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Design of a Web-Based BOR Prediction System as an Early Warning System for Overcapacity Using Growth Rate and Moving Average Methods

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Abstract: Bed availability is an important indicator of hospital service quality, as an imbalance between capacity and patient demand may increase the risk of overcapacity and reduce service quality. Capacity management that remains oriented toward historical data also limits a hospital's ability to anticipate future needs. This study aimed to implement a Bed Occupancy Rate prediction system as an early warning mechanism for evaluating bed-capacity adequacy in subsequent periods. A mixed-methods design with a time-series approach was employed. Quantitative data consisted of 24 months of historical Bed Occupancy Rate records obtained through documentation and analyzed using Growth Rate and Moving Average methods, while qualitative data were obtained through observation and interviews to identify system requirements. The system was developed using the Waterfall model and implemented with PHP Native, MySQL, Bootstrap, and AdminLTE. Features include historical-data management, prediction, Mean Absolute Percentage Error evaluation, dashboard visualization, an Early Warning System, and PDF and Excel reports. The system generated forecasts, displayed occupancy trends, and classified predicted conditions into safe, alert, and critical categories, thereby supporting more proactive and sustainable capacity planning.

Keywords: Bed Occupancy Rate, Growth Rate, Moving Average, Mixed Methods, Web

INTRODUCTION

Inpatient care is one of the main components of hospital health-service delivery. One indicator used as a basis for evaluating the effectiveness of inpatient-facility utilization is the Bed Occupancy Rate (BOR), which measures the percentage of occupied beds during a certain period (Pomarida Simbolon et al., 2025). BOR describes the balance between available bed capacity and patient-service needs. A BOR that is too low indicates suboptimal bed utilization, whereas a high BOR may lead to service delays, longer patient waiting times, and the risk of overcapacity. Therefore, periodic BOR monitoring is an important component of hospital statistics and is used by management to evaluate service planning (Mayangsari et al., 2022). To assess the effectiveness of inpatient-service management, hospitals use several performance

indicators, including BOR, which measures bed utilization over a specified observation period. Bed utilization can be categorized as optimal when BOR is within the range of 60–85% (Depkes RI, 2005).

Digital transformation in the health sector is one of the strategies continuously developed by the government to improve the quality, effectiveness, and efficiency of healthcare delivery. This effort is strengthened through Law Number 17 of 2023 concerning Health, which emphasizes that the national health system should be supported by the use of information technology and integrated health information systems. In line with this policy, Regulation of the Minister of Health of the Republic of Indonesia Number 24 of 2022 concerning Medical Records stipulates that every healthcare service must implement Electronic Medical Records as part of an integrated health information system. Hospital-service management is also regulated by Regulation of the Minister of Health of the Republic of Indonesia Number 3 of 2020 concerning Hospital Classification and Licensing, which emphasizes effective, efficient, and quality-oriented healthcare delivery. One aspect affecting inpatient-service quality is the hospital's ability to manage service needs. An imbalance between the number of available beds and the number of hospitalized patients may cause overcapacity, which can ultimately affect patient waiting time and reduce the efficiency of hospital resource utilization (Mandala, 2025).

Based on observations and interviews conducted at RSUD Syamsudin S.H, Bed Occupancy Rate has been calculated as one of the inpatient-service statistical indicators used to determine bed utilization. However, the use of BOR information remains focused on conditions that have already occurred after the service period has ended; therefore, it is evaluative and does not yet provide an overview of occupancy trends for the subsequent period. This becomes a problem when BOR tends to increase because the hospital does not yet have predictive information that can provide an earlier warning of potential increases in bed occupancy. This limitation may leave management with less time to anticipate changes in service needs, such as adjusting bed-capacity management and supporting inpatient resources. Thus, the problem does not lie in the availability of BOR calculations, but in the absence of predictive information capable of transforming historical data into a basis for anticipating future service-capacity conditions. This condition demonstrates the need for a BOR prediction system that uses historical data to describe BOR trends for the next period and functions as an early warning system supporting inpatient-capacity management decisions.

Previous studies have developed BOR prediction models using more complex methods, such as Autoregressive Integrated Moving Average and various machine-learning approaches (Indra et al., 2026). In contrast, this study focuses on designing an information system that can be used to support decision making. Growth Rate and Moving Average were therefore selected because their calculation mechanisms are relatively simple, easy to implement in a web-based system, easy for users to understand, and capable of producing transparent predictive information. Both methods are consistently applied to monthly and annual predictions so that users obtain prediction results through uniform and readily interpretable calculation mechanisms. To ensure that the results remain suitable as an information basis, prediction errors are evaluated using Mean Absolute Percentage Error (MAPE).

METHOD

Research Approach

This study applied a mixed-methods design by integrating qualitative and quantitative approaches in the development of a web-based Bed Occupancy Rate prediction information system.

Data Collection Techniques

- 1) Observation: observing the statistical-data management workflow and the BOR calculation process.

- 2) Interviews: obtaining more in-depth information regarding BOR calculations and the availability of data used as the basis for future BOR predictions.
- 3) Documentation study: reviewing available statistical data to obtain the quantitative data required for the system-design process.
- 4) Literature study: reviewing literature relevant to the research, including scientific journals, laws and regulations, and various references supporting the development of a web-based information system.

Data Processing Techniques

Growth Rate

$$\text{Growth Rate} = (\text{HP}_t - \text{HP}_{t-1}) / \text{HP}_{t-1}$$

Moving Average

$$\text{HP} = (\text{HP}_{t-1} + \text{HP}_{t-2} + \text{HP}_{t-3}) / 3$$

Monthly Predictive BOR Calculation

$$\text{BOR} = (\text{Patient Care Days} / (\text{Beds} \times \text{Days})) \times 100\%$$

