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Comparison of Turnaround Time for Complete Blood Count Before and After LIS–HMIS Integration in a Clinical Laboratory

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ABSTRACT

Turnaround Time (TAT) is a key indicator of clinical laboratory performance as it affects diagnostic accuracy and clinical decision-making. This study aimed to compare complete blood count (CBC) TAT before and after the implementation of LIS–HMIS integration at Tabanan Regional General Hospital. This study used a quantitative comparative design with secondary data obtained from LIS and HMIS logs. A total of 316 records before integration (January–March 2025) and 316 records after integration (May–July 2025) were selected using simple random sampling. Data were analyzed using the Mann–Whitney test with a significance level of 0.05. The results showed that the proportion of TAT meeting the standard increased from 71.52% before integration to 75.95% after integration. However, statistical analysis indicated no significant difference (p=0.259). These findings suggest that LIS–HMIS integration improves operational efficiency, although the improvement is not statistically significant.

Keywords: *Turnaround Time, Complete Blood Count, Hospital Management Information System, Laboratory Information System*

ABSTRAK

Turnaround Time (TAT) merupakan indikator utama mutu pelayanan laboratorium klinik karena berpengaruh terhadap ketepatan diagnosis dan pengambilan keputusan klinis. RSUD Tabanan telah menerapkan *Laboratory Information System* (LIS) yang diintegrasikan (*bridging*) dengan Sistem Informasi Manajemen Rumah Sakit (SIMRS) untuk meningkatkan efisiensi pelayanan

laboratorium. Penelitian ini bertujuan untuk menganalisis perbedaan TAT pemeriksaan darah lengkap (DL) sebelum dan sesudah penerapan *bridging* LIS dengan SIMRS di Instalasi Laboratorium Klinik RSUD Tabanan. Penelitian ini menggunakan desain kuantitatif komparatif dengan data sekunder yang diperoleh dari *log* LIS dan SIMRS. Sampel terdiri dari 316 data pemeriksaan sebelum *bridging* (bulan Januari, Pebruari dan Maret tahun 2025) dan 316 data sesudah *bridging* (bulan Mei, Juni dan Juli tahun 2025) yang dipilih dengan teknik *simple random sampling*. Analisis data menggunakan uji *Mann–Whitney* dengan tingkat signifikansi 0,05. Hasil penelitian menunjukkan bahwa capaian TAT pemeriksaan DL sesuai standar sebelum bridging adalah 71,52 %, sedangkan sesudah bridging meningkat menjadi 75,95 %. Hasil uji statistik menunjukkan nilai *p-value* sebesar 0,259 (sig.> 0,05), yang berarti tidak terdapat perbedaan TAT pemeriksaan DL sebelun dan sesudah *bridging* LIS dengan SIMRS. Hal ini disebabkan capaian TAT pemeriksaan DL sesuai standar sebelum dan sesudah *bridging* LIS dengan SIMRS kenaikannya tidak terlalu besar yaitu 4,43 %. Meskipun demikian, peningkatan capaian TAT mengindikasikan adanya peningkatan efisiensi pelayanan laboratorium setelah penerapan *bridging* LIS dengan SIMRS.

Kata kunci: *Turnaround Time*, Darah lengkap, SIMRS, LIS

INTRODUCTION

Clinical laboratory services are a critical component of hospital healthcare systems because they support disease diagnosis, therapeutic monitoring, and medical decision-making. The World Health Organization (WHO) reported that approximately 70% of medical decisions are influenced by diagnostic test results, including laboratory examinations, emphasizing the importance of accurate and timely laboratory services(1,2). As the demand for rapid and reliable laboratory testing continues to increase, laboratory operations have gradually shifted from manual processes to automated systems. This transformation requires competent laboratory personnel and effective information technology systems to ensure high-quality laboratory performance and patient care. In Indonesia, clinical laboratories are required to comply with quality standards and accreditation requirements as stipulated by the Ministry of Health. One of the most important indicators of laboratory service quality is Turnaround Time (TAT), defined as the interval between specimen receipt and result reporting(3,4). Delays in TAT may adversely affect clinical decision-making, postpone treatment initiation, and reduce patient satisfaction. National standards recommend a TAT of ≤60 minutes for complete blood count (CBC) examinations and ≤140 minutes for clinical chemistry testing(5).

