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Evaluating Software-Based Methods for Replacing Manual Collection of Midnight Totals: A Study from Sri Lanka

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ABSTRACT: The manual collection of midnight totals in hospitals has long been used to calculate key performance indicators such as bed occupancy rates. Despite technological advancements, many hospitals still rely on labour-intensive manual methods prone to inaccuracies at multiple stages. This study introduces and evaluates the Smart Hospital Metrics Calculator, a tool developed to automate the calculation of midnight totals and same-day discharges using patient admission and discharge dates from the electronic Indoor Morbidity and Mortality Return (eIMMR). Both manual and software-based methods exhibited inaccuracies, but errors in software-based calculations were primarily due to issues with entering dates, which can be mitigated by improving workflows and refining the eIMMR system. In contrast, improving manual methods requires addressing challenges across multiple levels. Data from three hospitals were analysed, and while the results do not yet demonstrate these outcomes, it is postulated that with enhanced date entry processes, software-based methods, such as the Smart Hospital Metrics Calculator, could achieve near-zero inaccuracies. These findings suggest that transitioning to this automated approach has the potential to streamline data collection, enable real-time monitoring, and improve hospital data management—without requiring additional workload or significant investment. If successfully implemented, this change could represent a seamless transformation, realizing benefits without disrupting current operations.

KEYWORDS: Bed occupancy rate, Daily census, Healthcare informatics, Hospital data management, Hospital performance indicators, Sri Lanka, Total inpatient days

INTRODUCTION

For decades, the process of manually collecting midnight totals (MNT) at hospitals has been ingrained in healthcare practices, symbolizing a time-honoured tradition predating the era of computing technologies. Every night, within the confines of each hospital wards healthcare personnel meticulously record MNT—an arduous yet fundamental practice that has stood the test of time.

MNT reflect the number of patients in a hospital at midnight, a critical figure used to calculate inpatient days, which are essential for determining key hospital performance indicators such as Bed Occupancy Rate (BOR), Average Length of Stay (ALOS), and Turnover Interval (TI). The process involves recording the MNT, adding the same-day discharges (SDD), and compiling this data over time to calculate the total inpatient days (TID). Ward nurses prepare midnight reports that capture both MNT and SDD, which are then submitted daily to the hospital administration.

In the absence of computational aids, this process was the cornerstone of deriving critical healthcare indices, such as total inpatient days, bed occupancy rates, and ward-level statistics. It is a testament to the dedication and precision of healthcare staff who upheld this labour-intensive method in the absence of automated tools. Despite the advent of the computer era and the proliferation of technology in various facets of healthcare, this traditional practice has persisted, remaining unaltered and unchallenged. The reliance on manual collection of MNT signifies a deeply rooted system, reflecting an established protocol passed down through generations of healthcare professionals.

However, as noted by Ilham et al. (1), the accuracy of manually collected daily census data is often affected by factors such as staff workload, knowledge, and behaviour, leading to potential discrepancies in hospital statistics. Similarly, Utami et al. (2) emphasizes

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the importance of training on standardized procedures, such as filling out the daily census, to improve staff knowledge and minimize the errors and miscalculations frequently observed in census preparation by nurses. A study by Sandanayaka et al. (2020)(3) too identify discrepancies in the calculation and use of MNT in reports.

The enduring practice of manual MNT collection, while commendable for its steadfastness, raises questions about its adaptability and potential advancements in a technologically advancing landscape. The reluctance to transition from a well-established manual process to computer-assisted calculations, though understandable, raises important questions about the feasibility and benefits that modern computational tools could offer. Despite advances in computing capabilities, the continued reliance on the manual collection of MNT highlights the need to assess the practicality and potential advantages of adopting software-based solutions.

Silver et al. (4) point out that calculating the daily census at a fixed time, such as midnight, is of limited value in settings like the ICU, where bed occupancy fluctuates throughout the day. A more accurate approach would involve capturing census data at multiple intervals rather than relying on a single daily figure. Similarly, DeLia (5) notes that annual bed statistics often overlook real-time fluctuations in hospital occupancy, advocating for more frequent and accurate data collection. Simon et al. (6) also emphasize the importance of multiple daily census checks in nursing quality measurement.