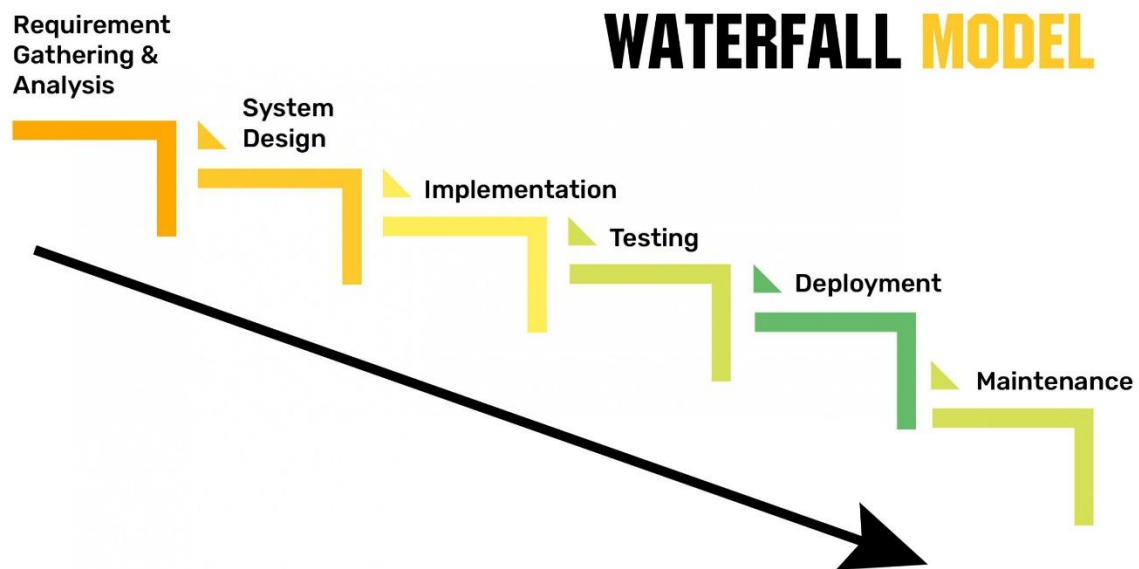
Prediction Accuracy Evaluation

$$\text{MAPE} = (|\text{Actual} - \text{Prediction}| / \text{Actual}) \times 100\%$$

System Development Stages

The system-development process used the Waterfall method. This method was selected because its development flow is systematic and sequential, allowing each stage to be carried out after the previous stage has been completed (Sahputra et al., 2025). This approach was appropriate because system requirements had been determined from the beginning based on the requirements analysis and did not change significantly during development.

- 1) Requirements Analysis: identifying system requirements based on the existing condition of inpatient-service statistical management.
- 2) System Design: following up the requirements analysis to produce a system design that meets user needs. The design includes a Flowmap, Context Diagram, Data Flow Diagram, and Entity Relationship Diagram as representations of process flows, data flows, and relationships among system entities.
- 3) Program Coding: implementing the design as a web-based application using PHP Native for server-side programming, JavaScript for interface interactions, Bootstrap and AdminLTE as interface frameworks, and MySQL as the database-management system.
- 4) Program Testing: using Black Box Testing to determine whether each system function operates according to the specified requirements.
- 5) System Maintenance: maintaining optimal system performance and adapting the system to future needs after implementation. However, maintenance was not conducted in this study because the research scope was limited to system implementation and testing.



Source: Processed by the authors based on Sahputra et al. (2025).

Figure 1. Stages of the Waterfall Method

RESULTS AND DISCUSSION

Results

Interview Results

Interviews were conducted to obtain information regarding Bed Occupancy Rate data management, problems in presenting BOR information, and prediction of bed occupancy. The interview data were then processed descriptively by grouping information according to topics related to the existing process, problems, information requirements, and system requirements.

Based on the processed interview data, several findings were obtained as the basis for system design.

Table 1. Interview Results

No.	Aspect Examined	Interview Result	System Requirement
1	BOR data management	BOR data are used as information to determine the hospital bed-occupancy level.	The system can store and manage historical BOR data in a structured manner.
2	BOR prediction	No dedicated feature is available to estimate BOR for the next period.	The system provides BOR prediction using Growth Rate and Moving Average methods.
3	Capacity-condition warning	Information is required to help identify bed-capacity conditions based on prediction results.	The system provides an Early Warning System with capacity-condition categories.

Based on the identified requirements, the system was designed with several main functions: historical BOR data management; BOR processing and prediction using Growth Rate and Moving Average; presentation of results in graphical form; and early-warning information based on the categories of predicted conditions.

Analysis of the Existing Workflow

Based on observations and documentation studies, BOR data management begins with collecting inpatient-service data consisting of patient care days, the number of available beds, and the number of days in a specified period. These data are then processed to calculate BOR according to hospital statistical formulas. The calculation results are subsequently recapitulated in statistical reports used to evaluate inpatient-service performance and submitted to hospital management. This management process has been able to provide information about bed utilization in past periods. However, the information produced remains descriptive because it only represents actual conditions based on historical data. The BOR values have not yet been

used to estimate conditions in the following period. This condition means that hospital management does not yet have predictive information that can be used as a basis for anticipating changes in bed occupancy. If the number of patients increases significantly, bed-capacity adjustments are generally made only after BOR indicates a high occupancy level. Conversely, when the number of patients decreases, the hospital does not yet have an adequate basis for evaluating whether the available bed capacity remains appropriate to service needs. The existing workflow is illustrated in the Existing-System Flowmap shown in Figure 2.

Analysis of New System Requirements

Based on observations and documentation studies, the main user requirement is not limited to historical BOR data management but also includes the system's ability to generate predictive information regarding bed-capacity conditions in the next period.

System Design

System design was conducted as a follow-up to the requirements analysis. The design process aimed to produce a comprehensive representation of the system structure, including process flows, data management, relationships among entities, and user-interface design.

