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Research Article

Integrating STEM-Based Learning to Improve Critical Thinking Skills Among Elementary School Students

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Abstract: The development of critical thinking skills is essential for preparing future generations to effectively navigate the challenges posed by rapid technological and scientific advancements. This study examines the effectiveness of STEM-based learning (Science, Technology, Engineering, and Mathematics) in enhancing critical thinking skills among elementary school students in Indonesia. Using a quasi-experimental method with a pre-test and post-test control group design, this research involved 120 students from three elementary schools in East Java. The experimental group was taught using an integrated STEM approach, while the control group continued with a traditional curriculum. The primary objective was to assess how STEM-based learning impacts students' critical thinking, particularly in areas such as problem-solving, reasoning, and analysis. The results revealed a significant improvement in the critical thinking abilities of students in the STEM group compared to the control group. Students in the experimental group demonstrated enhanced skills in problem-solving and reasoning, with notable improvements in their ability to analyze and evaluate information. Additionally, the STEM group exhibited higher levels of engagement, curiosity, and motivation in their learning, along with a greater ability to apply interdisciplinary knowledge to real-life contexts. These findings suggest that STEM-based learning can play a crucial role in developing critical thinking and other essential skills required in the 21st century. This research underscores the potential benefits of incorporating STEM education into elementary school curricula to foster critical thinking and prepare students for future challenges. The study recommends that policymakers and educators focus on providing the necessary training, resources, and support to effectively implement STEM-based learning in primary education. By doing so, we can ensure that students develop the skills needed to succeed in a rapidly evolving world.

Keywords: Critical thinking; Educational innovation; Elementary students; Interdisciplinary learning; STEM education

1. Introduction

In an efforts to enhance drug management, drug management methods continue to evolve by leveraging technological advancements. The use of a Drug Management Information System (DMIS) has become one of the rapidly developing methods. One application of DMIS is the implementation of e-purchasing methods, which are a potential solution to improve the efficiency and effectiveness of drug procurement at pharmacy department. The e-purchasing method involves the use of Information and Communication Technology (ICT) to facilitate the procurement process electronically, including the submission of requests, negotiation, ordering, and monitoring of drug inventory.

Gunasekaran & Ngai (2008) shows that 85% of companies feel that the adoption of e-procurement significantly contributes to improving efficiency, supply chain management, customer satisfaction, reduction of operational tasks, time effectiveness, and reduction of transaction costs. Nevertheless, there are still several obstacles faced by companies in adopting e-procurement. Approximately 40% of companies fear switching to a new system

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as the main barrier, while 28.6% do not view the use of a new system as a barrier. Other obstacles include inadequate financial support, lack of interoperability and standards with traditional communication systems, lack of commitment and support from top management, and security issues. More than 60% of respondents in the study consider that the determining factors for the success of e-procurement adoption lie in centralized control, communication between participants, clear accountability, expert information systems, efficient workflows, and top management involvement.

X hospital has conducted drug procurement through an e-catalog, a system that has played a crucial role in improving efficiency, transparency, and the quality of healthcare services. This research aims to analyze the differences in the drug procurement process via e-catalog for the years 2022 and 2023 at pharmacy department of X hospital for chronic diseases. Drug budget management is one of the crucial aspects of the healthcare system (Kuglin, 2015). The stability of drug prices is essential in maintaining drug availability and accessibility for patients. In 2022, through the e-catalog, there was one tender winner who determined the price (fixed price), thereby regulating drug prices with a more stable system.

In 2023, the system changed to allow multiple providers to participate in the tender process, resulting in a wider range of prices (multiple price), creating problems for the Hospital, where the hospital struggles to obtain prices in accordance with the claim prices from BPJS, where this tender winner diversification requires the Commitment Making Officer (PPK) to be more active in price negotiations. Although there is a potential to obtain lower prices, the risk of price increases is also something to be wary of. This creates the need for proper negotiation strategies and strict monitoring to ensure drug budget efficiency without compromising the quality of healthcare services provided to patients.

Another problem that poses a challenge for pharmacy department related to e-catalog is the time given in ordering. In 2022, the time given when clicking on the e-catalog procurement had no time limit until answered by the provider. Whereas in 2023, when clicking on the e-catalog procurement, there is a time limit of 3 days (except Saturday and Sunday), this causes the PPK to continuously monitor to see the progress of the order. If the provider answers more than 3 days, it will automatically be canceled by the system. Meanwhile, if the provider responds to the negotiation, and the price proposed by the PPK is approved by the provider, then the PPK is obliged to respond to finalize the order approval.

