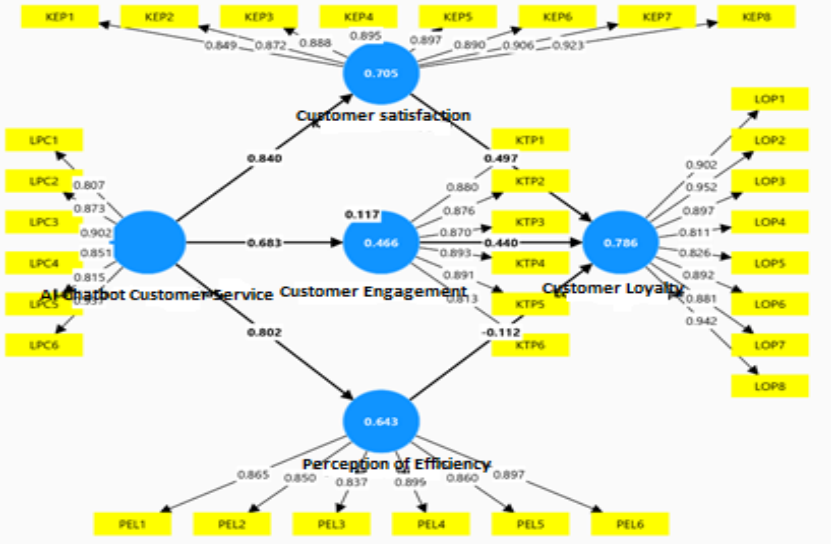

Figure2. PLS-SEM Algorithm Results

Based on Figure 2, all loading factor values are above 0.5, therefore, no indicators need to be excluded. This result confirms that each indicator is valid and adequately represents its corresponding latent variable.

Convergent Validity Analysis

Convergent validity was assessed using the outer loading values. An indicator is considered valid when its outer loading exceeds 0.7. The results show that all indicators in this study have loading factors above the threshold, demonstrating a strong relationship between each indicator and its respective construct. Accordingly, the indicators for AI-based chatbot customer service, customer satisfaction, customer engagement, perceived efficiency, and customer loyalty are valid and suitable for further analysis.

Construct Reliability and Validity

Table 6. Construct Reliability and Validity

Variables	Cronbach's alpha	Composite reliability (rho_a)	Average Variance Extracted (AVE)
Customer satisfaction	0.963	0.963	0.793
Customer engagement	0.936	0.937	0.758
AI chatbot customer service	0.933	0.943	0.749
Customer loyalty	0.962	0.965	0.79
Perceived Service Efficiency	0.935	0.938	0.754

Source: SMART-PLS output

A variable is considered reliable if its Cronbach's alpha value exceeds 0.6. As shown in Table 6, all variables have Cronbach's alpha values above this threshold, indicating that they demonstrate strong reliability.

Furthermore, a variable is also considered reliable if the composite reliability (CR) value is greater than 0.7, which is commonly applied in confirmatory research. For exploratory studies, CR values between 0.6 and 0.7 are acceptable. Based on Table 6, the CR values of all variables are above 0.7, confirming the reliability of the variables used in this study.

The Average Variance Extracted (AVE) is used to assess data validity. A variable is considered valid if its AVE value exceeds 0.5. As shown in Table 6, the AVE values of all five variables are above this threshold, indicating that each variable in this study demonstrates good validity.

Inner Model

The R-Square value is used to evaluate the explanatory power of the inner model. An R-Square above 0.70 indicates a strong model, above 0.50 indicates a moderate model, and above 0.25 indicates a weak model. In general, the higher the R-Square value, the better the model explains the variance of the dependent variable.