Manual methods struggle to keep up with these demands, whereas software-based solutions can easily be adapted to capture real-time data, offering a significant improvement over traditional approach. This study seeks not to diminish the historical significance or dedication embodied by the manual process but rather to explore the possibilities and efficiencies that software-based calculations might offer. It aims to bridge the gap between tradition and innovation, assessing the accuracy, efficiency gains, and feasibility of adopting automated systems within hospitals' established workflows.

A. Current Practice in Sri Lanka

Ward nurses perform nightly patient headcounts, which are reported daily through a hierarchical process (see Figure 1). These reports include aggregate data such as the MNT, SDD, and deaths, along with individual patient reports (1). While the MNT is particularly important, as it is regularly collected, stored, and analysed for key performance indicators like the BOR, the quality of the data is questionable. Individual patient reports are rarely subject to routine analysis and, even more concerning, the data entered into the electronic Indoor Morbidity and Mortality Return (eIMMR) is not consistently double-checked.

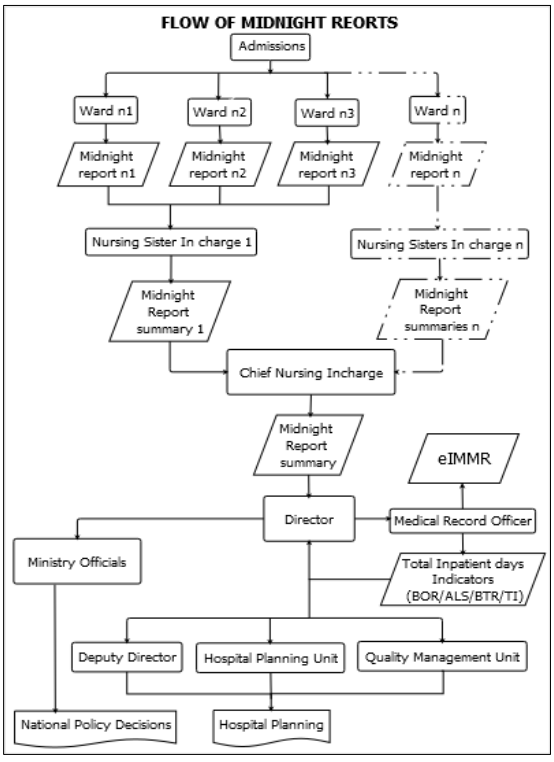

Figure 1:Flow of midnight counts at present

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Despite the "electronic" label, eIMMR is not a foolproof system. Many data points, such as MNT and SDD, are manually entered and often transferred from multiple documents, increasing the risk of errors and discrepancies. This reliance on unverified manual data entry means that the eIMMR can carry inaccuracies, misleading stakeholders who assume its data is reliable due to its electronic nature.

Once these manually collected MNT and SDD reports reach the medical records room, they are entered into the eIMMR without further validation. These figures, alongside key performance indicators like BOR, are then communicated to ministry officials (Figure 1). However, the process is labour-intensive and frequently causes delays, further compromising the accuracy of the data.

The option of calculating MNT, SDD, and TID directly from existing hospital records has been overlooked for years, likely due to the ingrained reliance on manual methods. However, hospitals routinely record patient admission and discharge dates—data that is always available within the eIMMR system. This readily available data can be harnessed to calculate MNT, SDD, and TID automatically through simple spreadsheet functions or more efficiently with dedicated software. To address this gap, we developed the Smart Hospital Metrics Calculator (SHMC) as part of this study, designed specifically to automate these calculations and provide additional insights like BOR, BTR, ALOS, and TI in one step.

As highlighted earlier, the eIMMR contains both the manually entered MNT and SDD data, alongside admission and discharge records. In this study, we used the SHMC to compute MNT and SDD from admission and discharge data available in the eIMMR, then compared these calculated figures with the manually entered values.

Figure 1 demonstrates the current, labour-intensive method of MNT collection, which heavily relies on manual efforts to generate key indicators like MNT, SDD, and TID. In contrast, Figure 2 showcases a more efficient workflow using automated data to calculate these metrics, reducing the burden on staff and eliminating the need for manual collection altogether.

