



## Evaluation Of Electronic Medical Record Downtime Management On Patient Service Efficiency At Hospital X

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### Abstract

Electronic medical record (EMR) implementation in hospitals is vulnerable to downtime, during which the system becomes inaccessible because of infrastructure disruption, network failure, software malfunction, or cyberattack, potentially delaying care and increasing patient-safety risks. Evidence concerning how downtime management affects service efficiency in Indonesian hospitals remains limited. This study evaluated EMR downtime management and its implications for patient service efficiency at Hospital X. A descriptive qualitative design was applied using semi-structured interviews with four informants directly involved in downtime management. Data were analyzed using the Miles and Huberman interactive model and validated through source triangulation with internal standard operating procedures and official downtime reports. Hospital X had a basic response mechanism consisting of conversion to manual documentation followed by data re-entry after system recovery, with responsibilities divided between electrical-facility maintenance and the hospital information-system unit. Official documentation for March-April 2026 recorded five downtime events totaling approximately 4 hours 28 minutes, caused by a firewall anomaly, Transmedik server anomalies, and a total power outage. Server anomalies occurred most frequently, while the firewall anomaly produced the longest single disruption. Downtime resulted in patient backlogs, slower clinical services, longer waiting for supporting examinations, and additional staff workload from retrospective data entry. Major constraints were delayed or unclear notifications, uncertain recovery estimates, and dependence on hierarchical approval, whereas existing standard operating procedures did not explicitly define escalation criteria or decision-making authority. Current management is operationally usable but remains predominantly manual. Hospital X therefore requires more structured communication triggers, explicit escalation authority, and consideration of digital backup mechanisms to strengthen service continuity, efficiency, and patient safety during EMR disruption.

**Keywords:** Downtime, Electronic Medical Record, Service Efficiency, Patient Safety, Business Continuity

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## 1. Introduction

Digital transformation in health care has encouraged hospitals to implement electronic medical record (EMR) systems as part of efforts to improve service quality. EMRs can improve operational efficiency, accelerate access to patient information, support clinical decision-making, and enhance patient safety through data integration and clinical decision support systems (Neprash et al., 2022; Jo et al., 2024). In Indonesia, EMR implementation has been further strengthened by Regulation of the Minister of Health of the Republic of Indonesia Number 24 of 2022 concerning medical records, which requires health-care facilities to maintain medical records electronically (Ministry of Health of the Republic of Indonesia, 2022). Despite these benefits, EMR implementation is also challenged by downtime, defined as a condition in which an electronic medical record system becomes partially or completely inaccessible because of system maintenance, hardware disruption, network failure, software error, or cyberattack (Lyon et al., 2023). During downtime, health-care workers may need to temporarily return to manual documentation, potentially causing service delays, increased staff workload, documentation errors, delays in diagnostic or supporting examinations, and greater patient-safety risk (Dameff et al., 2023).

Previous studies have demonstrated the substantial impact of EMR downtime on hospital services. Lyon et al. (2023) described standardized district-level downtime and uptime procedures used during scheduled downtime, including safe and efficient data recovery. Staff feedback in that study identified opportunities to improve resource allocation, support materials, and communication concerning the start and end of downtime, emphasizing the need for stronger contingency planning. Fang et al. (2025) identified 204 EMR downtime events in one hospital, 96.1% of which were unplanned, with incidents occurring more frequently during weekday mornings, a pattern relevant to the events observed at Hospital X. Downtime also affects patient-service efficiency in emergency care. Dameff et al. (2023) reported that major EMR disruption increased health-care workload, length of stay, and crowding in emergency departments. Harmon et al. (2023) similarly reported that unintended EMR consequences, including downtime, can contribute to patient-safety risks such as documentation errors or orders being placed in the wrong patient record. Khairat et al. (2021) found that interruptions during operational care were associated with increased operating-room utilization time and longer hospitalization, although mortality was not increased.

