



ROLE ARTIFICIAL INTELLIGENCE (AI) IN FORECASTING AND PLANNING MANAGEMENT OF PHARMACEUTICAL PROCUREMENT IN PHARMACIES

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ABSTRACT

The rapid development of Artificial Intelligence (AI) has permeated various aspects of life, including the healthcare sector. In pharmacies, the adoption of AI is critical for enhancing operational efficiency and addressing common issues such as drug shortages and excess inventory. This study was conducted to evaluate the effectiveness of AI technology in the forecasting and planning processes of pharmaceutical procurement. This study employed a quantitative research design using a quasi-experimental method. A purposive sampling method was used to select ten pharmacies that still rely on conventional methods for pharmaceutical forecasting and procurement. Total 30 respondents were included. This study's primary instrument was a questionnaire. This study utilized primary data, which was collected directly from the research respondents. A Mann-Whitney U test was performed to assess the significance of AI use in forecasting and planning pharmaceutical procurement. The results showed a significant difference between the control group (mean rank = 11.45) and the treatment group (mean rank = 29.55). The test statistic was $U = 19.0$ with a significance value of $p < 0.001$, indicating that AI significantly improves the accuracy of procurement forecasting and planning. Furthermore, user satisfaction with the AI application was high, with 57.14% of respondents strongly agreeing and 42.86% agreeing that the technology facilitates the procurement process.

Keywords: artificial_intelligence; forecasting; procurement; pharmacy; stock management

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INTRODUCTION

The history of Artificial Intelligence (AI) is marked by the continuous development of concepts and technologies that aim to replicate human intelligence in machines (Rifai, 2021). From its foundational discoveries to its current rapid evolution, AI has profoundly impacted various sectors, including education, industry, and healthcare (Dawis, 2022). The growing public interest is evident in its widespread adoption; for instance, Indonesia ranked third globally in AI application usage between September 2022 and August 2023, with 1.4 billion visits, equivalent to 5.60% of total internet usage (Farwati, 2023). This trend highlights that integrating AI into the workplace is not merely a matter of keeping pace with technology but a necessity for enhancing operational efficiency, driving innovation, and strengthening competitiveness (Sanhaji, 2023). AI's ability to perform routine tasks with speed and accuracy far beyond human capability has led many industries, particularly healthcare, to adopt it to optimize time and resources (Pongtambing, 2023).

In the healthcare sector, the rapid advancement of AI has significantly influenced therapy management, medical diagnosis, and overall service delivery (Bosnjak, 2020). AI's capacity to analyze vast amounts of complex data and identify hidden patterns has been shown to support clinical judgment, improve decision-making, and optimize healthcare services (Trenggono, 2023). With the increasing complexity of modern healthcare systems and the limited number of healthcare professionals, AI provides a transformative solution by enhancing the quality and accessibility of services for all levels of society (Salvera, 2023). One specific healthcare service that has begun to implement AI is pharmacy management (Akzatria, 2023).

Pharmacies serve as comprehensive pharmaceutical service facilities, handling everything from procurement and stock control to drug distribution (Sanhaji, 2023). However, they frequently face critical issues such as drug shortages (out of stock) and excess inventory (overstock) (Saraswati, 2021). Drug shortages can impede patient access to necessary medication, negatively impacting their recovery, while overstocking, particularly of slow-moving drugs, leads to financial losses from accumulated inventory and potential spoilage due to expiration (Amelia, 2023). Poor procurement management results in lost sales and increased storage costs, hindering capital turnover and ultimately harming both the pharmacy's profitability and patient care (Saraswati, 2021).

To mitigate these issues, effective drug procurement forecasting and planning are essential (Werawati, 2020). This process, defined as the art and science of predicting future events, involves analyzing historical data to project future needs (Darma, 2021). Given the potential of AI to enhance these predictive capabilities, this study aims to examine the role and efficacy of AI technology in the forecasting and planning of pharmaceutical procurement in pharmacies. This research is also part of an effort to realize the fourth ASTA CITA, which is to strengthen development in the field of technology.

METHOD

Study Design

This study employed a quantitative research design using a quasi-experimental method to evaluate the effectiveness of an AI-powered application on pharmaceutical forecasting and procurement in pharmacies. The specific design utilized was a posttest-only control group design, which assessed the impact from the perspective of pharmacy staff. The AI application used in this research was PharmApp by Martadita. This application's primary feature is its AI Forecasting capability, which serves as an intelligent assistant for drug management. Its purpose is to enhance the accuracy of forecasting and planning pharmaceutical procurement, thereby preventing issues such as drug shortages or excess stock.