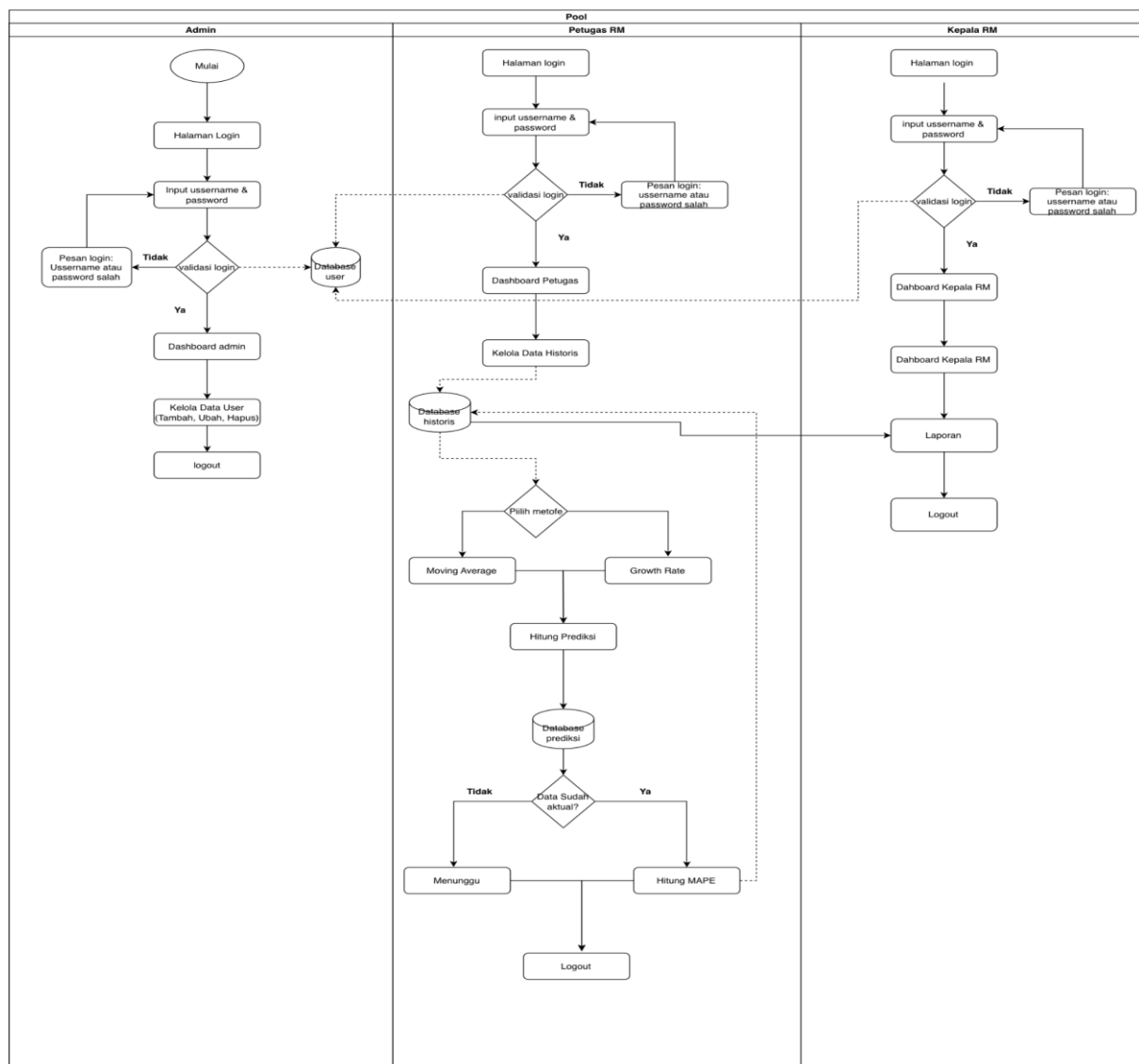


Figure 2. Existing-System Workflow

Context Diagram

The Context Diagram shows the relationship between the Bed Occupancy Rate prediction system and external entities that interact directly with it. The entities involved include the administrator, medical record officer, and head of medical records.

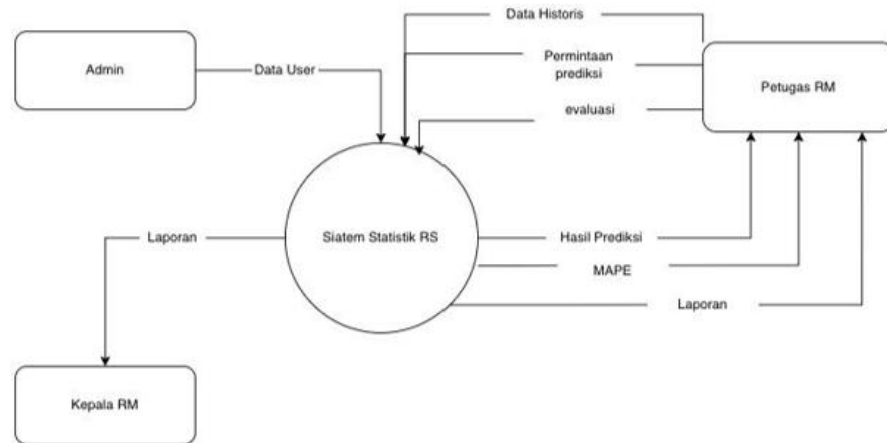


Figure 3. System Context Diagram

Data Flow Diagram Level 1

The Level 1 Data Flow Diagram describes in greater detail the main processes within the Bed Occupancy Rate prediction system, ranging from historical BOR data management and BOR prediction to prediction-accuracy evaluation and presentation of results.

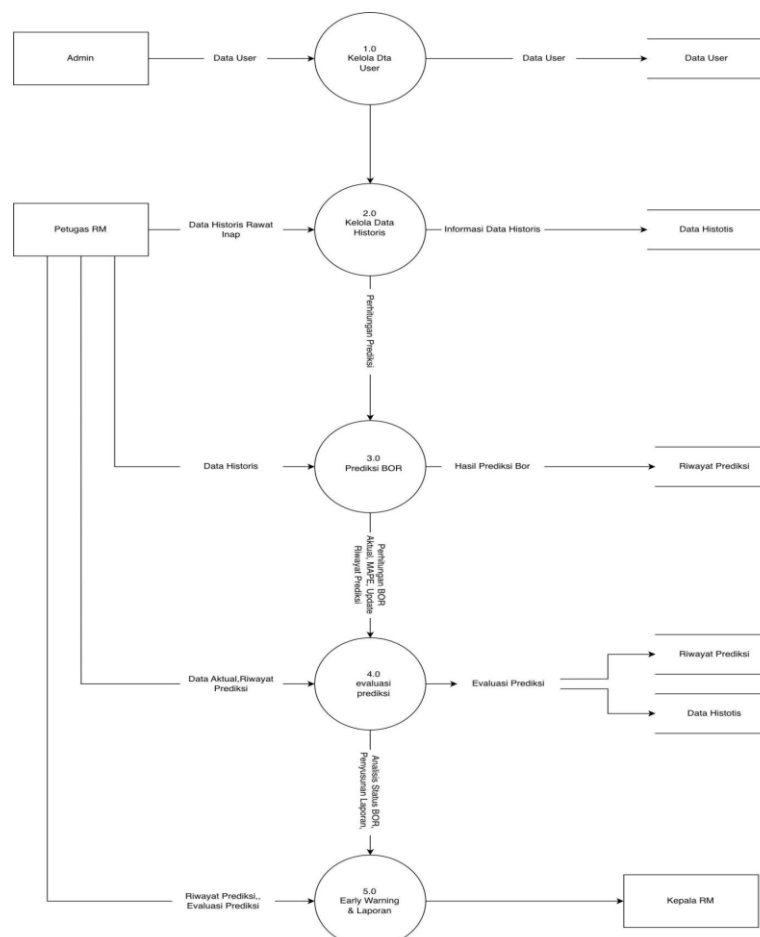


Figure 4. System Data Flow Diagram Level 1

Entity Relationship Diagram

The Entity Relationship Diagram describes the database structure used by the system and the relationships among entities supporting data management. The ERD was designed to ensure that each dataset is stored in a structured manner and supports consistent information processing and presentation.