The growth of threats to hospital information systems, particularly cyberattacks, further increases the urgency of downtime preparedness. Neprash et al. (2022) reported 374 ransomware attacks on hospitals, clinics, and other health-care delivery organizations in the United States between 2016 and 2021, with consequences including downtime, cancelled services, ambulance diversion, and exposure of millions of patients' health data. Organizational readiness therefore depends not only on management policies but also on the preparedness of frontline personnel to execute mature contingency procedures that maintain continuity of care and patient safety. Various innovations have been developed to reduce the effects of downtime. Jo et al. (2024) developed an Emergency Query Program





and Emergency Prescription System that allowed clinicians to continue accessing patient information and delivering services digitally during scheduled system maintenance. Their findings showed that backup-system solutions could maintain continuity of care with high user satisfaction, although implementation depends on local information-technology infrastructure and human-resource capability.

Although previous research has examined patient-safety consequences, health-worker workload, and contingency-system development, most studies have been conducted outside Indonesia, where information systems, infrastructure, and governance differ from those of Indonesian hospitals. Research specifically evaluating EMR downtime management in relation to patient-service efficiency in Indonesian public hospitals remains limited. Searches of national scientific databases such as Garuda and Google Scholar through early 2026 also revealed few publications specifically evaluating the conformity of EMR downtime management with hospital standard operating procedures in Indonesia. The novelty of this study lies in its broader evaluative scope. Rather than focusing only on patient-safety consequences or workload, this study simultaneously evaluates four dimensions: downtime handling procedures, division of responsibilities among units, conformity between actual practice and applicable standard operating procedures (SOPs), and the efficiency of handling together with recommendations for improvement, based on actual conditions in an Indonesian public hospital.

Hospital X has implemented an EMR system and is therefore potentially exposed to both scheduled and unscheduled downtime. Such disruptions can affect service speed, administrative processes, medical documentation, laboratory and pharmacy services, and coordination among service units. Official downtime reports for March-April 2026 recorded five events totaling approximately 4 hours 28 minutes, caused by a firewall anomaly, Transmedik server anomalies, and a power outage. These events contributed to patient accumulation, slower clinic services, and additional staff workload because manually recorded data had to be re-entered after recovery. Management was also constrained by miscommunication concerning notification and estimated recovery time and by dependence on hierarchical approval when recovery time could not be estimated, while the applicable SOPs did not explicitly define escalation criteria or authority. Accordingly, this study aimed to evaluate EMR downtime management in relation to patient-service efficiency at Hospital X. The findings are expected to support refinement of contingency planning, improve human-resource preparedness, and strengthen continuity of health-care services when the electronic medical record system is disrupted.

## 2. Research Methods

This study used a descriptive qualitative approach to evaluate EMR downtime management and its relationship with patient-service efficiency at Hospital X. Informants were selected using purposive sampling based on direct involvement in the management and handling of hospital information-system downtime rather than formal educational background. Inclusion criteria were: (1) direct involvement in downtime handling within the respective work unit; (2) at least one year of work experience in the relevant unit; (3) previous experience of an EMR downtime event and participation in its handling; and (4) willingness to participate. Primary data were obtained through semi-structured interviews





with four eligible informants. Interviews were audio-recorded and transcribed verbatim to preserve accuracy before analysis.

**Table 1.** Characteristics of Research Informants

| Informant   | Position                             | Unit               | Length of Service | Highest Education                |
|-------------|--------------------------------------|--------------------|-------------------|----------------------------------|
| Informant 1 | Head of Medical Records Installation | Medical Records    | 15 years          | Diploma III in Medical Records   |
| Informant 2 | System and Network Management        | SIMRS/IT           | 20 years          | Bachelor's degree in Hospitality |
| Informant 3 | Registration Officer                 | Registration       | 1 year 2 months   | Diploma III in Medical Records   |
| Informant 4 | Nurse                                | Outpatient Nursing | 26 years          | Bachelor's degree in Nursing     |