Complete blood count examination is among the most frequently requested laboratory tests and plays a crucial role in supporting diagnosis, treatment monitoring, and patient management. Therefore, timely reporting of CBC results is essential for ensuring effective healthcare delivery. To improve laboratory efficiency and reduce reporting delays, healthcare institutions increasingly adopt Laboratory Information Systems (LIS), which are computerized systems designed to manage laboratory workflows from pre-analytical, analytical, and post-analytical phases (6,7).

Laboratory Information Systems facilitate patient registration, specimen tracking, data processing, result validation, and report distribution in a more integrated manner. Previous studies have demonstrated that LIS implementation significantly improves laboratory workflow efficiency and reduces turnaround time. Indyanty et al. reported a significant reduction in TAT for hematology and clinical chemistry examinations following LIS implementation in a regional hospital setting(8). Similarly, Hammoudeh et al. found that the average TAT for inpatient CBC testing decreased from more than 180 minutes to approximately 103 minutes after LIS utilization(8). Musawir et al. further highlighted improvements in service quality and patient satisfaction associated with laboratory information technology implementation(9).

Despite these advantages, standalone LIS applications may still create inefficiencies when they are not integrated with the Hospital Information Management System (HIMS) or Sistem Informasi Manajemen Rumah Sakit (SIMRS). In non-integrated environments, laboratory requests from the hospital information system must be manually re-entered into the LIS, examination results often require

manual printing, and result delivery depends on patients or ward staff. These processes increase workload, prolong turnaround time, and elevate the risk of transcription errors. Consequently, many healthcare institutions have adopted bridging systems that integrate LIS and SIMRS to enable seamless electronic data exchange between both platforms(10).

Several studies have reported positive outcomes following LIS-SIMRS integration. Integrated systems allow laboratory requests to be transmitted automatically from SIMRS to LIS, while validated laboratory results can be electronically returned to clinicians without manual intervention. Such integration reduces administrative workload, minimizes data-entry errors, and improves reporting efficiency(11). However, previous studies have also documented several implementation challenges, including duplicate patient records, discrepancies in medical record numbers, software bugs, network interruptions, and system incompatibilities(12). These technical issues may affect laboratory performance and contribute to prolonged turnaround time.

Tabanan Regional General Hospital, a Type B teaching and referral hospital in Bali, has implemented a Hospital Information Management System since 2000. The Clinical Laboratory Installation introduced a Laboratory Information System in 2018 and began implementing LIS-SIMRS bridging in April 2025. Although the integration was expected to improve laboratory efficiency, several operational problems remain, including duplicate patient data, unsuccessful transmission of laboratory requests from SIMRS to LIS, limited computer resources, insufficient information technology support, and network instability. These conditions occasionally require manual data entry, manual report printing, and physical retrieval of laboratory reports, resulting in prolonged turnaround time. Preliminary observations revealed that the turnaround time for complete blood count examinations before LIS-SIMRS bridging frequently exceeded 100 minutes, substantially higher than the recommended standard of less than 60 minutes. These delays may compromise laboratory service quality, delay diagnosis, and postpone patient treatment.

Although previous studies have investigated the effectiveness of LIS implementation, limited evidence is available regarding the impact of LIS-SIMRS bridging on complete blood count turnaround time in Indonesian regional hospitals. Furthermore, studies evaluating laboratory performance before and after system integration remain scarce. Therefore, the novelty of this study lies in its evaluation of the effect of LIS-SIMRS bridging on complete blood count turnaround time within a hospital laboratory setting using a before-and-after comparative approach.