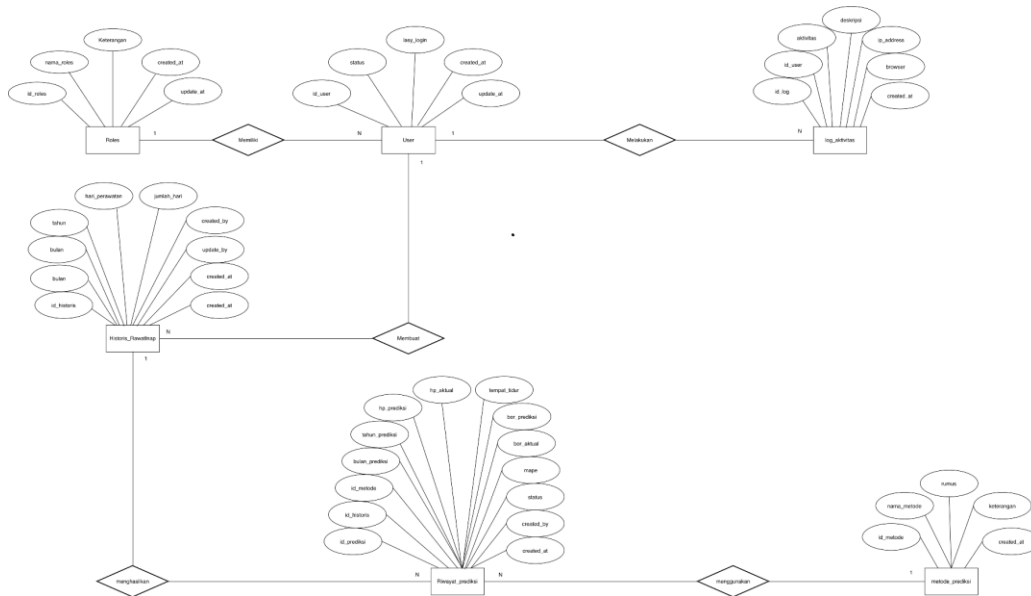


Figure 5. System Entity Relationship Diagram Design

System Implementation

The implementation resulted in a web-based application used to support historical Bed Occupancy Rate data management, prediction, accuracy evaluation, and presentation of information as decision support.

Login Page

The login page is used for user authentication before accessing the system according to the assigned access rights.

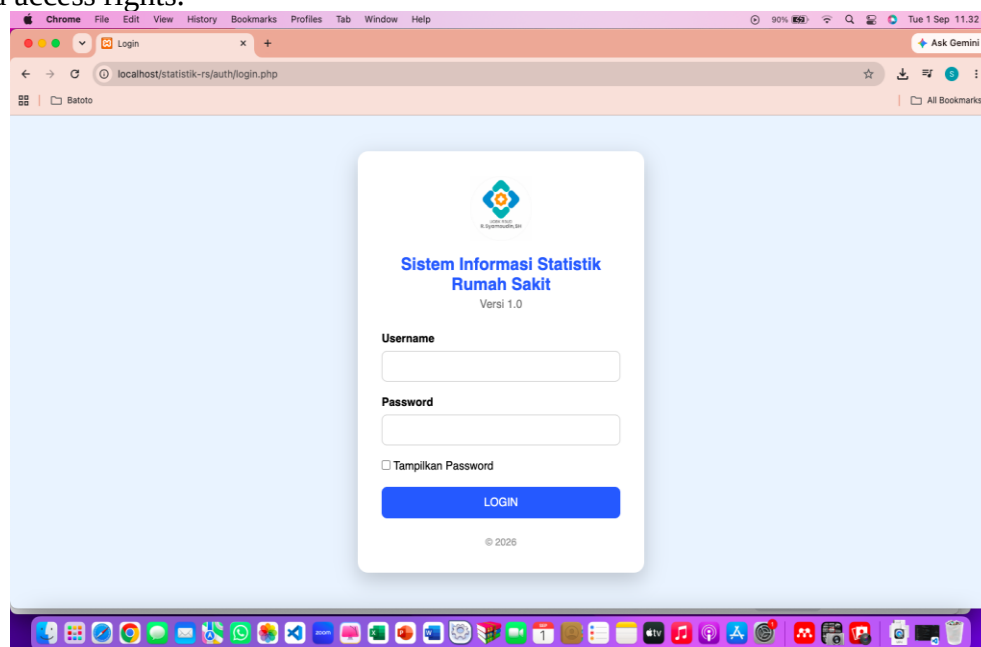


Figure 6. Login Page Display

Dashboard

The dashboard displays key information, including the number of stored historical BOR records, actual BOR, the next-period BOR prediction, and the Early Warning System status. It also presents a monthly BOR trend chart illustrating changes in bed occupancy based on historical data.

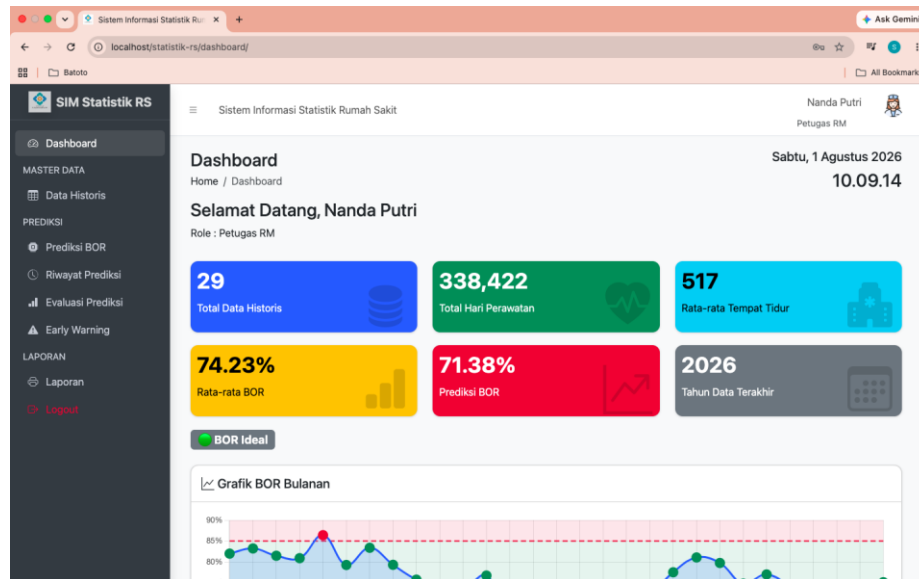


Figure 7. System Dashboard Display

Historical Data Page

The Historical Data page is used to manage inpatient-service statistical data. Stored historical data constitute the main source for the prediction process; therefore, data accuracy and completeness affect the prediction results. Officers can comprehensively manage historical data through add, edit, delete, and search functions.