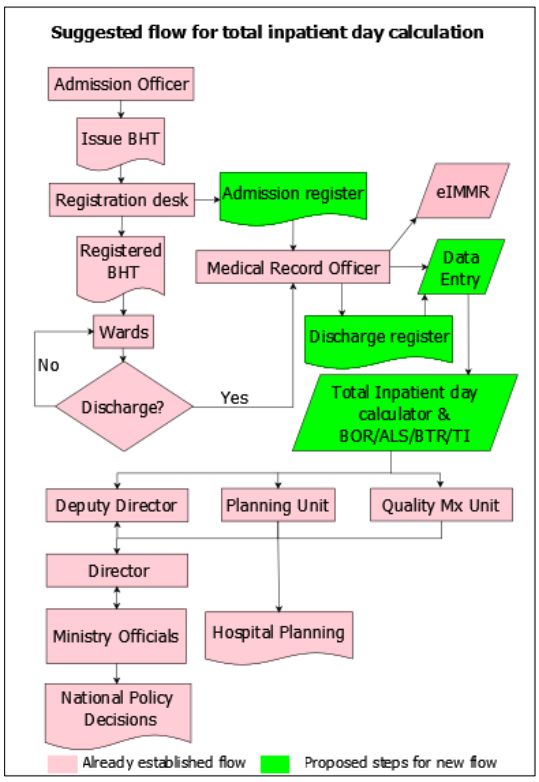

Figure 2: Suggested flow of midnight counts

B. Study Context

In Teaching Hospital Kurunegala, the manual collection of MNT faced operational challenges, which prompted the development and implementation of a software-based method. This new approach not only provided more reliable calculations but also significantly reduced the labour involved in manual data collection.

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METHODOLOGY

A. Research Design:

A quantitative, comparative study was conducted to assess and compare MNT and SDD calculated through two methodologies—manual processing and software-generated—in three randomly selected hospitals.

B. Study Setting:

Data was collected from the eIMMR at three hospitals in Kurunegala District: Nikaweratiya Base Hospital (NBH), Wariyapola Divisional Hospital (WPDH), and Wellawa Divisional Hospital (WLDH).

C. Sample Size:

A formal sample size calculation was unnecessary as the data collected covered all admissions and discharges from January 1st to September 30th, 2022.

D. Sample Selection:

The study intentionally selected hospitals from different categories—Base Hospital and Divisional Hospitals A and B—to represent varying admission rates and bed capacities. This approach aimed to include diverse scenarios in hospital operations.

Three hospitals from each category were systematically chosen based on their contribution to the eIMMR database. The MNT and SDD for each hospital from April 1st to September 30th, 2022, were extracted and recorded. Admission and discharge dates, along with Bed Head Ticket (BHT) numbers from January 1st to September 30th, 2022, were compiled into a CSV file for analysis.

E. Research Instruments:

The research instruments employed in this study consisted of the SHMC software and an Excel sheet used for manually collecting MNT and same-day discharges SDD.

1) ***Software Development:*** The SHMC was created through a systematic process. Initially, stakeholders were consulted to establish the necessary software features, ensuring a comprehensive understanding of its functionality. In the design phase, algorithms were developed to calculate TID using patient admission and discharge dates. The various inpatient stay scenarios (Figure 3) were mapped out to account for all possible variations within the hospital system, ensuring accurate calculations. These algorithms were then integrated into the software during development. Extensive testing, including the use of both dummy and actual data, confirmed the accuracy and reliability of the software in calculating inpatient days.

