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The Role of 5S methodology in supporting electronic medical record digitalization: empirical insights from Indonesian hospitals

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Abstract

The global imperative for healthcare digitalization, particularly the mandated implementation of Electronic Medical Records (EMR) in Indonesia, presents significant operational and cultural challenges for hospitals. Successful EMR adoption critically hinges on a prepared physical and organizational environment. This qualitative study investigates the initial implementation of the 5S methodology (Sort, Set in order, Shine, Standardize, Sustain) as a foundational strategy to support and facilitate effective medical record digitalization. The research was conducted using a multiple-case study approach across three distinct hospital types (B, C, and D) in Central Java, between 2023 and 2024. Data were collected through semi-structured interviews with management, IT staff, and clinical personnel, direct observation of work areas, and review of internal project documentation. Thematic analysis was utilized to synthesize findings regarding 5S practices, their perceived impact on digitalization readiness, and associated barriers, especially concerning national interoperability requirements. The study reveals that 5S significantly contributes to physical space optimization, streamlining the paper-to-digital data transition, and enhancing data quality. Among the three hospitals investigated, the Sort phase at the Type D hospital particularly stood out for effectively addressing an longstanding overloaded medical record storage problem. This initiative not only generated IDR 11 million in revenue from shredding irrelevant archives but also critically emphasized the immediate urgency to digitize primary patient data. This phase also leveraged the existing Hospital Information System to identify and verify duplicate patient data, leading to data cleansing. Furthermore, the Standardize phase proved crucial for ensuring internal data consistency and alignment with national platform requirements like SatuSehat. This study provides empirical insights into the practical application of 5S as a strategic enabler for EMR adoption in Indonesian hospitals, offering a unique perspective on bridging physical readiness with digital transformation, including the critical aspect of national data interoperability.

Keywords: Electronic Medical Records; 5S; Healthcare Digitalization; Data Interoperability; SatuSehat

1. Introduction

The global healthcare landscape is undergoing a profound digital transformation. Governments and healthcare organizations worldwide are increasingly mandating and adopting Electronic Medical Record (EMR) systems, aiming to enhance patient safety, improve care coordination, reduce operational costs, and foster data-driven decision-making [1]. In Indonesia, this drive towards digitalization is particularly prominent, with the Ministry of Health mandating the implementation of EMR for all healthcare facilities [2]. This directive underscores a critical national agenda to modernize healthcare delivery and improve public health outcomes.

While the benefits of EMR are widely acknowledged, its successful implementation is far from straightforward. Hospitals frequently encounter substantial challenges, including significant capital investment, complex technology integration, and data migration hurdles. Critically, user resistance stemming from workflow disruptions, lack of digital

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literacy, and concerns about productivity loss also poses a substantial barrier [3,4]. The transition from a paper-dominated environment to a digital platform necessitates not only technological readiness but also a fundamental shift in organizational culture and work processes. Furthermore, in the Indonesian context, a specific challenge arises from the integration of diverse, independently developed Hospital Information Systems (HIS) with the national SatuSehat platform, a government initiative designed to consolidate health data across the archipelago. This disparity often leads to data redundancy, inconsistencies, and significant interoperability barriers at the national level [2].

In this context, Lean management philosophy, with its emphasis on waste elimination and continuous improvement, has gained significant traction in healthcare due to its ability to streamline operations and enhance efficiency. Among the foundational Lean tools, the 5S methodology (Sort, set in order, Shine, Standardize, Sustain) stands out as a pragmatic and highly effective approach to workplace organization and standardization. Originating from the Toyota Production System, 5S comprises five Japanese terms: Sort (*Seiri*) for separating necessary from unnecessary, Set in order (*Seiton*) for logical arrangement, Shine (*Seiso*) for thorough cleaning, standardize (Seiketsu) for establishing consistent procedures, and Sustain (*Shitsuke*) for fostering continuous adherence and improvement [5,6]. Although traditionally associated with manufacturing, 5S principles are profoundly relevant to healthcare, enhancing workplace organization, reducing errors, improving patient safety, streamlining processes, and boosting staff morale [7,8]. Its visual and practical nature makes it highly accessible to frontline healthcare staff.