This study aimed to determine the difference in complete blood count turnaround time before and after the implementation of Laboratory Information System and Hospital Information Management System bridging at the Clinical Laboratory Installation of Tabanan Regional General Hospital. The findings are expected to provide evidence regarding the effectiveness of information system integration in improving laboratory service quality and operational efficiency.

METHODS

This study employed a quantitative descriptive design to evaluate the turnaround time (TAT) of complete blood count (CBC) examinations before and after the implementation of bridging between the Laboratory Information System (LIS) and the Hospital Information Management System (HIMS/SIMRS) at the Clinical Laboratory Installation of Tabanan Regional General Hospital. The study was conducted from October to November 2025 at the Clinical Pathology Unit of Tabanan Regional General Hospital, Bali, Indonesia.

The study population consisted of all complete blood count examination records generated during two observation periods: before LIS-SIMRS bridging (January–March 2025) and after LIS-SIMRS bridging (May–July 2025). Each period comprised approximately 1,500 examination records obtained from both outpatient and inpatient services without additional laboratory test requests.

Samples were selected using a simple random sampling technique from eligible complete blood count examination records within each study period. The inclusion criteria consisted of CBC requests originating from the hospital information system and processed through the Clinical Laboratory

Installation. Records with incomplete timestamps or missing laboratory information were excluded from the analysis. The independent variable was the implementation status of LIS-SIMRS integration, categorized as before bridging and after bridging. The dependent variable was turnaround time (TAT), defined as the time interval between the receipt of a laboratory examination request and the availability of validated results for clinicians. TAT data were obtained from electronic timestamps recorded within the LIS and SIMRS databases. For descriptive analysis, TAT values were categorized as compliant with the national standard (<60 minutes) or non-compliant (≥60 minutes).

Secondary data were collected through retrospective extraction of laboratory records from the integrated LIS-SIMRS database. For each selected record, the following information was obtained: medical record code, examination request time, result verification time, and calculated turnaround time. TAT was calculated using the following formula:

TAT = Verification Time − Examination Request Time

The resulting data were grouped into pre-bridging and post-bridging categories for subsequent statistical analysis. Data analysis was performed using IBM SPSS Statistics version 26. Descriptive (univariate) analysis was conducted to summarize the distribution of TAT values and the proportion of examinations meeting the established TAT standard. Inferential (bivariate) analysis was performed using the Mann–Whitney U test because the TAT data were not normally distributed. A p-value of <0.05 was considered statistically significant. Statistical significance indicated a difference in complete blood count turnaround time before and after LIS-SIMRS bridging implementation.

This study received ethical approval from Tabanan Regional General Hospital under Ethical Clearance Number 445/813/TIMKORDIK/RSUD/2025 and institutional research permission Number 445/818/TIMKORDIK/RSUD/2025. The study exclusively utilized secondary data extracted from laboratory information systems. To ensure confidentiality, all patient identifiers were removed and replaced with research codes prior to analysis. Data were used solely for research purposes and managed in accordance with ethical principles of confidentiality, transparency, and accountability.

RESULTS

Characteristics of the Study Setting

This study was conducted at the Clinical Laboratory Installation of Tabanan Regional General Hospital, a secondary referral teaching hospital that provides clinical pathology, anatomical pathology, clinical microbiology, and blood management services. Complete blood count (CBC) testing represents one of the most frequently requested laboratory examinations and plays a critical role in supporting clinical decision-making. To improve laboratory workflow efficiency, the hospital implemented a Laboratory Information System (LIS), which was subsequently integrated with the Hospital Information Management System (SIMRS) through a bridging system in April 2025.

Turnaround Time of Complete Blood Count Examinations Before LIS-SIMRS Bridging

A total of 316 complete blood count examination records from January to March 2025 were analyzed to evaluate turnaround time performance before LIS-SIMRS bridging implementation. The distribution of turnaround time compliance is presented in Table 1.