Data analysis used the Miles and Huberman interactive model and consisted of three stages. First, data reduction summarized and focused the material on procedures, causes, constraints, recommendations, and downtime management while excluding transcript portions unrelated to the research substance, such as off-topic conversation and technical interruptions during recording. Second, data display organized the reduced material into thematic narratives so that relationships among themes could be interpreted more clearly. Third, conclusion drawing and verification involved interpreting patterns emerging from the data in relation to the research objectives. Trustworthiness was maintained through source triangulation by comparing overlapping responses among informants, for example regarding downtime causes and the mechanism for returning to manual documentation, and by checking interview statements against downtime SOP documents and official Hospital X downtime reports before interpretation.

### 3. Results and Discussion

#### a. Results

Interviews with the four informants generated nine interrelated themes: downtime handling procedures, division of responsibilities, causes of downtime, effects on service efficiency, system recovery time, handling constraints, effectiveness and recommendations for improvement, patient registration during downtime, and the effect of downtime on nursing services. Together, these themes converge on patient-service efficiency, including registration speed, continuity of clinical and nursing care, and staff workload during the shift to manual documentation and subsequent data re-entry.



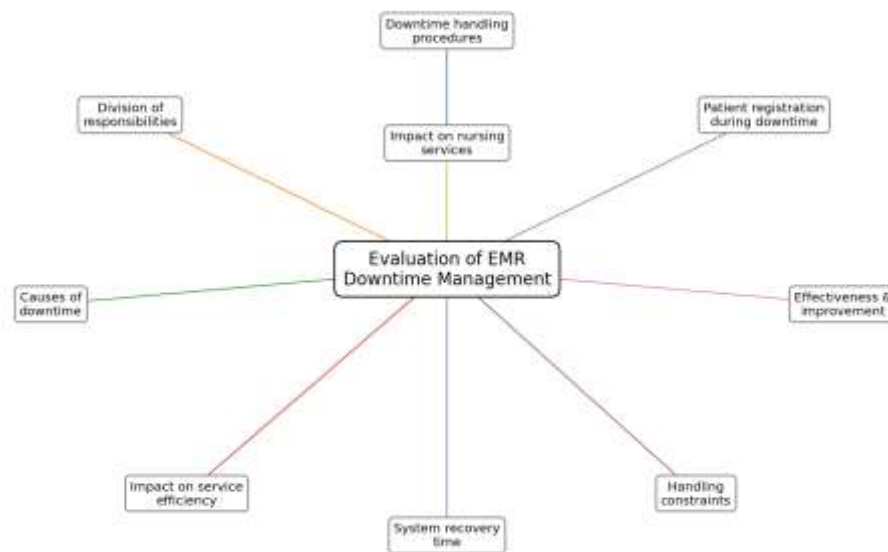


**Figure 1.** Thematic Diagram of Interview Findings on EMR Downtime Management

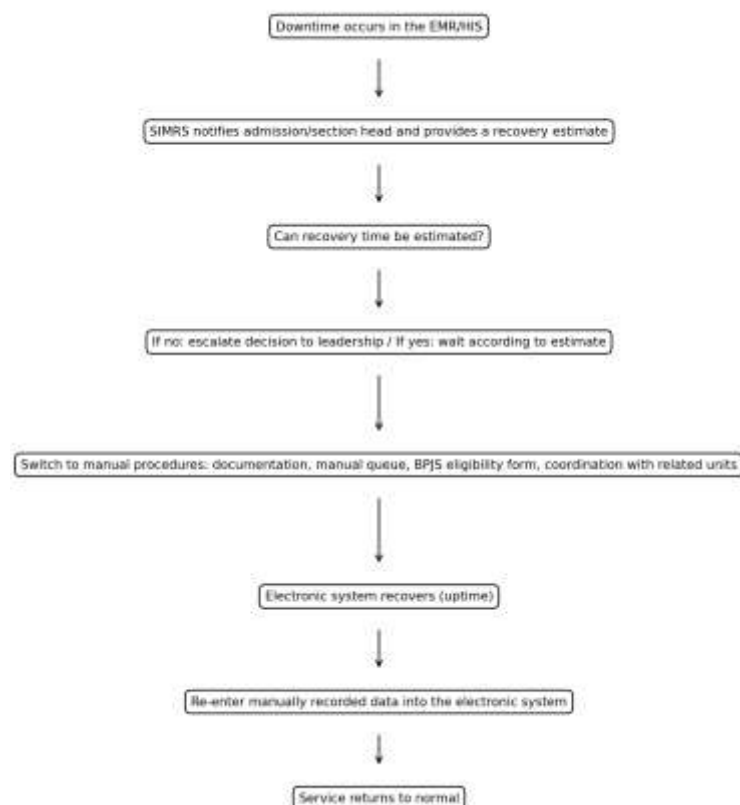


**Figure 2.** EMR Downtime Management Flow at Hospital X





Downtime disrupted outpatient service efficiency by slowing registration, increasing patient queues, delaying clinical services, and adding to staff workloads because manually recorded information had to be re-entered after system recovery. Limited backup electricity also affected service continuity because power was prioritized for critical areas, including the intensive care unit (ICU) and operating room.

At the registration level, patients experienced longer waiting times and increased complaints while staff awaited technical information from SIMRS. Manual registration involved queue management, verification of appointment schedules, distribution of patients among four counters according to their destination clinics, and preparation of manual eligibility forms for BPJS participants. Eligibility verification was completed after the system recovered.