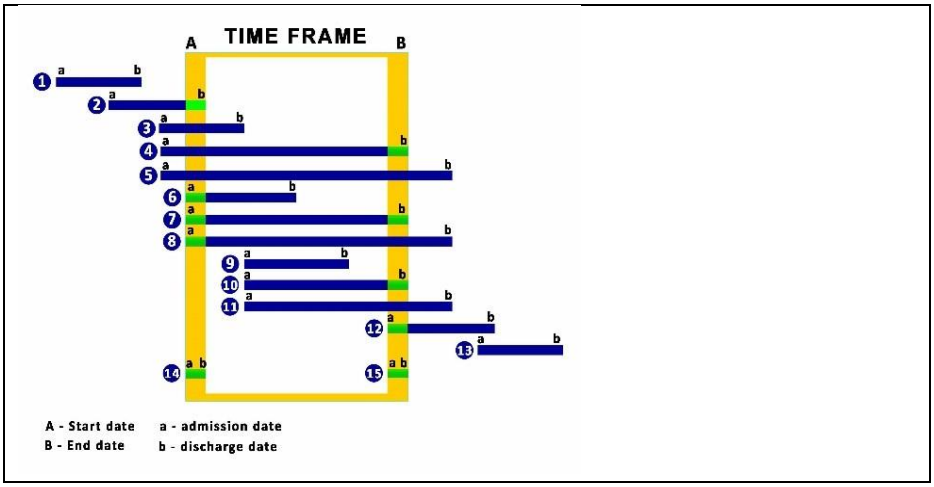

Figure 3: Diagram illustrating TID calculation logic using admission and discharge dates.

2) ***Data Requirements for the SHMC:*** To ensure the completeness and accuracy of inpatient day calculations, specific data handling measures were applied. The eIMMR database included records of both current-year admissions and discharges, as well as ongoing patient records. To account for patient stays that spanned beyond the standard 90-day period (A patient can stay for a maximum of 90 days under one BHT.), admission dates from the previous 90 days were added to the dataset (Figure 4). This ensured

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that all ongoing patient stays were captured accurately. The SHMC required a CSV file with admission and discharge dates formatted as mm/dd/yyyy, and the number of patient beds in the relevant ward or hospital.

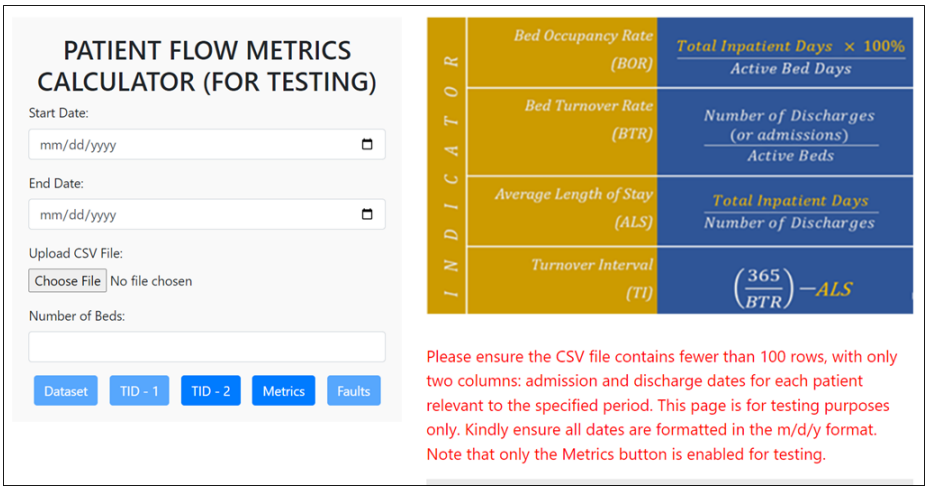
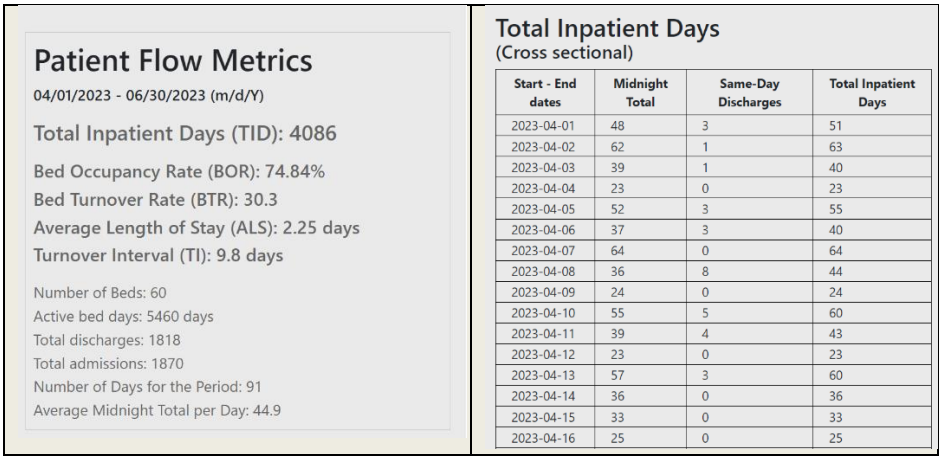