Table 1. Turnaround Time Performance Before LIS-SIMRS Bridging

TAT Category	Number of Records (n)	Percentage (%)
Compliant with TAT Standard (<60 minutes)	226	71.52

Non-compliant with TAT Standard (≥60 minutes)	90	28.48
Total	316	100.00

As shown in Table 1, most complete blood count examinations performed before LIS-SIMRS bridging met the established turnaround time standard. A total of 226 examinations (71.52%) were completed within 60 minutes, while 90 examinations (28.48%) exceeded the recommended turnaround time threshold.

Turnaround Time of Complete Blood Count Examinations After LIS-SIMRS Bridgin

To evaluate the impact of system integration, 316 complete blood count examination records from May to July 2025 were analyzed following the implementation of LIS-SIMRS bridging. The results are presented in Table 2.

Table 2. Turnaround Time Performance After LIS-SIMRS Bridging

TAT Category	Number of Records (n)	Percentage (%)
Compliant with TAT Standard (<60 minutes)	240	75.95
Non-compliant with TAT Standard (≥60 minutes)	76	24.05
Total	316	100.00

Following system integration, the proportion of complete blood count examinations meeting the turnaround time standard increased to 75.95% (240 examinations), while the proportion exceeding the standard decreased to 24.05% (76 examinations). These findings suggest an improvement in laboratory reporting performance after the implementation of LIS-SIMRS bridging.

Comparison of Turnaround Time Before and After LIS-SIMRS Bridging

To determine whether the observed differences were statistically significant, a Mann–Whitney U test was performed. The results are presented in Table 3.

Table 3. Comparison of Turnaround Time Before and After LIS-SIMRS Bridging

Variable	p-value
Complete Blood Count Turnaround Time Before and After LIS-SIMRS Bridging	0.259

The Mann–Whitney U test yielded a p-value of 0.259, which was higher than the predetermined significance level of 0.05. Therefore, no statistically significant difference was observed in complete blood count turnaround time before and after the implementation of LIS-SIMRS bridging. Although the percentage of examinations meeting the turnaround time standard increased from 71.52% to 75.95% following system integration, this improvement was not sufficient to demonstrate a statistically significant effect. These findings indicate that the implementation of LIS-SIMRS bridging alone did not significantly reduce turnaround time during the study period.

DISCUSSION

This study evaluated the effect of Laboratory Information System (LIS) and Hospital Information Management System (SIMRS) bridging on the turnaround time (TAT) of complete blood count (CBC) examinations at the Clinical Laboratory Installation of Tabanan Regional General Hospital. The findings demonstrated that before the

implementation of LIS-SIMRS bridging, 71.52% of CBC examinations met the established TAT standard (<60 minutes), whereas after implementation, the proportion increased to 75.95%. Although this increase indicates a positive trend toward improved laboratory performance, statistical analysis using the Mann–Whitney U test showed no significant difference between the two periods ($p = 0.259$).

The observed increase in TAT compliance following system integration is consistent with the theoretical advantages of laboratory information technology. Bridging between LIS and SIMRS facilitates automatic transmission of laboratory orders, reduces duplicate data entry, minimizes transcription errors, and enables faster reporting of validated laboratory results. Previous studies have reported that laboratory information systems improve workflow efficiency and reduce administrative burdens by integrating pre-analytical, analytical, and post-analytical processes(13). Consequently, the increase in TAT compliance observed in this study may reflect the operational benefits of electronic data exchange between hospital and laboratory information systems.

However, despite the observed improvement, the absence of a statistically significant difference suggests that system integration alone may not be sufficient to substantially reduce turnaround time. Laboratory performance is influenced by multiple factors beyond information technology infrastructure. Delays may occur during specimen collection, specimen transportation, sample preparation, instrument operation, result verification, and report validation processes. Therefore, improvements in information systems must be accompanied by optimization of laboratory workflow and human resource management to achieve a meaningful reduction in TAT(5).