In nursing services, downtime delayed access to supporting examination results and consequently postponed subsequent clinical assessments. Nevertheless, the nursing informant reported that a specific downtime SOP was available and considered understandable and feasible. Patient care continued using manual procedures, with data entered into the electronic system after recovery.

Document reviews identified three successive SOP documents: the 2024 downtime-handling SOP, the 2025 EMR downtime SOP, and the revised medical-record downtime SOP dated March 5, 2026. The latest revision provided more detailed procedures, including verification of online appointments by security personnel and allocation of manual registration counters according to destination clinics.

The practice of switching to manual documentation and re-entering data after recovery was consistent with the documented procedures. However, the reviewed SOPs did not explicitly specify the 15-minute threshold for initiating manual registration or establish clear authority and criteria for formally declaring downtime. The director-approval number fields in the 2025 and 2026 documents were also blank. Furthermore, the recommendation to print medical summaries immediately after patient care was not explicitly covered by the existing SOPs.

Supporting downtime records for March–April 2026 documented five incidents with a combined duration of approximately 4 hours and 28 minutes. The longest incident occurred on March 3, 2026, due to a firewall anomaly that prevented the host from obtaining an IP address from the router, lasting 3 hours and 14 minutes. Other incidents involved Transmedik server anomalies and a total power outage, with durations ranging from 5 to 35 minutes.





**Table 1.** Summary of Downtime Events, March-April 2026

| No. | Date          | Event Cause               | Downtime Mechanism                                | Duration   |
|-----|---------------|---------------------------|---------------------------------------------------|------------|
| 1   | 3 March 2026  | Firewall anomaly          | Host did not obtain an IP address from the router | 3 h 14 min |
| 2   | 13 March 2026 | Transmedik server anomaly | All menus failed to appear after login            | 20 min     |
| 3   | 1 April 2026  | Total power outage        | No active generator backup was available          | 35 min     |
| 4   | 16 April 2026 | Transmedik server anomaly | All menus failed to appear after login            | 5 min      |
| 5   | 20 April 2026 | Transmedik server anomaly | Database traffic spike occurred                   | 14 min     |