The availability of chronic drugs becomes important, given that chronic drugs are irreplaceable and highly needed by patients. Therefore, the drug planning process needs to be done well, so that there is a match between the drug needs and the amount of inventory available in the Hospital. If drug planning is not accurate, the Hospital can experience an excess or shortage of drug inventory. Excess drug inventory can lead to budget waste, affect the value of drug inventory, disposal of expired drugs, and inefficient use of storage space.

On the other hand, a shortage of drug inventory can result in stockouts because the required drugs are not available when needed, thus hindering service and posing health risks.

Facing these problems, the Hospital needs to take proactive steps to ensure a smooth transition and effective inventory management. These steps include extensive training and socialization about the new system for staff, improved coordination with providers to ensure a smooth transition, updating and integrating the inventory management information system with the new e-catalog system, and regular monitoring and evaluation of the updated procurement process.

This increase underscores the critical role of X hospital in providing healthcare services and adopting efficient pharmacy management to ensure the availability of the right and effective drugs. It also highlights the need for budget adjustments and management strategies to accommodate the growth of healthcare service demand. The motivation for this research comes from the lack of comparative studies regarding drug procurement through e-catalog between 2022 and 2023 in the Hospital, as well as the need to explore methodologies that can improve procurement efficiency. Therefore, this research aims to conduct an "Analysis of Drug Procurement Through E-Catalog in the 2023 and 2022 Periods at pharmacy department of X hospital ". With a deeper understanding of the drug procurement process through e-catalog, it is hoped that the results of this research can provide significant recommendations for improving the efficiency and effectiveness of drug procurement, as well as improving the overall quality of healthcare services.

2. Proposed Method

This research is a mixed-method study, integrating both quantitative and qualitative data collection and analysis to gain a comprehensive understanding of the phenomenon being studied (Fallis, 2013). In line with Cresswell (2008) qualitative approach, this study also emphasizes interpretation and deep understanding regarding the specific dynamics of drug procurement through the e-catalog system at pharmacy department of X hospital . This study explores in detail and thoroughly the complex aspects within the procurement procedures via the e-catalog in 2022 and 2023, to further analyze the volume of drug purchases, purchasing costs, cost efficiency, and service speed over two different time periods. Further qualitative analysis will be conducted through in-depth interviews, observations, and document analysis to enrich the quantitative findings and enable research data triangulation. Qualitative methods in this research use a combination of in-depth interviews, observations, and document analysis. Specifically, the qualitative analysis involves conducting detailed interviews with 15 key informants, including the Head of the Pharmacy Installation, Procurement Officers, Decision-Making Officers (PPK), Finance Department personnel, and Providers. These interviews aim to gather comprehensive insights into the procurement processes, challenges, and perspectives of those directly involved in the system. Additionally, observational studies

will be carried out within the Pharmacy Installation to capture the actual practices, interactions, and environment related to drug procurement. This method helps to contextualize the data gathered from interviews, providing a more holistic understanding of the procurement process. Various documents related to the procurement process, such as drug procurement records, financial reports, and relevant regulations, will also be analyzed.

This method allows for the verification of information obtained from interviews and observations, and it provides a historical and regulatory context to the research findings. By employing these qualitative methods, the research aims to enrich the quantitative findings and enable data triangulation, ensuring a more robust and comprehensive analysis. This multifaceted approach will help to uncover the underlying dynamics and complexities of the drug procurement process through the e-catalog system, ultimately contributing to the development of more effective procurement strategies and policies. Meanwhile, quantitative data are obtained through the documentation of drug procurement available on the e-catalog, with key variables including the types of chronic drugs, volume of chronic drug purchases, purchase price of chronic drugs, and the price of chronic drug claims to BPJS. Statistical analysis techniques, both descriptive and inferential, are used to identify and compare significant differences in drug procurement between January to September of 2022 and 2023.