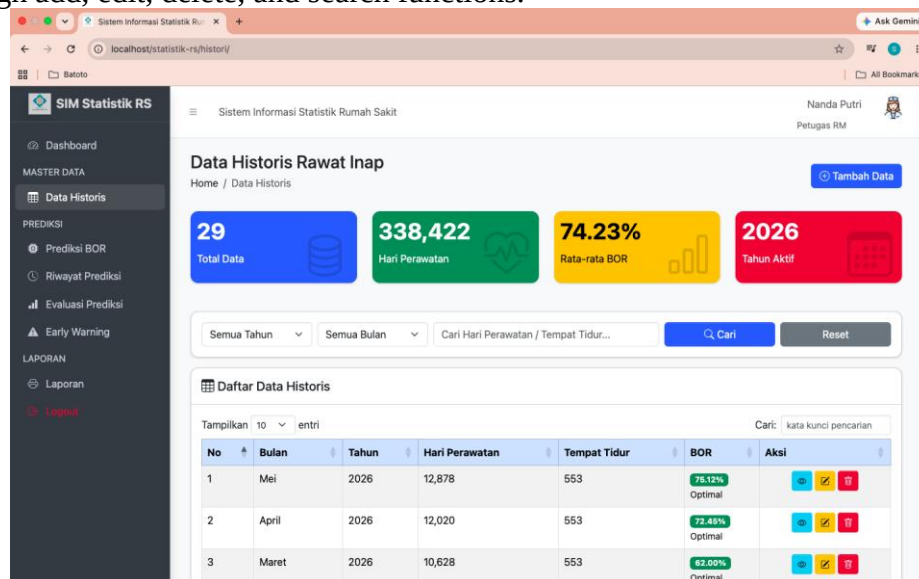


Figure 8. Historical Data Page Display

BOR Prediction Page

The BOR Prediction page displays the historical data used as the calculation basis together with the prediction results for the next period. All calculations are performed automatically after the user selects the data to be predicted. The system calculates the growth percentage based on the actual BOR in the previous period and uses the result to estimate BOR for the next period.

The system also automatically performs calculations using the Growth Rate and Moving Average methods.

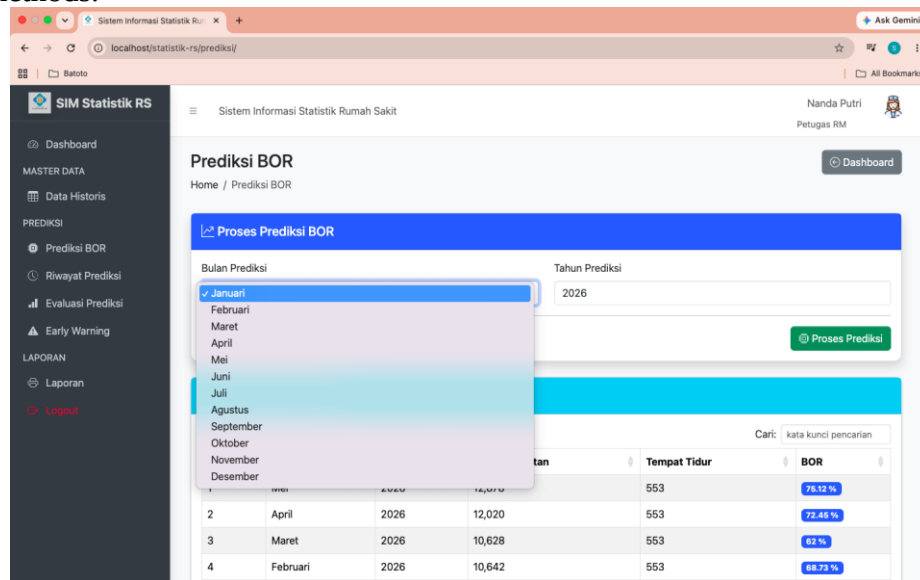


Figure 9. BOR Prediction Page Display

Prediction History Page

The Prediction History page stores calculated prediction results before the accuracy of the Bed Occupancy Rate prediction is evaluated. The system automatically calculates MAPE after a prediction has been used. The calculation is performed for each method so that users can determine the accuracy of Growth Rate and Moving Average based on the historical data used. After the accuracy value is calculated, the actual value is automatically entered into the historical-data page as the basis for the following month's prediction.

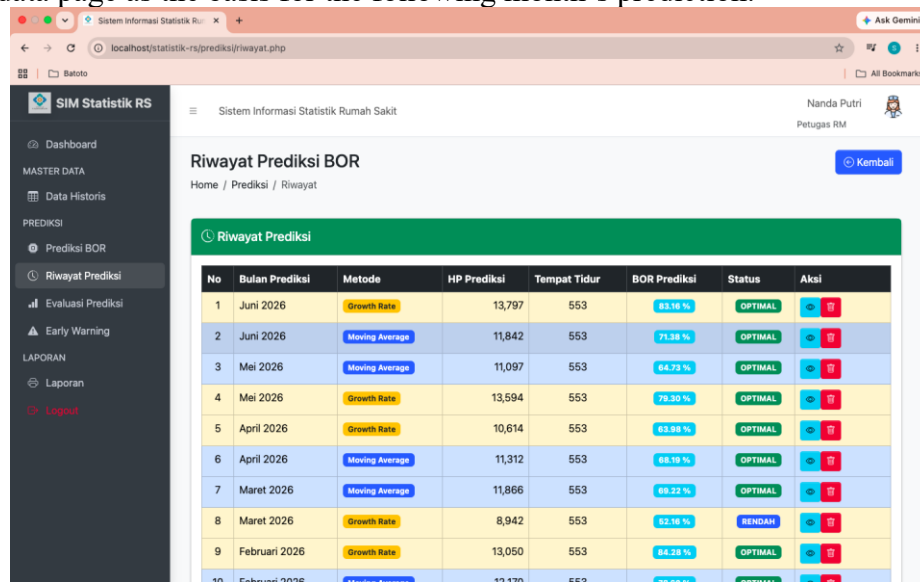


Figure 10. Prediction History Page Display

Early Warning System Page

The Early Warning System page presents Bed Occupancy Rate prediction results in information that is easier for users to interpret. Unlike a prediction result that only displays a BOR percentage, this page interprets the prediction into bed-capacity condition categories so that it can be used as a basis for decision making.