This study posits that the initial implementation of 5S serves as a critical preparatory step for successful EMR adoption in Indonesian hospitals. A cluttered and disorganized physical workspace, inefficient paper-based information flows, and a lack of standardized practices can severely impede the effective integration and utilization of digital systems [9]. By creating an organized, clean, and disciplined environment, 5S can reduce physical and informational waste, free up space for technology, enhance data flow readiness, and cultivate a culture of orderliness and continuous improvement, all essential for a smooth digital transition. Moreover, 5S, particularly its Standardize pillar, can establish an early framework for addressing both internal data consistency and external integration requirements, including the crucial readiness for interoperability with national platforms like SatuSehat [10,11].

Despite the growing recognition of Lean in healthcare, limited specific empirical research, particularly within the Indonesian context, explicitly examines the initial implementation of 5S as a direct enabler or prerequisite for large-scale digitalization projects such as EMR, including addressing national platform integration challenges. Therefore, this study aims to explore:

- The specific steps and adaptations undertaken during the initial 5S implementation phase in Indonesian hospitals preparing for EMR.
- The immediate observed improvements and perceived benefits attributed to 5S in facilitating EMR adoption.
- The initial challenges encountered in integrating 5S efforts with the broader digitalization agenda, including the perspective of national platform integration.

By providing empirical insights from the Indonesian healthcare landscape, this research contributes to the understanding of how foundational operational excellence methodologies can strategically support and accelerate healthcare digital transformation.

2. Material and methods

This qualitative study employed a multiple case study design to investigate the initial implementation of 5S as a supportive strategy for EMR digitalization in Indonesian hospitals. This approach allows for an in-depth understanding of complex phenomena within their real-world contexts [12].

2.1. Case Selection

Three Indonesian hospitals (referred to as Hospital A, Hospital B, and Hospital C for anonymity, representing Type B, C, and D facilities in Central Java) were selected based on the following criteria:

- They were in the early phases of formal EMR implementation (within the last 1-3 years) or actively planning it in response to the national mandate.
- They had explicitly initiated or were in the process of implementing the 5S methodology as part of their operational improvement strategy, with a recognized link to preparing for digitalization.
- They represented diverse characteristics (e.g., varying bed capacities, geographical regions within Central Java) to enhance the generalizability of findings within the Indonesian context.

2.2. Data Collection

Data were collected between January 2023 and March 2024, employing a triangulation approach to ensure data richness and validity

Semi-structured Interviews: A total of 30 interviews were conducted across the three hospitals (10 interviews per hospital). Interviewees included: Hospital Management (e.g., Operations Director, Quality Manager), IT Department Heads/Project Managers for EMR, Clinical Department Heads (e.g., Head Nurse, Head of Emergency Department), Frontline Clinical Staff (e.g., Nurses, Doctors involved in initial EMR use), and Lean/5S Facilitators or Quality Improvement Consultants. Interviews focused on: reasons for 5S implementation, specific 5S activities undertaken, perceived links between 5S and EMR, immediate improvements, challenges faced, and lessons learned.

Direct Observation: Structured observations were conducted in key clinical and administrative areas (e.g., nursing stations, emergency departments, outpatient clinics, medical records departments) before and during initial 5S activities, and concurrently with EMR pilot phases where applicable. Observations focused on the level of organization, cleanliness, and efficiency of workflows, as well as the placement and use of digital devices.

Document Review: Relevant internal documents were collected and reviewed, including: 5S implementation plans, checklists, and audit reports; EMR implementation timelines and training materials; and internal communications related to 5S and EMR initiatives.

2.3. Data Analysis

Interview transcripts, observation notes, and document review summaries were thematically analyzed, following the six-phase approach by Braun and Clarke [13]:

- Familiarization with data,
- Generating initial codes,
- Searching for themes,
- Reviewing themes,
- Defining and naming themes, and
- Producing the report.

Cross-case analysis was then performed to identify commonalities and differences across the three hospitals, allowing for a more robust understanding of the phenomenon. Ethical considerations, including informed consent and anonymity, were strictly adhered to.

3. Results

The data analysis from the three Indonesian hospitals revealed consistent patterns regarding the initial implementation of 5S to support medical record digitalization. This section presents the specific 5S activities undertaken, the immediate improvements and perceived benefits for digitalization, and the initial challenges encountered, followed by a comprehensive discussion of these findings in relation to existing literature and their implications.