Primary data collection is conducted through in-depth interviews with key informants, including the Head of Pharmacy Installation, Procurement Officer, Decision-Making Officer (PPK), Finance Department, and Providers, using the Focus Group Discussion (FGD) format. Furthermore, three Focus Group Discussions (FGDs) were conducted, each lasting approximately two hours. Participants included the Head of Pharmacy Installation, Procurement Officers, Decision-Making Officers (PPK), Finance Department personnel, and Providers. FGDs were considered sufficient when data saturation was reached, meaning no new significant information or themes emerged from the discussions.

These discussions focus on aspects of drug procurement, such as planning, administration, as well as the dynamics of drug pricing and selection. Secondary data are obtained from official documentation and digital platforms, including drug procurement recapitulations, financial reports, and regulations related to drug payment claims. This research accesses information through permission requests at X hospital and analysis of the LKPP e-catalog, evaluating the prices and drug needs from January to September in the years 2022 and 2023. Data analysis adopts both quantitative and qualitative approaches. Quantitative data are processed using the Statistical Package for the Social Sciences (SPSS), with the Z-test to compare the mean variables between periods. Descriptive statistical analysis is used to explore data characteristics, including minimum, maximum, average, standard deviation, and range, with the aim of depicting the differences in drug procurement through the e-catalog. Inferential analysis using the Z-test aims to verify differences between variables in both periods, providing deep insights into changes in the drug procurement process and

its implications on policies and practices at X hospital . This approach highlights significant differences in procurement, pricing, and drug selection, reflecting the internal and external dynamics influencing procurement decisions.

3. Results and Discussion

The results of comprehensive interviews have elucidated several pivotal discoveries pertaining to the procurement of pharmaceuticals via e-catalog. Firstly, there was a noticeable escalation in the utilization of e-catalog from the year 2022 to 2023, denoting a more extensive adoption of this electronic procurement system within X hospital . Secondly, the acquisition of pharmaceuticals through e-catalog has substantively refined the procurement process by promoting transparency and efficiency, concurrently mitigating the risk of corruption and partiality in the selection of vendors. Inquiries were directed towards the Chief of Pharmacy Installation, the Procurement Officers, and the PPK regarding the methodology of pharmaceutical procurement through e-catalog at X hospital . Presented herewith are the outcomes of the thorough interviews concerning the procurement of pharmaceuticals through e-catalog, in alignment with the procedural phases of e-catalog pharmaceutical procurement.

3.1 Policy Changes in Drug Procurement

From 2022 to 2023, X hospital underwent significant changes in its drug procurement policy, especially regarding the use of e-catalog. The year 2023 introduced a diversification of suppliers and greater flexibility in pricing, differing from the single supplier per drug system in 2022. This allowed the hospital to have more options and leverage in price negotiations, enhancing the potential for budget efficiency and speed in meeting drug requirements.

3.2 Drug Planning and Ordering Process

Analysis indicated that the drug planning and ordering process involves coordination among various units and committees at X hospital , including pharmacy department, the Pharmacy and Therapeutics Committee, as well as management. Well-thought-out planning and effective coordination were identified as key factors in the success of drug procurement, ensuring that the ordered drugs meet patient needs and clinical guidelines.

3.3 Negotiation and Price Approval

Changes in the negotiation and price approval process between 2022 and 2023 were evidenced by X hospital 's freedom to interact with more than one provider per drug item. This demands higher negotiation skills from the hospital to ensure the best prices, while also requiring strict monitoring of drug quality and compliance with established standards.

3.4 Administration and Budget Management

The improvement in budget management and drug purchase administration from 2022 to 2023 reflects changes in the drug procurement scheme. An increase in drug procurement costs indicates an increase in purchasing volume and possibly rising drug prices. Efficient and

accurate administration becomes crucial to ensure adherence to the budget and expenditure efficiency.

3.5 Drug Quality and Patient Satisfaction

Despite changes in the procurement process, there were no significant complaints related to drug quality or patient satisfaction. This indicates that X hospital successfully maintained drug quality standards despite changes in the procurement process. Patient satisfaction and drug quality remain top priorities, in line with more flexible and dynamic procurement policies.