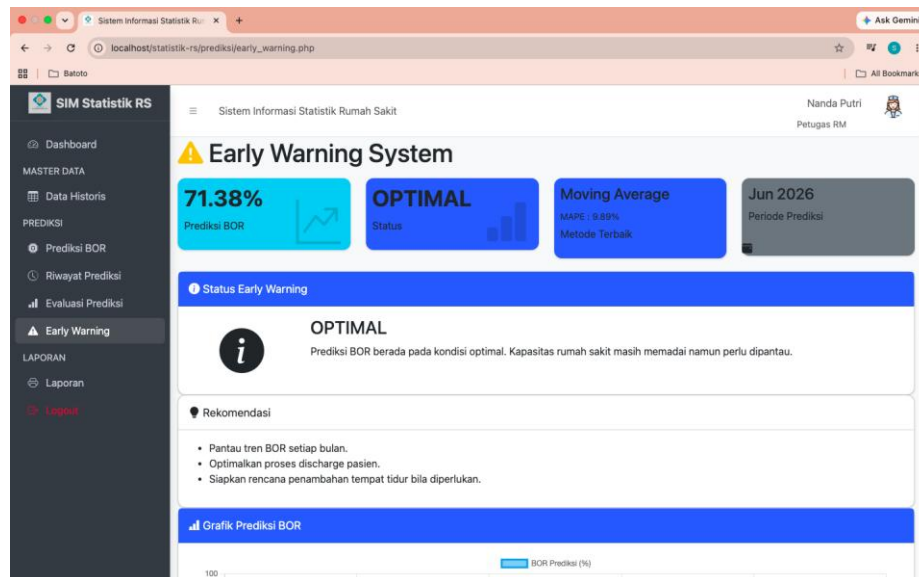


Figure 11. Early Warning System Display

Report Printing Page

The Bed Occupancy Rate Prediction Report feature presents prediction results in a structured and documented format. It displays the prediction period, method used, predicted and actual patient care days, predicted and actual BOR, Mean Absolute Percentage Error, and bed-capacity status. The information is complemented by hospital identity, printing date, report summary, and a facility for printing the report in PDF format. This presentation facilitates review of prediction results, evaluation of accuracy, and documentation of analysis as decision-support material for bed-capacity management.

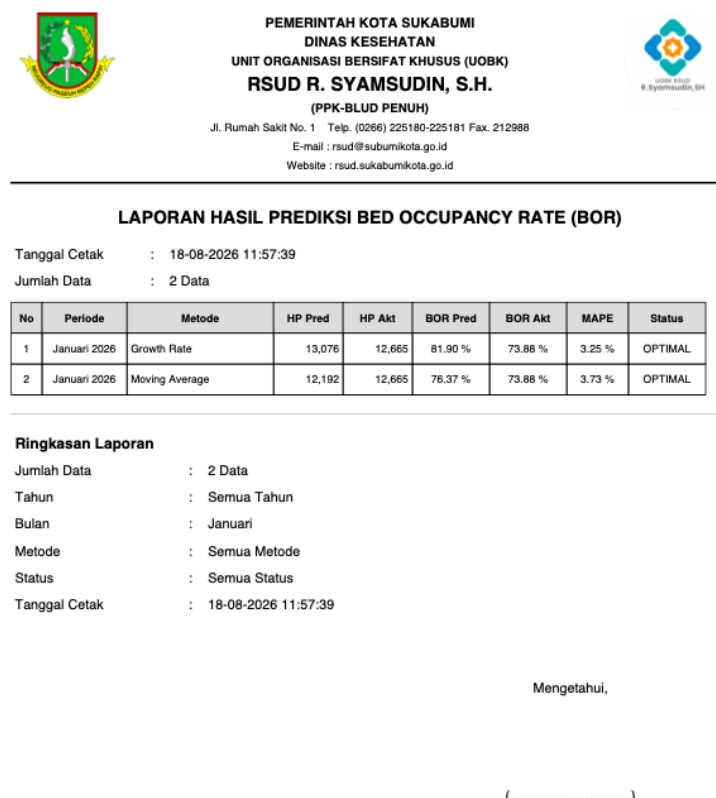


Figure 12. Printed Report Output

System Testing

System testing was conducted using Black Box Testing to ensure that each system function operated as intended. Testing covered the main features available in the system by comparing the obtained results with the expected results.

Table 2. Black Box Testing Results

N o.	System Feature	Test Scenario	Expected Result	Status
1	Login	User enters a valid username and password.	The system displays the main page according to the user's access rights.	Valid
2	User Management	Administrator adds, edits, and deletes user data.	User data are successfully managed and stored in the database.	Valid
3	Historical Data Input	Medical record officer enters hospital historical data.	Historical hospital data are successfully stored in the database.	Valid
4	Prediction Calculation	Medical record officer enters prediction data.	The system displays BOR predictions using Growth Rate and Moving Average.	Valid
5	MAPE Calculation	Medical record officer calculates prediction accuracy.	The system displays the MAPE value according to the calculation result.	Valid
6	Early Warning System Status	Predicted BOR falls within a specified category.	The system displays Low, Optimal, or High status.	Valid
7	Report	User accesses the prediction-data report.	The system displays the prediction-data report correctly.	Valid
8	Logout	User exits the system.	The system redirects the user to the login page.	Valid

Discussion

Bed Occupancy Rate prediction was calculated using two methods, namely Growth Rate and Moving Average. The data used as the prediction basis were hospital historical data from previous periods. The calculations produced predicted patient care days (HP Pred), which were then used to obtain the predicted BOR (BOR Pred). The actual data consisted of actual patient care days (HP Act) and actual BOR (BOR Act) obtained from hospital records. The difference between predicted and actual values was then used to calculate Mean Absolute Percentage Error as an indicator of prediction accuracy.

Table 3. Calculation Results

No .	Period	Method	HP Pred	HP Act	BOR Pred	BOR Act	MAPE
1	January	Growth Rate	13,076	12,665	81.90%	73.88%	3.25%
2	January	Moving Average	12,192	12,665	76.37%	73.88%	3.73%
3	February	Growth Rate	13,050	10,642	84.28%	68.73%	22.63%
4	February	Moving Average	12,170	10,642	78.60%	68.73%	3.25%
5	March	Growth Rate	8,942	10,628	52.26%	62.00%	15.68%
6	March	Moving Average	11,866	10,628	69.22%	62.00%	11.65%
7	April	Growth Rate	10,614	12,020	63.98%	72.45%	11.70%
8	April	Moving Average	11,312	12,020	68.98%	72.45%	5.89%
9	May	Growth Rate	13,594	12,878	79.30%	75.12%	5.56%
10	May	Moving Average	11,097	12,878	64.73%	75.12%	13.83%
11	June	Growth Rate	13,797	12,679	83.16%	76.43%	8.82%
12	June	Moving Average	11,842	12,679	71.38%	76.43%	6.60%

In January, the Growth Rate method produced an HP Pred of 13,076, while the actual patient care days recorded by the hospital were 12,665. This resulted in a BOR Pred of 81.90%, whereas the actual BOR was 73.88%. Comparison of the predicted and actual values produced a MAPE of 3.25%. In the same period, the Moving Average method produced an HP Pred of 12,192 with a BOR Pred of 76.37%. The actual hospital data showed 12,665 patient care days and an actual BOR of 73.88%. Based on this comparison, the MAPE was 3.73%. This value indicates that the Moving Average prediction had an error rate of 3.73% relative to the actual January data. The same calculations were performed from February to June for both methods. The test results showed differences in error levels between Growth Rate and Moving Average in each period. These differences are related to the characteristics of each method in processing historical data. Growth Rate accounts for growth changes between historical periods, whereas Moving Average uses the average of three historical periods, so its prediction tends to follow the average of previous data.