Population and Sample

The population of this study consisted of all pharmacies located in the Denpasar area. A purposive sampling method was used to select ten pharmacies that still rely on conventional methods for pharmaceutical forecasting and procurement. These pharmacies were chosen based on specific inclusion and exclusion criteria. Total 30 respondents were included. The selected pharmacies were then divided into two groups: the treatment group and the control group. The first five pharmacies that met the inclusion criteria were assigned to the treatment group, where they were provided with the AI application for forecasting and planning pharmaceutical procurement. The remaining five pharmacies served as the control group and continued to use their conventional methods. Data on the effectiveness of the AI tool was collected via a questionnaire distributed to the pharmacy staff in both groups.

Instruments

This study's primary instrument was a questionnaire containing questions on the effectiveness of AI in forecasting (6 questions), procurement planning (6 questions), and user satisfaction (7 questions). All questions were rated on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Data Collection

This study utilized primary data, which was collected directly from the research respondents. The respondents were pharmacy staff members responsible for forecasting and planning pharmaceutical procurement. The data collected included information on the efficiency of forecasting, the efficiency of procurement planning, and user satisfaction with the AI application.

Data Analysis

Univariate analysis was performed to describe the study variables. All data, including the level of user satisfaction, were presented in tabular form. The level of satisfaction with the AI application in forecasting and planning pharmaceutical procurement was categorized into five levels: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. The results were presented as percentages. Bivariate analysis was conducted to determine the difference between the two groups. The Shapiro-Wilk test was used to check for data normality. If the data were normally distributed, a Paired T-test would be used for the difference test. However, if the data were not normally distributed, the Mann-Whitney U test would be applied. A significant difference was defined as a p-value of <0.05.

RESULT

The research was a quasi-experimental study due to the inability to strictly control all variables. A posttest-only control group design was employed, with 10 pharmacies strategically divided into two groups. The five pharmacies in the control group and the five in the treatment group were all chosen based on predefined criteria.

Results of Validity and Reliability Test of Research Instruments

Validity tests and reliability tests are carried out on research instruments to see whether the instrument to be used is able to measure something accurately and is able to cover all variables in the research and the reliability test aims to measure the consistency of the measuring instrument to be used will provide results that are not significantly different if used repeatedly (Budiastuti & Bandur 2018).

Table 1.
Results of the Validity Test of Research Instruments

Item	r- count	r-Table	Information
1	0.748	0.361	Valid
2	0.792	0.361	Valid
3	0.578	0.361	Valid
4	0.217	0.361	Invalid
5	0.534	0.361	Valid
6	0.718	0.361	Valid
7	0.610	0.361	Valid
8	0.649	0.361	Valid
9	0.538	0.361	Valid
10	0.664	0.361	Valid
11	0.384	0.361	Valid
12	0.795	0.361	Valid
13	0.666	0.361	Valid
14	0.493	0.361	Valid
15	0.674	0.361	Valid
16	0.654	0.361	Valid
17	0.566	0.361	Valid
18	0.505	0.361	Valid
19	0.692	0.361	Valid
20	0.595	0.361	Valid

The validity of the questionnaire was tested using a sample of 30 respondents with a significance level of 5%. A question item was considered valid if its calculated r-value exceeded 0.361 and invalid if it was less than 0.361. Out of 20 question items, one item was found to be invalid as its calculated r-value was below the r-table value. (Wahyuni, V. 2022). Reliability was assessed using Cronbach's Alpha, also with SPSS 24. An instrument is considered reliable if its Cronbach's Alpha value is ≥ 0.6 . The reliability test yielded a Cronbach's Alpha of 0.900, indicating that the instrument as a whole is reliable. (Darma, B. 2021). The following table presents the reliability test results for the research instrument.

Table 2.
Reliability Test of Research Instruments

<i>Cronbach's Alpha</i>	<i>N of Items</i>
0,900	20

Results of the normality test of research data

The normality test aims to determine whether the data collected during research comes from a normally or non-normally distributed population (Darma B, 2021). The normality test is also used to determine the appropriate data analysis method. (Budiastuti and Agustinus 2018)

Table 3.
Normality Test Results

Group	<i>Shapiro-Wilk test</i>			Information
	Statistics	df	Say	
Control	0.847	20	0.005	Abnormal
Treatment	0.958	20	0.495	Normal

A Shapiro-Wilk test was performed to assess the normality of the data. The results showed that the control group data were not normally distributed, with a significance value of $p=0.005$ ($p<0.05$). In contrast, the treatment group data were found to be normally distributed, with a significance value of $p=0.495$ ($p>0.05$). Given that the overall data distribution was not normal due to the non-normal distribution in the control group, a non-parametric test, specifically the Mann-Whitney U test, was used for further analysis.