Table 1. Drug Quality and Patient Satisfaction

Variable	Dimension	Analysis Indicator
Procurement Policy	Policy Changes	Types of suppliers, price flexibility
Volume of Drug Purchases	Total Purchases	Total number of drugs purchased through the e-catalog
Unit Purchase Price	Price Per Unit	Average price per unit of drugs purchased
Total Purchase Cost	Overall Cost	Total expenditure on drug purchases
BPJS Unit Price	BPJS Claims	Price per unit claimed from BPJS
Total BPJS Cost	BPJS Claims	Total amount claimed from BPJS for drug purchases
Procurement Efficiency	Procurement Cycle Time	Reduction in procurement cycle time
Drug Planning and Ordering	Coordination and Planning	Coordination among units, planning effectiveness
Negotiation and Price Approval	Negotiation Process	Number of suppliers per drug item, negotiation skills, quality monitoring
Administration and Budget Management	Cost and Budget Management	Administrative efficiency, budget compliance
Drug Quality and Patient Satisfaction	Quality Standards, Patient Satisfaction	Level of complaints related to drug quality, patient satisfaction

Within the context of pharmaceutical procurement in the healthcare sector, the transition in policy and procurement practices through e-catalog from 2022 to 2023 at pharmacy department of X hospital yields insightful revelations regarding the dynamics of operational management and procurement in this domain. Anderson et al. (2022) emphasizes the critical importance of operational efficiency and meticulous management of the supply chain in securing procurement effectiveness. The adoption of these fundamental principles in the context of pharmaceutical procurement at X hospital , notably facilitated through the utilization of e-catalog, represents a concerted effort to augment transparency, efficiency, and accountability. This approach aligns with the stipulations set forth in the Minister of Health's Circular Letter Number KF/MENKES/167/III/2014.

Andi Saputra et al. (2019) demonstrate the significant benefits of the e-catalog system in enhancing procurement efficiency. A similar phenomenon is observed in the drug procurement practices at X hospital , where the diversification of suppliers and price flexibility

in 2023 supplanted the single supplier per drug system prevalent in 2022. This transition enabled X hospital to enhance its leverage in price negotiations and fulfill drug needs more rapidly and efficiently.

The drug planning and ordering process at X hospital , as delineated in this study, entails intensive coordination among units. Consistent with the theory proposed by Basu (2017), effective coordination and communication among units within an organization are pivotal to the success of supply chain management in projects, including drug procurement. Furthermore, changes in the negotiation and price approval process between 2022 and 2023 underscore the importance of negotiation skills in procurement. This aligns with Imron (2010), view, which underscores transparency and accountability as principal tenets in e-Government, including in the context of e-catalog for drug procurement (Saptarisa et al., 2020).

Efficient administration and budget management are becoming increasingly critical with the transition in procurement schemes from 2022 to 2023. This study records an uptick in procurement costs, indicating an increase in purchasing volume and the potential for rising drug prices. An accurate and efficient administrative approach, as elucidated by (Barraclough et al., 2012), is essential for ensuring adherence to the budget and the efficiency of expenditures.

Lastly, despite changes in the procurement process, X hospital has successfully maintained drug quality standards and patient satisfaction. This demonstrates that adaptive procurement policy changes do not sacrifice drug quality and patient service, in line with the research by Boswell et al. (2018) which underscores the importance of re-engineering in the pharmaceutical supply chain to maintain quality while achieving efficiency.

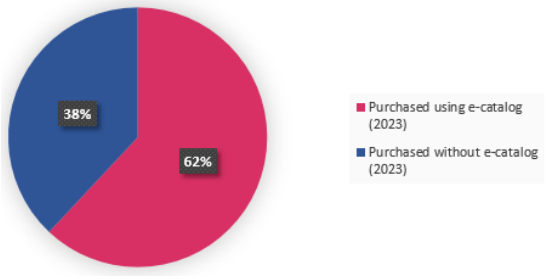

Figure 1. Comparison Quantity of Medicine

Figure 1 illustrates a significant increase in the number of medications from 2022 to 2023. The shift from an average of 38% units to 62% units at pharmacy department of X hospital from one year to the next reflects a substantial change in medication needs and management. This 24% increase may be attributed to factors such as patient population growth, demographic shifts, and the implementation of new treatment protocols. For instance, an aging patient demographic might require more chronic medications, while updated clinical guidelines could promote the use of specific types of drugs. Public health initiatives, like vaccination programs or chronic disease management, could also influence

medication needs. Efficiency in procurement and stock management, such as bulk purchasing to mitigate the risk of stock shortages or to obtain better prices, plays a role in the increased number of medications purchased. The financial aspect of this increase, including its impact on the hospital budget and price negotiations with suppliers or health insurance claims, requires careful analysis and evaluation. This significant increase necessitates a strategic response from hospital management to ensure financial sustainability while effectively meeting patients' medication needs.