Several operational challenges identified during the implementation period may explain the lack of significant improvement. According to observations conducted at the study site, technical issues such as duplicate patient records, unsuccessful transmission of laboratory requests from SIMRS to LIS, network instability, limited computer availability, and insufficient information technology support were still encountered. These conditions occasionally required manual intervention, including re-entry of patient data and manual printing of laboratory reports, thereby reducing the expected efficiency gains from system integration. Similar challenges have been reported in previous studies, which identified software compatibility problems, network interruptions, and data synchronization failures as major barriers to successful health information system integration(14).

Another possible explanation is that laboratory turnaround time is strongly affected by organizational and workload factors. The study was conducted in a busy referral hospital where fluctuations in patient volume, staffing levels, and specimen workload may influence laboratory performance. Previous research has demonstrated that increased specimen volume and workforce limitations are associated with prolonged turnaround time despite the availability of automated laboratory systems(5). Therefore, the effectiveness of LIS-SIMRS bridging may have been partially offset by operational pressures occurring during the study period.

Interestingly, although no statistically significant difference was identified, the proportion of examinations exceeding the TAT standard decreased from 28.48% before bridging to 24.05% after bridging. This finding suggests that LIS-SIMRS integration may contribute to incremental improvements in service efficiency. The absence of statistical significance could be related to the relatively short post-implementation observation period, during which laboratory personnel and clinicians were still adapting to the new

integrated workflow. Technology adoption often requires an adjustment phase before its full benefits become evident in routine practice(13,15,16).

The novelty of this study lies in its evaluation of LIS-SIMRS bridging implementation within a clinical laboratory setting in a regional referral hospital in Indonesia. While previous studies have primarily focused on the implementation of standalone laboratory information systems, limited evidence is available regarding the impact of integrated LIS-SIMRS platforms on laboratory turnaround time. The present findings indicate that although system integration improves operational connectivity and slightly increases TAT compliance, additional interventions addressing technical infrastructure, workflow management, and human resources are necessary to achieve significant improvements in laboratory performance.

This study has several limitations. First, the evaluation focused exclusively on complete blood count examinations and may not represent other laboratory tests with different analytical workflows. Second, the study did not assess specific causes of delayed turnaround time, such as specimen transport duration, instrument downtime, or staffing shortages. Third, the relatively short post-implementation period may not fully capture the long-term effects of LIS-SIMRS integration. Future studies should incorporate longer observation periods and evaluate additional operational variables to provide a more comprehensive assessment of information system integration in clinical laboratories.

CONCLUSION

This study evaluated the impact of Laboratory Information System (LIS) and Hospital Information Management System (SIMRS) bridging on the turnaround time (TAT) of complete blood count (CBC) examinations at the Clinical Laboratory Installation of Tabanan Regional General Hospital. The findings demonstrated that the proportion of CBC examinations meeting the established TAT standard increased following the implementation of LIS-SIMRS bridging. However, statistical analysis revealed that the observed improvement was not significant ($p = 0.259$). These results indicate that although system integration contributed to a positive trend in laboratory service efficiency, the implementation of LIS-SIMRS bridging alone was insufficient to produce a statistically significant reduction in turnaround time. The findings suggest that laboratory performance is influenced not only by information system integration but also by other operational factors, including workflow management, staffing, infrastructure reliability, network stability, and pre-analytical processes. Therefore, optimization of laboratory services requires a comprehensive approach that combines technological advancement with organizational and operational improvements.

DISCUSSION

1. WHO. Strengthening diagnostics capacity [Internet]. 2023 [cited 2026 Feb 3]. Available from: https://www.who.int/activities/strengthening-diagnostics-capacity

2. Marzinke MA, Clarke W, Dietzen DJ, Hoofnagle AN, McMillin GA, Willrich MA V. The VALIDity of Laboratory Developed Tests: Leave it to the experts? J mass Spectrom Adv Clin lab. 2023 Jan;27:1–6.