The calculation results were subsequently used as the basis for evaluating the application of the prediction methods in the system. In addition to producing predicted BOR values, the system presents actual values and MAPE so that users can compare predictions with conditions

that actually occurred. This information then supports the use of prediction results as part of an early warning system for bed-occupancy conditions.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the system implementation and testing results, this study successfully developed a web-based Bed Occupancy Rate prediction information system using Growth Rate and Moving Average methods. The system can manage historical BOR data, perform predictions automatically, evaluate accuracy using Mean Absolute Percentage Error, and present prediction results through an Early Warning System. The application of Growth Rate and Moving Average shows that both methods can be used to predict BOR for the next period with different characteristics. Growth Rate is more responsive in detecting changes in bed-occupancy trends, whereas Moving Average produces more stable predictions for fluctuating data patterns. Evaluation using MAPE indicates that the prediction results provide useful levels of accuracy and can therefore be used as supporting information in decision-making processes. The implementation of the Early Warning System constitutes the main contribution of this study because it transforms BOR prediction results into information that is easier to interpret through safe, alert, and critical categories. This approach enables hospital management to obtain an early warning of potential changes in bed occupancy so that service-capacity evaluation can be conducted before overcapacity occurs. Overall, the developed system functions not only as a medium for processing hospital statistics but also as a data-driven decision-support tool. The predictive information helps hospital management assess whether the bed capacity used in the previous period remains adequate for service needs in the following period, allowing bed additions, reductions, or redistribution to be planned more accurately, effectively, and proactively.

Limitations

The scope of this study was limited to system implementation and Black Box Testing; the maintenance stage had not yet been conducted. The prediction evaluation used the historical data available in the study period and two relatively simple forecasting methods, namely Growth Rate and Moving Average. Therefore, the findings should be interpreted within the operational context and data characteristics of RSUD Syamsudin S.H.

Recommendations

Further implementation should include system maintenance and periodic evaluation using newly accumulated data. Future studies may compare Growth Rate and Moving Average with other forecasting approaches and evaluate usability, operational impact, and decision-support effectiveness over a longer observation period.

Author Contributions

Shilvana Mahardika contributed to research conceptualization, data collection, system analysis, system development, testing, data interpretation, and manuscript preparation. Irda Sari and Adhita Arif Setyawan contributed to supervision, methodological guidance, interpretation of findings, critical review, and manuscript revision. All authors should review and approve the final manuscript before submission.

AI Disclosure Statement

While preparing this English-language manuscript, the authors used ChatGPT by OpenAI for translation and academic-language editing. The authors are responsible for reviewing the translated content, verifying its accuracy against the original Indonesian manuscript, and approving the final version before publication.

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REFERENCES

- Adelard, R., & Narulita, S. (2026). Predicting the Bed Occupancy Rate (BOR) of psychiatric hospitals using the SARIMA method: Comparison of weekly and monthly seasonal patterns. *Dinamik*, 31(2), 455–466. doi:10.35315/dinamik.v31i2.10446. Penelitian ini sangat dekat dengan topik Anda, karena secara langsung melakukan prediksi BOR menggunakan time-series forecasting.
- Avinash, G., Pachori, H., Sharma, A., & Mishra, S. (2025). Time series forecasting of bed occupancy in mental health facilities in India using machine learning. *Scientific Reports*, 15, 2686. doi:10.1038/s41598-025-86418-9.
- Ayu, D. D., Rahayu, D. S., & Gojali, A. (2026). Quadratic regression predicts Bed Occupancy Rate recovery at Depok Regional Hospital. *Academia Open*, 11(2). doi:10.21070/acopen.11.2026.14596. Artikel ini penting karena menggunakan model pertumbuhan/tren untuk memproyeksikan BOR sampai tahun berikutnya, sehingga dekat dengan komponen growth rate penelitian Anda.
- Cheng, Q., Argon, N. T., Evans, C. S., Liu, Y., Platts-Mills, T. F., & Ziya, S. (2021). Forecasting emergency department hourly occupancy using time series analysis. *The American Journal of Emergency Medicine*, 48, 177–182. doi:10.1016/j.ajem.2021.04.075. Studi ini juga membandingkan forecasting dengan pendekatan rolling average, sehingga sangat berguna sebagai dasar metode moving average.
- Eyles, E., Redaniel, M. T., Jones, T., Prat, M. D., & Keen, T. (2022). Can we accurately forecast non-elective bed occupancy and admissions in the NHS? A time-series MSARIMA analysis of longitudinal data from an NHS Trust. *BMJ Open*, 12(4), e056523. doi:10.1136/bmjopen-2021-056523.
- Fattouh, M., Lyssenko, L., Heilmeyer, F., Ball, T., & Haverkamp, C. (2026). Forecasting hospital bed occupancy: A time series approach with Prophet. *BMC Medical Informatics and Decision Making*, 26, 162. doi:10.1186/s12911-026-03542-w. Penelitian ini juga mengimplementasikan hasil prediksi ke dalam dashboard untuk capacity planning, sangat sesuai dengan konsep sistem web dan early warning Anda.
- Fitriani, Z., Susanti, F. A., & Hardiana, H. (2024). Efisiensi pengelolaan tempat tidur instalasi rawat inap menggunakan Grafik Barber Johnson di Rumah Sakit X tahun 2023. *Jurnal Manajemen Informasi dan Administrasi Kesehatan*, 7(1), 10–17. doi:10.32585/jmiak.v7i1.5058.
- Gitto, S., Di Mauro, C., Ancarani, A., & Mancuso, P. (2021). Forecasting national and regional level intensive care unit bed demand during COVID-19: The case of Italy. *PLoS ONE*, 16(2), e0247726. doi:10.1371/journal.pone.0247726. Studi ini menggunakan growth models untuk memproyeksikan kebutuhan tempat tidur, sehingga penting untuk mendukung metode growth rate.
- Heins, J., Schoenfelder, J., Heider, S., Heller, A. R., & Brunner, J. O. (2022). A scalable forecasting framework to predict COVID-19 hospital bed occupancy. *INFORMS Journal on Applied Analytics*, 52(6), 508–523. doi:10.1287/inte.2021.1115.
- Huang, Y., Xu, C., Ji, M., Xiang, W., & He, D. (2020). Medical service demand forecasting using a hybrid model based on ARIMA and self-adaptive filtering method. *BMC Medical Informatics and Decision Making*, 20, 237. doi:10.1186/s12911-020-01256-1.
- Indra, D. N., Suswojo, H., & Absor, S. (2026). Analisis trend Bed Occupancy Rate (BOR) di Klinik Mitra 39 dalam kurun waktu 3 tahun terakhir. *Journal of Public Health Science*,