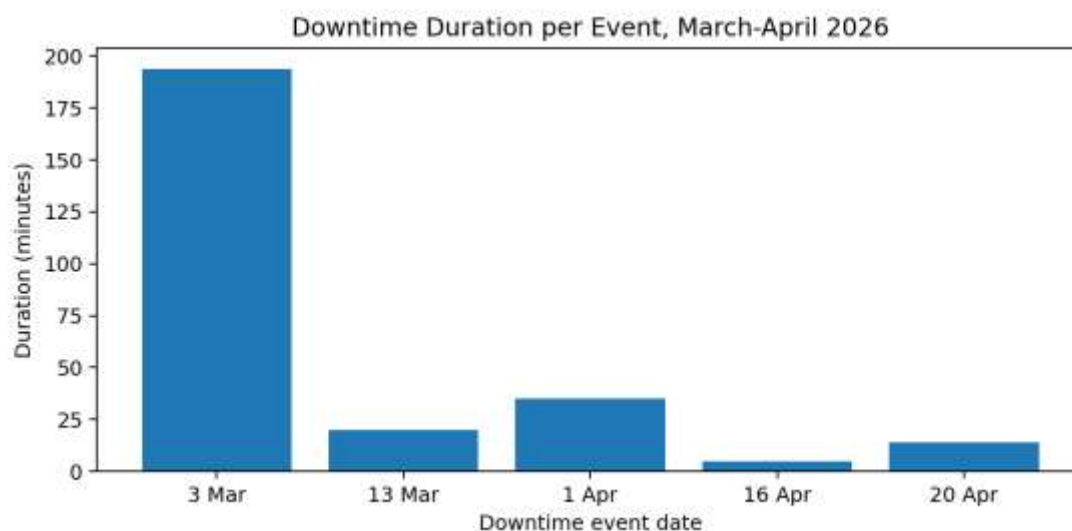


**Figure 3.** Duration of Downtime Events, March-April 2026

## b. Discussion

The procedure of returning to manual documentation during downtime and re-entering data after system recovery is consistent with recommended EMR contingency practice. The Institute for Safe Medication Practices (2022) emphasizes that contingency planning should include paper-based documentation and reconciliation after restoration so that clinical information is not lost during transition. Lyon et al. (2023) similarly showed that completeness of manual documentation during downtime supports safer and more efficient post-event recovery. The different time thresholds reported by informants do not necessarily represent contradiction but rather two levels of decision-making. At the operational registration level, manual procedures are initiated when the estimated recovery time exceeds 15 minutes, as





stated by Informant 3. At the broader interunit coordination level, when recovery time cannot be estimated at all, the decision to switch to manual procedures depends on leadership policy, as stated by Informant 1. Thus, the 15-minute threshold functions as a unit-level technical mechanism, whereas escalation to leadership applies when the duration is completely uncertain.

The division of responsibility between the electrical/facility unit (IPS RS) and the information-system unit (SIMRS) reflects a logical organizational separation of roles. Nevertheless, the evidence on varied causes of downtime indicates that clear role definition and escalation pathways are essential so that response does not depend on sequential approval that may slow action, particularly during emergencies (Neprash et al., 2022). The most frequently documented cause in this study was the Transmedik server anomaly, whereas the longest single event was the firewall anomaly. Informant 2 nevertheless perceived power failure and server failure as the most significant causes. This difference likely reflects the fact that staff perceptions are influenced by the disruption that is most immediately felt across the hospital, while official documentation captures event frequency and duration. The interdependence described by informants, in which failure of an external system such as BPJS affects operations even when the internal hospital system remains functional, also illustrates the reliability challenges created by interoperability.

The effects of downtime on service efficiency—patient accumulation, slower clinic services, and increased staff workload—are consistent with Dameff et al. (2023), who reported increased workload, length of stay, and emergency-department crowding during major electronic-system disruption. Lyon et al. (2023) also demonstrated the importance of standardized downtime and uptime procedures for safe and efficient data recovery. Recovery time was predictable for scheduled maintenance but unpredictable for electricity-related downtime. This finding is consistent with Harmon et al. (2023), who described unanticipated EMR disruption as a continuing source of patient-safety risk in emergency nursing. Khairat et al. (2021) reported that interruptions can increase operating-room utilization and length of stay without necessarily increasing mortality. This is relevant to Hospital X, where generator power is prioritized for the ICU and operating room, a strategy that may protect critical care while delaying services in other areas.