3.1. Specific 5S Activities Undertaken for EMR Readiness

All three hospitals formally initiated their 5S programs within 6-12 months prior to or concurrently with their EMR implementation pilot phases. While intensity and scope varied, common activities for each S were observed

3.1.1. Sort (Seiri)

This was often the most impactful initial step. In medical records departments, staff systematically reviewed patient charts, archiving older records and discarding duplicates or unnecessary forms. In a specific case study at a Type D hospital in Central Java, the Sort pillar proved vital in addressing the issue of overloaded medical record warehouses. With an average addition of 2,000 new medical records monthly and a complete lack of prior medical record retention, the three existing warehouses had become highly inefficient. Through collaboration with the IT team, Sort also leveraged the Hospital Information System (HIS) to identify duplicate or redundant data (e.g., records with identical National Identity Number, name, date of birth, and address) within the database, which were then verified and, if necessary, either deleted or specifically archived. Following the Sort initiative, the hospital successfully shredded sacks of no-longer-needed medical records, while diligently maintaining patient data security. This activity not only freed up

much-needed storage space but also unexpectedly generated revenue of IDR 11 million from the sale of the shredded materials. In clinical areas, expired medications, unused supplies, and excess equipment were removed. A nurse from Hospital B noted, "Before 5S, our nursing station was buried under piles of old patient files and random equipment. We couldn't even find space for the new computers." This directly freed up physical space.

3.1.2. Set in order (Seiton)

Following sorting, arrangement was a critical step. This included labeling shelves, cabinets, and drawers in supply rooms and at nursing stations. Shadow boards were created for frequently used tools. Crucially, clearly marked, dedicated spaces were established for new EMR hardware (e.g., charging stations for tablets, printer locations, network points for desktop computers). In medical record warehouses, Set in order also played a crucial role in reorganizing file storage, optimizing flow and accessibility. An IT Manager from Hospital A commented, "We needed designated spots for every new EMR device, and 5S ensured staff knew exactly where to put them, and where to find them when needed."

3.1.3. Shine (Seiso)

Regular cleaning schedules were implemented, extending beyond routine sanitation to include cleaning of computer screens, keyboards, and peripheral devices. This proactive cleaning identified damaged equipment or connectivity issues early on. Particularly in medical record warehouses, Shine was instrumental in identifying and addressing files found to be damaged due to poor or humid storage conditions, which could then be appropriately discarded or processed for digitization. A physician from Hospital C highlighted, "A clean workspace feels more professional, and it helps you spot if something is wrong with equipment, like loose cables."

3.1.4. Standardize (Seiketsu)

Standard operating procedures (SOPs) for maintaining the first three S's were developed. This included visual aids like 5S checklists for daily or weekly routines. Training was conducted to educate staff on these new standards. Importantly, standardized procedures for handling paper records prior to digitalization (e.g., dedicated bins for scanning, shredding bins) were introduced. Furthermore, the Standardize initiative was also directed at reviewing data within the hospital's internal HIS, with the aim of preventing duplicate data and ensuring data consistency that would form the foundation of the EMR. This effort was undertaken with an acute awareness of the needs and requirements for data integration with the national SatuSehat platform, ensuring that internally developed data standards would support future interoperability.

3.1.5. Sustain (Shitsuke)

While still in early stages, initial efforts included assigning 5S champions in each department, conducting peer audits, and incorporating 5S into regular staff meetings. All the hospitals in this study have introduced a system in which "before and after" photos of 5S initiatives were displayed, and small recognition events were held.