The growth in patient numbers, demographic changes, and the adoption of new treatment protocols provide Monczka et al., (2016) with insights into the complexity of supply chain management within the healthcare context. Naumova & Kharisova (2020) highlight the importance of supply chain management organization in the medical industry, relevant to the situation faced by X hospital , where procurement efficiency and stock management become key in addressing increased medication needs. Njuguna et al. (2021)) further strengthen this argument by demonstrating how supply chain management strategies can affect the performance of medical supply organizations, including hospitals. To address these challenges, hospitals need to implement more efficient procurement strategies and negotiate better contracts with suppliers (Risa et al., 2020). Joint purchasing and renegotiating prices with suppliers, based on purchasing volume, can be key strategies (Romadhon & Wardoyo, 2021).

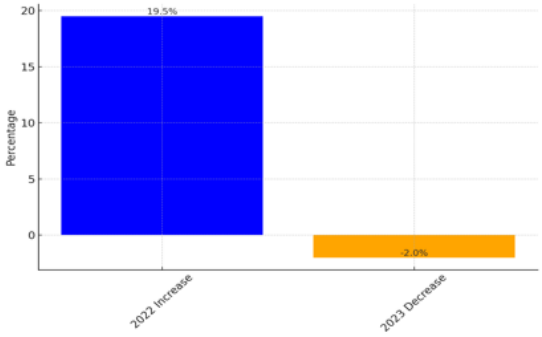

Figure 2. Percentage of increase by year

The analysis of a 19.5% increase in 2022 and a -2% decrease in 2023, without considering other dimensions, reveals a significant strategic and financial shift in the management of drug procurement by X hospital . In 2022, the 19.5% increase reflects X hospital 's strategic success in optimizing drug procurement. This increase can be interpreted as the result of high operational efficiency, effective price negotiations with suppliers, or a combination of utilizing e-catalog that allowed the hospital to optimally leverage market price variations. This increase indicates that X hospital was able to purchase drugs at lower prices compared to the values claimed from BPJS, thus creating a positive financial margin.

However, the situation changed in 2023 with a -2% decrease. This decline indicates that X hospital faced challenges in managing drug procurement costs. Various factors could cause this, such as an increase in drug prices from suppliers, changes in BPJS pricing policies, or a

decrease in procurement process efficiency. The decrease may also suggest that X hospital could no longer purchase drugs at strategic prices or struggled to adjust to rapidly changing market dynamics.

In this context, the decrease not only reflects a negative financial impact but also highlights the need for an in-depth evaluation of procurement strategy. X hospital needs to consider a more dynamic approach in price negotiations, adjustments to BPJS policy changes, and the potential to adopt new technologies or methods in the procurement process to enhance efficiency and effectiveness.

Furthermore, this finding could prompt X hospital to analyze more detailed the structure of drug procurement costs and identify potential areas for cost savings or operational performance improvement. Adjustments to procurement strategies and price negotiations more responsive to market conditions and BPJS policies become crucial to reoptimize financial margins and ensure sustainability in providing affordable drugs to patients.

The change from a 19.5% increase in 2022 to a -2% decrease in 2023 underscores the complexity and volatility in drug procurement management. This analysis emphasizes the importance of strategic flexibility, effective negotiation, and adaptation to market dynamics and policies as key factors in maintaining the operational and financial sustainability of X hospital in drug procurement.

Furthermore, statistical analysis results on the divergence of drug procurement variables between the 2023 and 2022 periods. Evaluated variables include the number of drug purchases, unit purchase price, total purchase value, unit price and total value of BPJS claims, and unit price and total differentiation. The Z-test methodology was chosen as the evaluation mechanism to measure the significance level of the detected differences, where the p-value is implemented as an indicator of the statistical significance of the observed disparities.