The nursing findings reinforce that downtime affects not only administrative processes but the entire clinical pathway. Informant 4 described prolonged waiting for supporting examination results before patients could proceed to physician assessment. However, the nursing unit reported having a downtime SOP that was easy to understand and implement and continued patient care while physicians re-entered data after recovery. This difference suggests that downtime resilience is not uniform across service units and that clearer unit-level procedures may serve as a practical model for other units, particularly registration. Miscommunication and uncertainty about recovery estimates underline the need for a structured communication trigger during downtime (Baldauf, 2025). The assessment that current handling is reasonably effective but still depends on leadership approval indicates a gap between technical





readiness and decision-governance readiness. From a business continuity management perspective, continuity cannot rely only on technical recovery; it also requires explicit decision structures. Hospital X already has elements of a disaster recovery plan in its manual-documentation and data-re-entry process, but explicit escalation criteria and authority remain insufficiently formalized. This interpretation is consistent with Simanullang (2026), who reported that improvements in hospital information-system reliability require technical optimization together with governance improvement.

The absence of standardized escalation criteria in the reviewed SOPs reinforces the governance gap. ISMP (2022) recommends clear criteria and decision authority so that service units do not remain dependent on hierarchical approval during urgent disruption. The evolution of Hospital X SOPs from 2024 through the 2026 revision demonstrates continuous improvement in technical manual-service details, but decision escalation and authority should be strengthened in future revisions. The proposal to print patient medical summaries as a physical backup is a simple mitigation measure consistent with the broader concept of downtime kits and paper backup forms. However, compared with digital backup solutions such as the Emergency Query Program and Emergency Prescription System developed by Jo et al. (2024), Hospital X still relies predominantly on manual procedures. Hospitals with adequate information-technology resources may therefore consider digital backup mechanisms to maintain service efficiency more effectively during downtime.

#### 4. Conclusion

EMR downtime management at Hospital X has a basic operational mechanism consisting of switching to manual documentation and re-entering data after system recovery, with responsibilities clearly divided between the electrical/facility unit and the information-system unit. Official March-April 2026 records showed five events totaling approximately 4 hours 28 minutes. Server anomalies occurred most frequently, while recovery time could be estimated mainly for scheduled downtime. Downtime continued to reduce patient-service efficiency through patient accumulation, slower clinical services, delayed supporting examinations, and additional workload associated with retrospective data entry. The main constraints were miscommunication regarding downtime notification and recovery estimates and decision-making that still depended on hierarchical approval. Although technical manual-service procedures have been progressively refined in SOPs from 2024 to 2026, explicit criteria and authority for downtime escalation have not yet been formalized. Hospital X should therefore establish a structured communication trigger that defines the person responsible for notification, official interunit communication channels, and the minimum information that must be communicated during downtime. The SOP should also specify escalation criteria and authority for example, a defined time threshold that permits the responsible technical unit to act promptly without waiting for sequential leadership approval while maintaining patient safety as the principal consideration. Overall, a hospital that has implemented EMRs still requires a digital business-continuity mechanism in addition to manual procedures. Structured communication, clearer decision governance, strengthened contingency planning, and





consideration of digital backup systems are required to improve efficiency without compromising quality and patient safety during EMR downtime.

## 5. Compliance with Ethical Standards

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### Disclosure of Conflict of Interest

The authors declare no conflict of interest related to this study.

### Statement of Informed Consent

Participation in the interviews was voluntary. Informants who met the inclusion criteria agreed to participate, and interview data were used for research purposes while maintaining confidentiality.

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