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Optimizing MRI Examination Planning through a Computational Formula: A Mixed-Method Study of Radiology Management in Indonesian Hospitals

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ABSTRACT

Background. The healthcare sector is a fundamental aspect of human life, requiring continuous attention from governments to improve service quality. In radiology services, particularly Magnetic Resonance Imaging (MRI), optimizing resource use is crucial due to high equipment costs and the complexity of operations.
Purpose. This study develops a computational formula designed to assist radiology department heads in planning and calculating daily MRI examination targets during the equipment's lifespan. Factors such as hospital type, service fees, operational costs, and regional location are incorporated into the formula.
Method. The research employs a mixed-method approach, combining preliminary surveys with the development and validation of the computational formula. Validation by financial and radiology experts demonstrated the formula's reliability and accuracy. Additionally, large-scale testing involving ten stakeholders confirmed the application's functionality, reliability, and user-friendliness.
Results. The Results show that this tool significantly improves the planning and operational management of MRI equipment, offering a solution that is adaptable to new regulations and real-time data.
Conclusion. This application provides a promising method for optimizing MRI use in hospitals, particularly within the context of the National Health Insurance (JKN) system. Its flexibility and ease of use make it applicable for both government and private hospitals, ensuring effective MRI utilization and financial management.

KEYWORDS

Hospital Operational Management, MRI Utilization, National Health Insurance (JKN), Radiology Services, Target Formula

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INTRODUCTION

Health is one of the fundamental aspects of human life, which requires serious attention from the government to maintain the welfare of its citizens (Harjanto Setiawan, 2020). The government has a responsibility to continue to improve the quality of health services, in line with national development programs (Devi Lawra & Adriyanti, 2021). which presents comprehensive data on national health conditions, including the number of health facilities, medical personnel, and the budget allocated for the health sector each year

(Permenkes 21 Tentang Rencana Strategies Kementrian Kesehatan RI, 2020).

As part of improving health services, the development of health facilities and infrastructure is an important priority. Among the facilities that play a central role in medical diagnosis and therapy are radiology installations in hospitals. Based on the Regulation of the Minister of Health (Permenkes) No. 24 Tahun 2020 about Clinical Radiology Services, radiology services are categorized into four levels: pratama, madya, utama, and dan paripurna (Permenkes No.24 Standar Pelayanan Radiologi Diagnostik Di Sarana Pelayanan Kesehatan, 2020). Each level of service is determined by the availability of human resources and medical equipment, which has a direct effect on the quality of radiology services that can be provided.

In the era of the National Health Insurance (JKN), which began in 2014, Healthcare management, including radiology, has undergone significant changes in terms of financing. Casemix fare system INA CBG's (Perpres RI No. 64 Tentang Jaminan Kesehatan, 2020), which sets rates based on diagnosis and procedures, forcing hospitals to optimize their operations to continue to provide quality services without losing money (Saputra et al., 2020; Suprapto et al., 2023). In this context, efficiency and good management are the keys to success, especially for high-tech radiology services such as Magnetic Resonance Imaging (MRI).

MRI services in plenary and main-type hospitals, as regulated in Permenkes No. 24 of 2020, are an important example of how the procurement of expensive medical devices such as MRI must be accompanied by careful planning. The head of the radiology room, who generally has a background as a radiographer, is often required to play a role in the planning and management of the procurement and management of MRI equipment. However, based on preliminary surveys, managerial knowledge and skills in tool planning are still relatively lacking, thus posing challenges in achieving optimal operational efficiency.

This study aims to develop a computation-based formula that can assist the head of the radiology room in determining the target number of MRI examinations that must be achieved during the useful life of the device. With this formula, it is hoped that the head of the room can make more accurate planning, including in managing operational costs, and ensure that every decision on procurement and management of MRI can provide maximum value for the hospital.

Previous research in the field of radiology service management has discussed a lot about optimizing the use of medical devices (Bravo & Austin-Breneman, 2023), including MRI (Rao, 2020; Seo et al., 2022), However, it generally focuses on technical and medical aspects without paying attention to computing-based operational management that can efficiently predict the target use of the tool. One of the further research opportunities identified is the lack of studies that develop comprehensive, computing-based formulas that can calculate the target number of visits or check-ups per day over the useful life of the MRI tool by taking into account relevant economic and operational factors. In addition, most research has also not focused on the application of this formula for government hospitals that are faced with operational efficiency challenges related to INA-CBG's-based financing.

This research offers a new contribution by developing a computation-based application formula specifically designed to assist hospital managers in calculating the target number of MRI examination visits based on determining factors such as hospital type, INA-CBG's rates, and the useful life of the device. The novelty lies in a computational approach that integrates a thorough analysis of managerial and technical factors, allowing for higher validity and reliability in the planning of the use of medical devices. In addition, this research not only helps optimize MRI equipment but also provides the potential for wider application in the management of other medical devices that have similar operational characteristics.

RESEARCH METHODOLOGY

This research uses the Research and Development (R&D) method with a mixed approach. At the quantitative stage, a preliminary survey was carried out to map the knowledge and managerial abilities of the head of the radiology room in several government and private hospitals. This survey was conducted through a Google Form which contained ten closed questions related to the involvement of respondents in planning the procurement of radiology equipment and determining the target of visits. The results of the survey are measured in the form of percentages to assess the level of knowledge. Furthermore, supporting data in the form of MRI unit prices, hospital operating costs, and health insurance rates were collected as the main variables in the development of the formula.