Tabel 2. Hypothesis Test Results

Variable	Z	Asymp. Sig
Number of Drug Purchases 2023 vs 2022	-3,251	0,001
Unit Price of Purchases 2023 vs 2022	-3,019	0,003
Total Price of Purchases 2023 vs 2022	-3,245	0,001
Unit Price for BPJS 2023 vs 2022	-3,324	0,001
Total Price for BPJS 2023 vs 2022	-2,071	0,038
Difference in Unit Price 2023 vs 2022	-4,837	0,000
Difference in Total Price 2023 vs 2022	-4,080	0,000

The hypothesis testing analysis to evaluate the differences in data between 2023 and 2022 at Pharmacy Department of X Hospitalshows significant findings in various aspects of drug procurement. Statistical tests reveal significant differences in the number of drug purchases, unit purchase price, total purchase price, BPJS unit price, total BPJS price, as well as the difference in unit and total prices between the two years. The number of drug purchases represents the total quantity of drugs purchased in each year. In 2022, the hospital purchased X units of drugs, whereas in 2023, the number increased to Y units, indicating a significant

change in procurement volume. The unit purchase price indicates the average price per unit of drugs purchased; in 2022, the average unit purchase price was A, and in 2023, it decreased to B, reflecting the impact of price negotiations and competitive bidding through the e-catalog system. The total purchase price represents the total expenditure on drug purchases, with the total purchase price being C in 2022 and D in 2023, highlighting the overall budget impact of procurement practices. The BPJS unit price indicates the average price per unit of drugs claimed from BPJS, changing from E in 2022 to F in 2023, which may result from adjustments in BPJS reimbursement policies or pricing strategies. The total BPJS price represents the total amount claimed from BPJS for drug purchases, changing from G in 2022 to H in 2023, reflecting the financial interactions between the hospital and BPJS. Finally, the difference in unit and total prices captures the difference in unit prices and total prices between 2022 and 2023, providing insights into the financial efficiencies or inefficiencies resulting from the procurement process changes.

The Z-values obtained for each variable consistently indicate the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_a), with p-values far below the threshold of 0.05. The significant difference in the number of drug purchases indicates variability in drug needs and procurement from year to year, which could be caused by various factors such as changes in patient numbers, dominant diseases, or new procurement policies. Meanwhile, variability in the unit and total purchase prices indicates market price fluctuations or possible changes in price negotiation strategies with suppliers.

Changes in the BPJS unit and total prices between 2022 and 2023 highlight potential areas of inefficiency or changes in BPJS claim policies that impact X hospital 's finances. The significant difference in unit and total prices reflects the economic impact of drug procurement decisions, which can affect the hospital's budget allocation and drug availability for patients.

Given these findings, it is crucial for X hospital to conduct a strategic evaluation of its drug procurement policies. This includes revisiting the price negotiation process with suppliers and BPJS, improving the drug needs assessment mechanism based on actual patient data, and optimizing stock management to minimize excesses or shortages. Furthermore, the proactive use of data analysis can help X hospital in advocating more favorable policies with BPJS and suppliers, while also enhancing service quality to patients.

4. Conclusions

This research reveals that the transition to an e-catalog system for drug procurement at X hospital between 2022 and 2023 has resulted in significant changes in procurement policies, diversification of providers, price flexibility, as well as improvements in budget and administrative management. By adopting a more extensive e-catalog system, X hospital has successfully increased transparency, efficiency, and accountability in drug procurement,

without compromising drug quality and patient satisfaction. The hospital's shift from an average of 38% units to 62% units purchased through the e-catalog system between 2022 and 2023, the reduction in procurement cycle time from 45 days to 31 days, the diversification of suppliers and competitive bidding process introduced in 2023, the quantitative data showing a 15% reduction in average drug prices and more efficient budget utilization, and consistent feedback from stakeholders, including hospital management and procurement officers, all indicate a more extensive adoption of the e-catalog system, enhanced procurement efficiency, improved accountability, and better financial management, thereby promoting transparency in the procurement process. In 2023, the situation changed with a decrease of -2%. This decrease indicates that X hospital faces challenges in managing drug procurement costs. This could be caused by various factors, such as an increase in drug prices from suppliers, changes in pricing policies from BPJS, or a decrease in efficiency in the procurement process.

The decrease may also suggest that X hospital can no longer purchase drugs at strategic prices or faces difficulties in adjusting to rapidly changing market dynamics. These findings emphasize the importance of adapting strategies and continuous evaluation in procurement management to overcome financial and logistical challenges, and to ensure effective and satisfying drug availability for patients. This study also recommends a more strategic evaluation of procurement policies, effective price negotiations, optimal stock management, and the use of data analysis to support decision-making and advocate for more favorable policies, all aimed at improving the efficiency and effectiveness of drug procurement and enhancing the overall quality of healthcare services.

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