Average Test Results (Mean) from the control and treatment groups

Uji rata-rata (Mean) from the control group and the treatment group aims to find out the difference in the mean value of the control group and the treatment group from the question points asked in the research instrument

Table 4.
Results of the Mean Test of the Control and Treatment Groups

Question	Control	Treatment
A1	3	4
A2	2	4
A3	3	4
A4	3	3
A5	3	3
A6	3	3
B1	3	4
B2	3	4
B3	3	4
B4	4	3
B5	3	4
B6	3	4

Average test results (mean) control group and treatment group on the question points in the research instrument, the results obtained were that the average treatment value increased in question points A1, A2, A3, B1, B2, B3 B5 and B6. Question points A4, A5 and A6 did not increase in the treatment group and in question point B3 in the treatment group experienced a decrease in the mean value.

The results of the significance test of the use of AI in forecasting and planning the procurement of pharmaceutical preparations using the test methodMann-Whitney

The Mann-Whitney U test was used to determine the significance of the AI implementation in pharmaceutical forecasting and planning. The following are the results of the data analysis

Table 5.
Mann-Whitney Test Results

Group	N	Mean Rank	Sum of Ranks
Control	20	11,45	229,00
Treatment	20	29,55	591,00
Total	40		

Table 6.
Test Statistics *Mann-Whitney*

Test Statistics	Mark
<i>Mann-Whetney U</i>	19,000
<i>Wilcoxon W</i>	229,000
<i>WIT</i>	-4,931
<i>Asmp. Sig. (2-tailed)</i>	<0,001

The results of the Mann-Whitney U test showed a significant difference between the control and treatment groups. The control group had a mean rank of 11.45, while the treatment group had a significantly higher mean rank of 29.55. The test yielded a U-value of 19.0 with a significance value of $p < 0.001$, which is well below the significance level of 0.05. This finding indicates that the AI application had a significant positive effect on the total scores of the respondents in the treatment group.

Results of the satisfaction test of the use of AI for forecasting and planning pharmaceutical supplies

The following section presents the results of the satisfaction test, which was conducted using a Likert scale to measure respondents' agreement or disagreement with the AI application. This method employs a bipolar scale to capture both positive and negative responses to the survey questions (Ningtiyas et al., 2021). The average satisfaction scores for each question regarding the use of AI for pharmaceutical forecasting and planning are detailed below.

Table 7.
Results of AI Usage Satisfaction Test

Question	Assessment
C1	5
C2	5
C3	4
C4	5
C5	4
C6	4
C7	5

The results of the user satisfaction test regarding the AI application in pharmaceutical forecasting and planning showed highly positive outcomes. Out of the seven questions on the questionnaire, four questions (57.14%) received an average score of 5, which corresponds to "Strongly Agree" on the Likert scale. The remaining three questions (42.86%) received an average score of 4, corresponding to "Agree." These findings demonstrate that the implementation of AI for forecasting and planning has a positive impact on pharmacy operations.

DISCUSSION

This study employed a posttest-only control group design. This method was chosen for its key advantage: the absence of a pretest ensures that any observed differences between the groups are genuinely attributable to the treatment provided. Furthermore, this design mitigates the "testing effect," which can occur when participants' awareness of the study's objectives is heightened by a pretest, potentially influencing their responses (Akbar, 2023).

Validity and Reliability Test of Research Instruments

A validity test for the questionnaire was conducted using a sample of 30 respondents. With a 5% significance level and SPSS 24 software, a critical r-table value of 0.361 was obtained. An item was

considered valid if its calculated r-value exceeded 0.361 and invalid if it was below this threshold. Based on these criteria, one of the 20 question items was found to be invalid and was subsequently eliminated from the questionnaire. This occurred because the item was not consistent with the other questions and failed to measure the same underlying construct or variable (Wahyuni, V. 2022). Reliability was assessed using Cronbach's Alpha, also with SPSS 24. An instrument is considered reliable if its Cronbach's Alpha value is ≥ 0.6 . The reliability test yielded a Cronbach's Alpha of 0.900, indicating that the instrument as a whole is reliable. (Darma, B. 2021). The following table presents the reliability test results for the research instrument

Average Test Results (Mean) from the control and treatment groups

The results of the average test of the questionnaire questions obtained an average difference between the control group and the treatment group on several points of the questions. The answers to each question above showed that the average value of the treatment group was mostly higher than the control group. This average difference indicates that the treatment given had an effect on the variables measured in this study. These results are supported by research conducted by ath Thariq et al. 2024 where the application of treatment in sample testing can improve the assessment results of the sample itself. In questions A1, A3, B1, B2, B3, B5 and B6 the average value of the treatment group showed a higher number, namely 4, while for the control group gave a lower value, namely 3. This difference indicates that the treatment of using AI in the forecasting and planning process of pharmaceutical preparations in the treatment group gave positive results. However, there are several questions such as in questions A4, A5 and A6 where at this point there is no significant difference where the value of the average test of the control and treatment groups gives a value of 3. Meanwhile, in question B4 the average value of the control group has a higher value of 4 while the treatment group gives a value of 3. This shows that the treatment given does not have a significant impact in this case the use of AI in forecasting and planning the procurement of pharmaceutical preparations does not have a positive impact on the aspects measured in the question points contained in B4. The absence of changes in several aspects measured in this test can be caused by several factors including less effective AI application treatment, non-representative research samples, too small sample sizes and less sensitive measuring instruments can be an influence in this case (G. Sanhaji, 2023)