Figure 4: User interface of the SHMC

3) ***Data Output:*** The SHMC primarily computes total inpatient days but also generates other important metrics, including MNT and SDD (Figure 5). This ensures the software provides a robust set of data for the analysis of patient flow and hospital resource management. (Figure 5)



Start - End dates	Midnight Total	Same-Day Discharges	Total Inpatient Days
2023-04-01	48	3	51
2023-04-02	62	1	63
2023-04-03	39	1	40
2023-04-04	23	0	23
2023-04-05	52	3	55
2023-04-06	37	3	40
2023-04-07	64	0	64
2023-04-08	36	8	44
2023-04-09	24	0	24
2023-04-10	55	5	60
2023-04-11	39	4	43
2023-04-12	23	0	23
2023-04-13	57	3	60
2023-04-14	36	0	36
2023-04-15	33	0	33
2023-04-16	25	0	25

Figure 5: The SHMC output

In parallel, an Excel sheet was used to gather manually recorded MNT and SDD, providing a comparative dataset for validating the software's performance.

F. Data Collection:

Manually generated MNT and SDD were collected from the eIMMR system, organized in an Excel spreadsheet for comparison. Admission and discharge data from the first three quarters of 2022 were also compiled in a CSV file, which served as the input for the software. The software then generated MNT and SDD, which were recorded in a separate spreadsheet for comparative analysis.

G. Data Analysis Techniques:

Data analysis was performed using an online tool, https://colab.research.google.com/. Normality was assessed using the Shapiro-Wilk test. Since only one data series showed normal distribution, the Wilcoxon test was applied to assess significant differences between manual and software-generated values.

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RESULTS

The following tables summarize the findings across three hospitals, focusing on admissions, data entry, and the comparison between manual and software-based calculations of MNT and SDD.

Table I provides data on the number of BHTs issued and entered into the system across the three hospitals. It also highlights the average number of admissions per day and the average delay in data entry.

Table I: Admissions, Data Entry & Data Entry Delay

Hospital code	*No of BHTs Issued (T-BHT)*	*No of BHTs Entered to eIMMR*	*BHTs not entered*	*AVG[1] admissions per day*	*Data Entry Delay (days)*
WPDH	5279	5257	22	19.26	49.18
NBH	30160	29254	906	107.16	26.54
WLDH	1983	1983	0	7.26	30.53

NBH shows the smallest data entry delay (26.54 days on average) with 906 BHTs not entered eIMMR, indicating significant number of BHTs not entered to eIMMR. WPDH had the highest delay (49.18 days) and failed to enter 22 BHTs, while WLDH maintained a perfect data entry rate, with no missing BHTs.

Table II compares the average MNT and SDD calculated manually and through the SHMC across the three hospitals.

Table II: Comparison of Average MNT and SDD in Manual vs. Software-Based Systems

Hospital code	*AVG MNT-M[2]*	*AVG SDD - M[3]*	*AVG MNT-S[4]*	*AVG SDD - S[5]*	*Total SDD (T-SDD)*	$\left(\frac{T-SDD}{T-BHT}\right)100$
WPDH	21.78	5.69	22.13	11.51	3235	61.54
NBH	265.48	6.84	296.50	12.74	4396	15.03
WLDH	5.42	0.74	2.96	5.55	1580	79.68

In all hospitals, software-based calculations of midnight totals (MNT-S) and same-day discharges (SDD-S) were consistently higher than manual calculations (MNT-M/SDD-M), with the most significant difference observed in NBH. This consistent pattern suggests that the software captured more complete data than manual methods. For instance, the larger discrepancies between manual and software-based SDD percentages highlight how manual methods may fail to account for all discharges. The significant differences, particularly in SDD values, indicate that software-based methods provide a more comprehensive reflection of patient flows.