Table 7. R-Square

	R-square	R-square adjusted
Customer Satisfaction	0.705	0.7
Customer Engagement	0.466	0.457
Customer Loyalty	0.786	0.77
Perceived Service Efficiency	0.643	0.636

Source: SMART-PLS output

Based on Table 7, the AI chatbot customer service variable explains 70.5% ($R^2 = 0.705$) of customer satisfaction, 44.6% ($R^2 = 0.446$) of customer engagement, and 64.3% ($R^2 = 0.643$) of perceived service efficiency. Furthermore, AI chatbot customer service—through customer satisfaction, customer engagement, and perceived efficiency—explains 78.6% ($R^2 = 0.786$) of customer loyalty. Since this value exceeds 0.70, the model in this study can be categorized as strong.

Hypothesis Testing

The significance of the relationships between constructs was assessed using path coefficients, where the sign of each coefficient must align with the hypothesized direction. To determine statistical significance, a t-test (critical ratio) was performed through the bootstrapping resampling method.

This study applied a 5% significance level ($\alpha = 0.05$) with a critical t-value of 1.96. Accordingly, the decision rule for hypothesis testing is as follows: if the t-statistic > 1.96 and the p-value < 0.05, the hypothesis is accepted.

The results of hypothesis testing for both the inner and outer models are presented in the following table.

Table 8. Hypothesis Test Results

	Hypothesis	Original sample (O)	T statistics	P values	Significance
H_1	AI-Based Chatbot Customer Service → Customer Satisfaction	0.840	19,366	0.000	Significant
H_2	AI-Based Chatbot Customer Service → Customer Engagement	0.683	11,442	0.000	Significant
H_3	AI-Based Chatbot Customer Service → Perceived Service Efficiency	0.802	14,304	0.000	Significant

H_4	Customer Satisfaction → Customer Loyalty	0.497	2,865	0.004	Significant
H_5	Customer Engagement → Customer Loyalty	0.440	3.018	0.003	Significant
H_6	Perceived Service Efficiency → Customer Loyalty	-0.112	0.662	0.508	No Significant
H_7	AI-Based Chatbot Customer Service → Customer Satisfaction → Customer Loyalty	0.417	2,788	0.005	Significant
H_8	AI-Based Chatbot Customer Service → Customer Engagement → Customer Loyalty	0.300	2,809	0.005	Significant
H_9	AI-Based Chatbot Customer Service → Perceived Service Efficiency → Customer Loyalty	-0.090	0.653	0.514	No Significant
H_{10}	AI-Based Chatbot Customer Service -> Customer Loyalty	0.745	15.158	0.000	Significant

Source: SMART-PLS output

1) H1: AI-Based Chatbot Customer Service Positively Influences Customer Satisfaction.

Based on Table 6, the T-statistic value is 19.366 > 1.96, the p-value is 0.000 < 0.05, and the original sample value is positive. This indicates that an increase in the independent variable leads to an increase in the dependent variable. Therefore, H1 is accepted, confirming that customer service has a positive effect on customer satisfaction. This finding is consistent with Kim and Chang (2020), who found that AI-based customer service significantly influences customer satisfaction. Customer engagement in chatbot services is also an important factor in the intention to reuse chatbots. Satisfaction and reliability obtained through services encourage users to reuse chatbot services, particularly when the chatbot is perceived as reliable, which further strengthens the intention to reuse.

2) H2: AI-Based Chatbot Customer Service Positively Influences Customer Engagement

The T-statistic value is 11.442 > 1.96, the p-value is 0.000 < 0.05, and the original sample value is positive. Thus, H2 is accepted, indicating that customer service has a positive effect on customer engagement. This finding aligns with Shaikh et al. (2023), who reported that efficient customer service significantly affects customer engagement, where successful and satisfying interactions encourage customers to further engage with the company.

3) H3: AI-Based Chatbot Customer Service Positively Influences Perceived Service Efficiency

The T-statistic value is 14.304 > 1.96, the p-value is 0.000 < 0.05, and the original sample value is positive. Thus, H3 is accepted, meaning that customer service positively influences perceived service efficiency. This result is supported by Singh and Singh (2024), who found that AI chatbot implementation in customer service significantly impacts customers' perceived service efficiency.