3. Singhal N, Vardhan H, Jain R, Gupta P, Pandey A, Wagri NK, et al. Role of artificial intelligence in automating diagnostic procedures in clinical microbiology laboratories.

Curr Res Biotechnol [Internet]. 2025;10:100351. Available from: https://www.sciencedirect.com/science/article/pii/S2590262825000826

4. Lippi G, Ognibene A. Perspectives on emerging challenges and training needs for the Laboratory Medicine specialist of the future. Adv Lab Med. 2026 Mar;7(1):16–25.

5. K G N, Ahmad S, Kumar P, Mahto M, Bharti S. Turnaround Time of Laboratory Investigations and Factors Responsible for Delays in a Tertiary Care Teaching Hospital in Eastern India: A Cross-Sectional Study. Cureus. 2026 Jan;18(1):e100703.

6. Seo IH, Lee YJ. Usefulness of Complete Blood Count (CBC) to Assess Cardiovascular and Metabolic Diseases in Clinical Settings: A Comprehensive Literature Review. Biomedicines. 2022 Oct;10(11).

7. Cabalar I, Le TH, Silber A, O'Hara M, Abdallah B, Parikh M, et al. The role of blood testing in prevention, diagnosis, and management of chronic diseases: A review. Am J Med Sci [Internet]. 2024;368(4):274–86. Available from: https://www.sciencedirect.com/science/article/pii/S0002962924011698

8. Lukić V. Laboratory Information System - Where are we Today? J Med Biochem. 2017 Sep;36(3):220–4.

9. Hammoudeh S, Amireh A, Jaddoua S, Nazer L, Jazairy E, Al-Dewiri R. The Impact of Lean Management Implementation on Waiting Time and Satisfaction of Patients and Staff at an Outpatient Pharmacy of a Comprehensive Cancer Center in Jordan. Hosp Pharm. 2021 Dec;56(6):737–44.

10. Febrita H, Martunis M, Syahrizal D, Abdat M, Bakhtiar B. Analysis Of Hospital Information Management System Using Human Organization Fit Model. J Adm Kesehat Indones. 2021;9:23.

11. Zheng F, Wang K, Wang Q, Yu T, Wang L, Zhang X, et al. Factors Influencing Clinicians' Use of Hospital Information Systems for Infection Prevention and Control: Cross-Sectional Study Based on the Extended DeLone and McLean Model. J Med Internet Res. 2023 Jun;25:e44900.

12. Tsai CH, Eghdam A, Davoody N, Wright G, Flowerday S, Koch S. Effects of Electronic Health Record Implementation and Barriers to Adoption and Use: A Scoping Review and Qualitative Analysis of the Content. Life (Basel, Switzerland). 2020 Dec;10(12).

13. Edayan JM, Gallemit AJ, Sacala N, Palmer XL, Potter L, Rarugal J, et al. Integration Technologies in Laboratory Information Systems: A Systematic Review. Informatics Med Unlocked. 2024;50:101566.

14. Alzghaibi H, Hutchings HA. Barriers to the implementation of large-scale electronic health record systems in primary healthcare centers: a mixed-methods study in Saudi Arabia. Front Med. 2025;12:1516714.

15. Faiz F, Le V, Masli EK. Determinants of digital technology adoption in innovative SMEs. J Innov Knowl [Internet]. 2024;9(4):100610. Available from: https://www.sciencedirect.com/science/article/pii/S2444569X24001495

16. Rahimi B, Nadri H, Lotfnezhad Afshar H, Timpka T. A Systematic Review of the Technology Acceptance Model in Health Informatics. Appl Clin Inform. 2018 Jul;9(3):604–34.