3.2. Immediate Improvements and Perceived Benefits for Digitalization

Interviewees and observations consistently reported several immediate and perceived benefits of 5S that directly supported EMR implementation

- Enhanced physical readiness for EMR hardware: All hospitals reported easier and more organized deployment of computers, tablets, and network infrastructure. "We had clear spots for all our new computers and scanners, thanks to 5S. It was far less chaotic than it could have been," stated a clinical head from Hospital B.
- Streamlined paper-to-digital transition and data quality: Medical records departments specifically noted that the Sort and Set in order phases significantly accelerated initial data migration. The reduction of unnecessary files and the identification of duplicate data substantially improved the initial quality of data entering the EMR. Unnecessary paper was removed, and active charts were systematically organized for scanning or manual data entry. "Sorting out years of patient files was daunting, but 5S gave us a clear method to do it, making it much easier to decide what to scan into EMR," explained a Medical Records staff from Hospital C.
- Optimized storage space and revenue potential: The case of the Type D hospital demonstrated that 5S can drastically reduce the burden of overloaded storage space, even generating unexpected revenue from waste management. This provided an early return on investment for the 5S initiative.
- Improved information accessibility (physical and digital): While EMR enhances digital access, 5S improved physical access. This helped bridge the gap during the transition period. Staff reported spending less time searching for physical charts, which, in turn, allowed more focus on learning the EMR system.

- Enhanced data consistency and interoperability readiness: The Standardize efforts initiated with 5S, particularly in identifying and addressing duplicate data, directly supported a cleaner and more consistent data foundation, which is essential for seamless integration with the national SatuSehat platform.
- Increased staff comfort and acceptance of change: A well-organized environment reduced stress and frustration among staff. This, coupled with their active participation in 5S activities, fostered a sense of ownership and preparedness for broader changes like EMR. "When our area looked cleaner and more organized, staff felt more positive about EMR training. It felt like we were truly getting ready," shared a Lean Facilitator from Hospital A.
- Improved workflow efficiency at workstations: Organized workstations (desks, computers, peripherals) enabled more ergonomic and efficient use of EMR systems. Staff could navigate both physical tasks (e.g., handling lab results) and digital tasks seamlessly.
- Early identification of infrastructure needs: The Sort and Shine phases sometimes revealed underlying infrastructure issues (e.g., insufficient power outlets, poor layout) that could impact EMR deployment, allowing for proactive resolution.

3.3. Initial Challenges and Lessons Learned

Despite the numerous positive impacts, the initial phase of 5S implementation to support EMR also presented challenges

- Time and resource constraints: The most frequently cited challenge was allocating adequate time and personnel for 5S activities, especially given existing workload and the parallel demands of EMR training. "It felt like we were adding more to their plate when they were already struggling with daily patient care and EMR training," mentioned by Quality Manager from Hospital C.
- Resistance to initial Sort (Letting go of paper and old data): Some staff, particularly those accustomed to paper records, exhibited initial resistance to discarding documents or reorganizing their personal workspaces. This also extended to concerns about deleting duplicate data from systems, often rooted in fear of losing information or a lack of trust in the new EMR system.
- Lack of sustained momentum: While initial enthusiasm for 5S was high, maintaining discipline for the Standardize and Sustain pillars proved challenging after the initial push. Regular reminders and visible leadership commitment were crucial.
- Complexity of data standardization for interoperability: Efforts to standardize internal data were often met with the added complexity of ensuring compatibility with national data standards, such as HL7 FHIR standard required by SatuSehat, necessitating a deep understanding of technical and policy requirements.
- Integration with EMR Project Management: In some instances, 5S initiatives were seen as separate from the EMR project. A lack of clear coordination between the 5S team and the EMR implementation team, including those responsible for SatuSehat integration, led to missed opportunities for synergy.
- Measuring direct impact on EMR adoption: Quantifying the precise contribution of 5S to specific EMR adoption metrics (e.g., faster user proficiency) was difficult in the initial phase, often relying on qualitative observations.
- Lessons learned emphasized the need for:
    - Strong leadership advocacy directly linking 5S to EMR success and national integration,
    - Dedicated time allocation and resources for 5S,
    - Continuous communication and training to address resistance, and
    - Integrating 5S activities into the overall EMR project plan, with specific consideration for interoperability requirements.

4. Discussion of Findings

The findings from this multiple case study of Indonesian hospitals strongly support the proposition that the initial implementation of the 5S methodology plays a fundamental and highly beneficial role in preparing hospitals for successful Electronic Medical Record (EMR) digitalization. The observed activities across Sort, Set in order, and Shine directly address the physical and organizational prerequisites for the deployment of EMR hardware and efficient digital workflows. This aligns with and extends previous literature emphasizing 5S as a cornerstone of operational excellence in healthcare [8,7].