Significance test of the use of AI in forecasting and planning the procurement of pharmaceutical preparations using the test method Mann-Whitney.

The results of the significance test of the use of AI in forecasting and planning the procurement of pharmaceutical preparations with the Man-Whitney test obtained an average rank of 11.45 for the control group and 29.55 for the treatment group. The Mann-Whitney test value was 19.0 with a significance value of $p < 0.001$ (< 0.05), so it can be concluded that there is a significant difference between the control and treatment groups. This indicates that the treatment given has a significant effect on the total score of respondents. These results are in line with research conducted by Ath Thaariq et al. in 2024 with the title of research analysis of the application of artificial intelligence in the field of health where in this study it was concluded that the use of AI can increase the efficiency, accuracy, and effectiveness of overall health services. AI helps improve the quality of life of patients by supporting more accurate diagnoses, preventing medical errors, better clinical decision-making, and the implementation of electronic medical records and efficient telemedicine services. Ahmad Khanifudin et al.'s research, 2023, entitled "AVIBOT: Virtual Assistant for Drug Inventory Management at Mitra Sehat Purwokerto Pharmacy," found positive results. AVIBOT, a virtual assistant for managing pharmaceutical supplies at Purwokerto pharmacies, demonstrated that the application, as a virtual assistant, provided accurate and up-to-date information on drug inventory, assisting users in meeting their health needs more efficiently and effectively. The use of AI also yielded effective and efficient results in the study, entitled Applications of Artificial Intelligence for Demand Forecasting where in this research the use of AI can predict the needs of each industry more accurately and can provide Long Short-Term Memory (LSTM) namely a type of artificial neural network specifically designed to process and predict sequential data or time series

data, such as historical request data, text, or voice for more accurate forecasting (Thi Thuy Hanh Nguyen, 2023).

Satisfaction test of the use of AI for forecasting and planning pharmaceutical supplies

The results of the AI user satisfaction test related to the satisfaction of using AI in forecasting and planning pharmaceutical procurement in pharmacies showed positive results, where of the 7 questions in the questionnaire, 4 (57.14%) questions received a point of 5 where on a Likert scale, point 5 is interpreted as a value of Strongly Agree, while 3 (42.86%) questions received a point of 4 which means Agree. These results indicate that the application of AI in forecasting and planning pharmaceutical preparations in pharmacies has a positive impact on the pharmacies themselves. These results are supported by research conducted by Cahyono and Utama, 2022 through research on the analysis of satisfaction of using the application. Classroom learning during the Covid-19 pandemic using the Pieces method, where in this study the results obtained increased satisfaction with the use of the Classroom application with a Performance value of 4.037 (Satisfied), Information and data got a value of 3.995 (Satisfied), Economics got a value of 3.958 (Satisfied), Control and security got a score of 3.866 (Satisfied), Efficiency got a score of 3.855 (Satisfied) and Service got a score of 3.868 (Satisfied). Meanwhile, the total average level of satisfaction from all domains was 3.929 (Satisfied). Another study that measured the level of satisfaction with the use of AI in Writing Final Scientific Papers (TA-KTI) at the Ternate Computer Science Academy (AIKOM) Campus, North Maluku, Indonesia, written by Aswin Abbas, 2023, where the results of this study found that 51.4% agreed that AI helped them in completing TA-KTI. Furthermore, 45.7% or 16 students stated that they used AI in writing TA-KTI only in certain parts.

CONCLUSION

This study provides the results of a significance test of the use of AI in forecasting and planning the procurement of pharmaceutical supplies with a test man-whitney with the average rank of the control group being 11.45 and the treatment group being 29.55. The test value Mann-Whitney of 19.0 with a significance value of $p < 0.001$ (< 0.05), so it can be concluded that there is a significant difference between the control and treatment groups on the effectiveness of AI use in increasing the accuracy of Forecasting and Planning of Procurement of Pharmaceutical Supplies in pharmacies. The level of satisfaction with the use of AI also got positive results with a value of 57.14% of respondents stating Strongly agree and 42.86% of respondents stating Agree with the application of AI to facilitate forecasting and planning activities of procurement of pharmaceutical supplies in pharmacies.

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