- 3(1), 25–32. doi:10.70248/jophs.v3i1.3568. Artikel ini sangat penting karena melakukan proyeksi BOR menggunakan analisis deret waktu dan metode least square.
- Josling, G., Boyle, J., Riahi, V., Naumoski, Z., O’Sullivan, K., Jayasena, R., & Khanna, S. (2025). Demand prediction for better hospital capacity management. *Studies in Health Technology and Informatics*, 333, 70–75. doi:10.3233/SHTI251578. Studi ini membandingkan SARIMAX dengan rolling window dan six-week rolling average, sehingga sangat bagus untuk justifikasi penggunaan moving average.
- Kutafina, E., Bechtold, I., Kabino, K., & Jonas, S. M. (2019). Recursive neural networks in hospital bed occupancy forecasting. *BMC Medical Informatics and Decision Making*, 19, 39. doi:10.1186/s12911-019-0776-1.
- Mandala, E. M. S. (2025). The factors affecting of Bed Occupancy Rate (BOR) in hospital. *Professional Health Journal*, 7(2), 732–744. doi:10.54832/phj.v7i2.1246. Artikel ini dapat digunakan untuk menjelaskan variabel dan faktor yang menyebabkan naik-turunnya BOR.
- Mayangsari, A. I., Hidayat, B., & Intama, C. N. (2022). Hubungan demand kelas perawatan berdasarkan Bed Occupancy Ratio terhadap pendapatan di instalasi pelayanan rawat inap. *Jurnal Ilmiah Universitas Batanghari Jambi*, 22(2), 1015–1020. doi:10.33087/jiubj.v22i2.2216.
- Nawawi, A., Sufyana, C. M., & Gunawan, E. (2024). Implementasi sistem informasi triase IGD pasien rawat jalan di Rumah Sakit X. *Jurnal Teknologi Sistem Informasi dan Aplikasi*, 7(2), 752–759. doi:10.32493/jtsi.v7i2.39539. Artikel ini mendukung aspek implementasi sistem informasi rumah sakit dan pengujian sistem.
- Oktarina, R., Yunengsih, Y., & Sufyana, C. M. (2026). Implementasi sistem informasi rekapitulasi hasil analisis kuantitatif berkas rekam medis pasien rawat inap berbasis website di RS Edelweiss Bandung. *Dinasti Health and Pharmacy Science*, 3(3), 102–115. doi:10.38035/dhps.v3i3.3582. Ini merupakan salah satu artikel Candra Mecca Sufyana yang paling sesuai untuk bagian web-based hospital information system karena sistem dibangun untuk mengintegrasikan dan mengotomatisasi pengolahan data rawat inap.
- Ordu, M., Demir, E., Tofallis, C., & Gunal, M. M. (2021). A novel healthcare resource allocation decision support tool: A forecasting-simulation-optimization approach. *Journal of the Operational Research Society*, 72(3), 485–500. doi:10.1080/01605682.2019.1700186. Artikel ini sangat relevan dengan konsep decision support dan perencanaan kapasitas tempat tidur berdasarkan forecasting.
- Pramudia, T., Yunengsih, Y., & Sufyana, C. M. (2024). Desain sistem informasi administrasi rawat inap pasien BPJS IGD di Rumah Sakit Muhammadiyah Bandung dengan metode Waterfall. *Journal of Medical Record Student*, 2(3), 1–10. Artikel ini dapat menjadi dasar metode pengembangan web/information system rumah sakit pada penelitian BOR Anda.
- Rohman, H. (2019). Analisis efisiensi BOR, LOS, TOI, dan BTO berdasarkan Grafik Barber Johnson. *Jurnal Ilmu Kesehatan Bhakti Setya Medika*, 3, 11–21. doi:10.56727/bsm.v3i.41.
- Sahputra, E. S. A., Syibaihi, A., Alamsyah, B., Azhari, A. F., & Shobiha, S. (2025). Analysis of Waterfall and Agile Scrum approaches in information technology project management. *Jurnal Ekonomi Teknologi dan Bisnis*, 4(7). doi:10.57185/jetbis.v4i7.192. Referensi ini dapat dipakai pada bagian pemilihan metode pengembangan perangkat lunak.
- Sari, I., & Herfiyanti, L. (2019). Analisis metode Barber Johnson untuk menilai efisiensi pelayanan rumah sakit umum di Kota Bandung. *Jurnal Infokes*, 2(2), 59–71. doi:10.56689/infokes.v2i2.45. Ini relevan karena berasal dari Politeknik Piksi Ganesha dan secara langsung membahas BOR, LOS, TOI, dan BTO.
- Simbolon, P., Laia, T. C., & Hulu, L. P. C. (2025). Edukasi penggunaan tempat tidur. *Jurnal Bersama Pengabdian Kepada Masyarakat (SAMAMAS)*, 1(1), 18–24. doi:10.55123/samamas.v1i1.195.

- Tello, M., Reich, E. S., Puckey, J., Maff, R., Garcia-Arce, A., Bhattacharya, B. S., & Feijoo, F. (2022). Machine learning based forecast for the prediction of inpatient bed demand. *BMC Medical Informatics and Decision Making*, 22, 55. doi:10.1186/s12911-022-01787-9. Artikel ini secara langsung menghubungkan forecasting dengan deteksi risiko overcrowding dan capacity management.
- Vieira, A., Sousa, I., & Dória-Nóbrega, S. (2023). Forecasting daily admissions to an emergency department considering single and multiple seasonal patterns. *Healthcare Analytics*, 3, 100146. doi:10.1016/j.health.2023.100146. Artikel ini membandingkan regresi time series, ARIMA/SARIMA, dan exponential smoothing, sehingga baik sebagai landasan metodologis forecasting sederhana.