The strategic value of 5S during this digital transformation phase lies in its ability to simultaneously address physical clutter and cultivate a culture of orderliness and discipline. The case study of the Type D hospital in Central Java vividly illustrates how the Sort pillar not only effectively resolved the critical issue of overloaded medical record warehouses, which had no prior retention policy, but also actively contributed to the cleansing and organization of informational data. The capability to identify and act upon duplicate or redundant data within both physical storage and the hospital's

HIS through the Sort process demonstrates that 5S can proactively enhance the quality of data slated for EMR migration. This is a crucial step to ensure data integrity and accuracy within the new digital system, which is paramount for patient safety and clinical decisions. Furthermore, the unexpected benefit of IDR 11 million in revenue from the proper disposal of shredded records provides an additional financial justification for 5S initiatives. The shredded records are wrapped in sacks and stored in temporary storage as shown in Figure 1.

Figure 1 Shredded records and the shredder machines

By systematically organizing workplaces and storage areas, hospitals not only create the necessary physical space for new EMR equipment but also streamline the transition of information from paper form to digital formats. This is particularly relevant in the Indonesian context, where many hospitals have historically relied heavily on extensive paper documentation and now face a mandatory shift to EMR [2]. The Set in order and Shine pillars further contribute significantly by reorganizing file storage and eliminating files found to be damaged due to poor or humid storage conditions, ensuring that only relevant and intact records are digitized. This directly reduces the workload and complexity of the EMR data migration process, often a major bottleneck [17].

Crucially, a key insight revealed is the role of Standardize (*Seiketsu*) in addressing national integration challenges. Many Indonesian hospitals indeed develop their own internal HIS, which, while effective locally, can become a significant impediment when confronted with the interoperability requirements of national platforms like SatuSehat. The standardization efforts within 5S, which initially focus on internal data consistency and duplication avoidance, must critically also be balanced with an understanding and preparation to meet external data integration needs. This implies that Standardization in 5S is not merely about "internal orderliness" but also about "external orderliness" required for participation in the larger digital health ecosystem. Thus, 5S can serve as an early tool to help hospitals pre-process their data, minimizing friction during subsequent integration with SatuSehat. When staff witness tangible improvements in their physical environment due to 5S, it can foster a more positive attitude toward broader organizational changes, including the complex adoption of EMR. The participatory nature of 5S, where frontline staff are directly involved in organizing their own workspaces, empowers them and builds a sense of ownership, which is vital for the successful integration of new technologies [11].

However, the identified challenges, particularly time and resource constraints and difficulties in sustaining momentum for the Standardize and Sustain pillars, echo common implementation barriers in Lean healthcare initiatives [18,10]. In the context of EMR digitalization, these challenges are compounded by the parallel demands of training and technology adaptation, as well as the inherent complexity of national platform integration. This highlights the critical need for integrated project management where 5S initiatives are explicitly linked and resourced within the overall EMR implementation plan, with specific consideration for interoperability requirements and national platforms. Leadership commitment must extend beyond initial support to active participation, resource allocation, and continuous reinforcement to ensure that the gains from 5S are sustained and continue to support the evolving digital environment.

Future research could explore quantitative measures to assess the direct correlation between 5S maturity levels and EMR adoption rates or user proficiency, as well as the long-term financial impact of 5S initiatives supporting digitalization. Longitudinal studies would also be valuable to understand the sustained impact of initial 5S efforts on continuous use and optimization of EMR systems in Indonesian hospitals, especially in the context of readiness and successful integration with national platforms like SatuSehat. Additionally, investigating specific adaptations of 5S principles within different typologies of Indonesian hospitals (e.g., regional vs. national referral hospitals) could offer further insights.

5. Conclusion

In conclusion, this study provides empirical evidence from Indonesian hospitals affirming that the initial implementation of 5S is a valuable and foundational step in preparing for and facilitating medical record digitalization. By systematically organizing physical workspaces, cleansing and structuring data, and cultivating a disciplined culture aligned with national interoperability needs, 5S effectively addresses critical operational prerequisites, thereby smoothing the complex transition to EMR and enhancing the overall success of healthcare digital transformation efforts in Indonesia.

Compliance with ethical standards

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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