4) **H4 : Customer Satisfaction Positively Influences Customer Loyalty**

The T-statistic value is 2.865 > 1.96, the p-value is 0.004 < 0.05, and the original sample value is positive. Therefore, H4 is accepted, confirming that customer satisfaction positively influences customer loyalty. This finding is in line with Azizan and Yusr (2019), who stated that customer satisfaction significantly impacts customer loyalty.

5) **H5 : Customer Engagement Positively Influences Customer Loyalty**

The T-statistic value is 3.018 > 1.96, the p-value is 0.003 < 0.05, and the original sample value is positive. Therefore, H5 is accepted, indicating that customer engagement positively influences customer loyalty.

6) **H6: Perceived Service Efficiency Positively Influences Customer Loyalty**

The T-statistic value is 0.662 < 1.96, the p-value is 0.508 > 0.05, and the original sample value is negative. Thus, H6 is rejected, showing that perceived service efficiency does not have a positive effect on customer loyalty.

7) **H7 : Customer Satisfaction Mediates the Influence of AI-Based Chatbot Customer Service on Customer Loyalty.**

The T-statistic value is 2.788 > 1.96, the p-value is 0.005 < 0.05, and the original sample value is positive. Therefore, H7 is accepted, confirming that customer satisfaction mediates the relationship between customer service and customer loyalty. This finding is consistent with Sudarso et al. (2023), who reported that customer satisfaction mediates the effect of customer service on customer loyalty.

8) **H8 : Customer Engagement Mediates the Influence of AI-Based Chatbot Customer Service on Customer Loyalty**.

The T-statistic value is 2.809 > 1.96, the p-value is 0.005 < 0.05, and the original sample value is positive. Thus, H8 is accepted, showing that customer engagement mediates the relationship between customer service and customer loyalty.

9) **H9 : Perceived Service Efficiency Mediates the Influence of AI-Based Chatbot Customer Service on Customer Loyalty.**

The T-statistic value is 0.653 < 1.96, the p-value is 0.514 > 0.05, and the original sample value is negative. Therefore, H9 is rejected, indicating that perceived service efficiency does not mediate the effect of customer service on customer loyalty.

10) **H10 : AI-Based Chatbot Customer Service Positively Influences Customer Loyalty.**

The T-statistic value is 15.158 > 1.96, the p-value is 0.000 < 0.05, and the original sample value is positive. Thus, H10 is accepted, confirming that customer service positively influences customer loyalty. This result is consistent with Supriyanto et al. (2021), who found that AI chatbot implementation significantly impacts customer loyalty. Similarly, Rane et al. (2023a) also reported that AI chatbot-based customer service significantly contributes to customer loyalty.

CONCLUSION

This study confirms that the indicators used—AI chatbot customer service, customer satisfaction, customer engagement, perceived efficiency, and customer loyalty—are valid and reliable, demonstrating that the research model is appropriate. The hypothesis testing results show that customer service has a positive effect on customer satisfaction, customer engagement, perceived efficiency, and customer loyalty. Furthermore, customer satisfaction

and customer engagement both positively influence customer loyalty, while perceived efficiency does not. Mediation testing reveals that customer satisfaction and customer engagement mediate the influence of customer service on customer loyalty, whereas perceived efficiency does not.

The analysis also indicates that AI chatbot customer service explains 70.5% of customer satisfaction ($R^2 = 0.705$), 46.6% of customer engagement ($R^2 = 0.466$), and 64.3% of perceived efficiency ($R^2 = 0.643$). Through customer satisfaction, engagement, and perceived efficiency, AI chatbot customer service explains 78.6% of customer loyalty ($R^2 = 0.786$). Since this value is greater than 0.70, the structural model in this study can be classified as strong.

Despite these findings, this study has several limitations. The sample size may not fully capture the diversity of demographic and market segments, limiting the generalizability of the results. Moreover, the study was conducted in a single state-owned bank in Indonesia, which restricts the applicability of the findings to other industries. Finally, the use of subjective measures for customer satisfaction, engagement, and perceived efficiency may introduce response bias.

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