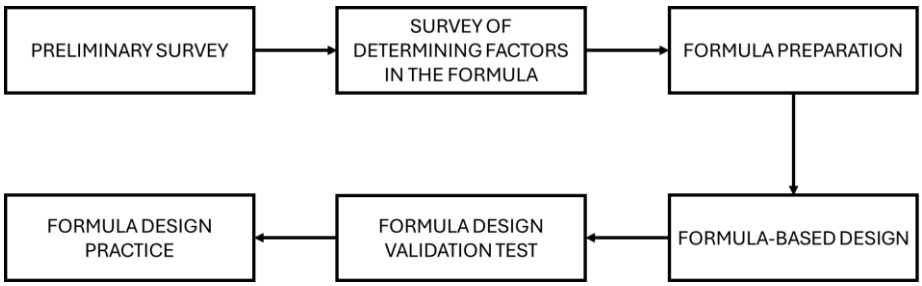

Figure 1. Research Design

In the next stage, the design of a Microsoft Excel-based application formula is created to calculate the target daily visits of the MRI tool during its useful life. After the manual formula was prepared, a validity test was carried out involving three experts from financial and radiology practitioners. This validation aims to assess the feasibility and accuracy of the formula before it is applied more widely (Eisenmann et al., 2021). The Practice Test was conducted by distributing a questionnaire to ten users, including financial and radiology practitioners, to evaluate the application based on six criteria: functionality, reliability, usability, efficiency, maintainability, and portability (Kroll & Weisbrod, 2020). The results of this training will be the basis for the development of a more efficient and progressive MRI service management strategy.

RESULT AND DISCUSSION

The results of the design of the computer-based application formula show that this application can facilitate the calculation of the target number of MRI examinations or visits in hospitals. The app is designed to assist decision-making in MRI procurement planning by considering various factors, such as service rates, operational costs, and the region of the hospital's location. Based on supporting data, this formula produces accurate calculations in determining the minimum number of daily visits required to recover the MRI procurement capital according to the useful life of the equipment. These factors are important in ensuring operational sustainability and optimizing the use of tools, This is in line with Bogatay, et al (1987) where the financial analysis of the acquisition of MRI units in hospitals should consider patient volume, equipment utilization, and revenue generation to ensure good investment and positive financial results. And also according to his opinion Schwartz & Jarl (1985) that better planning for MRI procurement in hospitals involves identifying unique cost issues and assessing the impact of reimbursement and pricing (Schwartz & Jarl, 1985).

In the development stage, data from MRI examination rates, hospital types, and regions following PERMENKES 3 of 2023 are integrated into the application. The use of this real-time data

helps hospitals understand the total costs that must be taken into account, both for outpatient care and additional costs associated with advanced medical technology (Crowe & Hailey, 1990). In addition, the app takes into account regional influences, so hospitals can plan their budgets more efficiently according to the geographical characteristics and local economic conditions. The results of the validation tests by experts also show that this application has good functionality and efficiency.

In the validation test, the formula was tested by three expert validators who gave high scores for functionality, reliability, usability, and application efficiency. Scale 5 (Likert) obtained from the assessment results shows that this formula meets important criteria in the management and procurement of MRI equipment in hospitals (Balasubramanian, 2012). This validity test ensures that this formula is reliable (Aprilisa et al., 2021), and meets the operational standards required in the hospital environment. In addition, the app is considered user-friendly and easy to use by stakeholders, with easy-to-follow steps.

A large-scale training trial involving 10 stakeholders at the hospital, including financial practitioners and radiology room heads, generated very positive feedback. Respondents considered this application to be effective in terms of functionality and portability, as well as reliable in performing calculations with fast and accurate results. The test also confirmed that the app is easy to use on a variety of digital platforms, including laptops and PCs, demonstrating a high level of portability. The app's ability to provide relevant estimates based on real-time data makes it a very useful tool in the financial management of MRI tools.

In addition, respondents considered this application to be very helpful in predicting daily visit targets efficiently, ensuring that hospitals can optimize the use of MRI equipment according to their useful life. The ease with which this application detects and corrects errors has also been appreciated by users, which shows that this formula is designed with maintainability in mind (Inoue & Koizumi, 2004). The scale of values given by the respondents showed that this application was very valid and could be applied in various hospitals, both government and private.

The integration of the Diffusion of Innovations theory and Kirkpatrick's Four-Level Training Evaluation Model corroborates the results of this study (Alsalamah & Callinan, 2022; Huang et al., 2022). The relative superiority, compatibility, and tryability of these apps are the main factors influencing adoption by users. Meanwhile, Excel-based training to improve accounting management competencies for radiology room heads can be further optimized, ensuring that this application is not only accepted but also implemented effectively in hospitals. These results show that this computing-based application provides tangible benefits in MRI asset management and can be widely implemented in government hospitals, supporting the National Health Insurance program.

CONCLUSION

Based on the results of the study, it can be concluded that the design of this computing-based application formula can facilitate the calculation of the target number of daily examinations for MRI equipment by considering various factors, such as equipment price, hospital type, region, clinical trends, and operational costs. Validation tests by experts show that this application is valid, reliable, and meets practical needs in the field, especially in helping hospitals maximize the use of MRI during its useful life. With the positive response from large-scale training trials, this formula is ready to be implemented on a wider scale in government hospitals.

It is recommended that this formula application is not only used in the planning process for the procurement of new equipment but also applied to hospitals that already have MRI equipment to evaluate and adjust the target use. In addition, it is important to update this formula data following

the development of new regulations, such as the PERMENKES related to pricing and hospital policies. With this flexibility in mind, the application can be used more widely to improve the operational efficiency of MRI equipment in various hospitals.

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AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Formal analysis; Methodology; Writing - initial draft.
Author 2: Conceptualizing in developing theories or concepts on which the research is based
Author 3: Writing - review and editing.
Author 4: Supervision; Validation.
Author 5: Supervision; Validation.
Author 6: Other contributions; Resources; Visualization; Writing - original manuscript.

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