Table **III** outlines instances where manual MNT and SDD values were lower than the software-based calculations, showing how often manual counts underestimated actual values.

Table III: Instances Where Manual MNT/SDD Values are Lower Than Software-Based MNT/SDD Across Hospitals

Hospital code	*MNT-M < MNT-S*	*MNT-M <MNT-S %*	*SDD - M < SDD - S*	*SDD - M < SDD – S %*
WPDH	70	38	180	98
NBH	149	81	151	82

[1] AVG: Average
[2] MNT – M: MNT counted manually
[3] SDD – M: SDD counted manually
[4] MNT – S: Software based calculations of MNT
[5] SDD – S: Software based calculations of SDD

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WLDH	12	7	174	95

In the majority of cases, manual counts were lower than software-based counts, particularly in SDD values. This indicates that the software captures more discharges compared to manual methods. While we cannot comment on the overall accuracy without considering the admission and discharge date entries, the software-based approach leaves less room for missing or omitted entries, especially in same-day discharge (SDD) cases.

Table **IV** presents the results of the Shapiro-Wilk test for normality, assessing whether manual and software-based MNT/SDD values follow a normal distribution.

Table IV: Normality results from Shapiro - Wilk test

Hospital code	*Calculation type*	*Indicator*	*P value*
NBH	Manual	MNT	0.48073
		SDD	0.00213
	SHMC	MNT	0.58409
		SDD	0.00044
WPDH	Manual	MNT	0.25694
		SDD	0.00073
	SHMC	MNT	0.20328
		SDD	0.00291
WLDH	Manual	MNT	0.00004
		SDD	7.188E-19
	SHMC	MNT	2.386E-08
		SDD	1.871E-06

The results suggest that, in most cases, the manual and software-based values for SDD and MNT are not normally distributed, particularly in WLDH. This finding emphasizes the need for alternative statistical tests for comparing manual and software-based methods.
Table V presents the Wilcoxon test results, comparing manual and software-based calculations across hospitals.

Table V: Wilcoxon test results comparing manual and software-based MNT/SDD values across hospitals

Hospital code	*Variable*	*P value*
NBH	MNT	5.663E-21
	SDD	1.852E-23
WPDH	MNT	6.627E-01
	SDD	1.752E-31
WLDH	MNT	9.252E-23
	SDD	2.093E-30

In the test results (Table V), the WPDH showed a P value of 0.6627 for MNT, indicating no significant difference between manual and software-based methods. This suggests that the data and date entries for the eIMMR at WPDH are likely accurate, further supporting the reliability of the SHMC used in the study. In contrast, the MNT values for NBH and WLDH, with P values of 5.663E-21 and 9.252E-23 respectively, indicate significant differences between the manual and software-based methods, likely attributed

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to data entry errors. Similarly, the SDD values for all hospitals also demonstrated significant differences, reinforcing the notion that inaccuracies in data entry impact the reliability of manual calculations.

DISCUSSION

The accuracy of admission and discharge dates is a crucial factor in generating reliable hospital metrics such as MNT and SDD, particularly when using automated software methods. It is important to highlight that while accurate admission and discharge dates do not affect the MNT and SDD calculated manually (MNT – M/SDD – M), as manual counts are based solely on headcounts and not on admission or discharge dates, these dates are essential for the accuracy of MNT and SDD (MNT – S/SDD – S) produced by the SHMC, which was developed as part of this study.

In this research, all data were extracted from eIMMR where they were originally entered manually, often transferred from multiple documents without verification. As a result, even though the system processes the data electronically, inaccuracies from the manual entries can persist. This highlights that while automated methods such as the SHMC can enhance accuracy when using reliable admission and discharge data, the underlying issue of unverified manual data entry still poses risks to data quality. Therefore, accurate date entries, combined with automated tools like the SHMC, offer a more reliable alternative to traditional manual headcount-based methods.

Data Entry Errors: Comparing Inaccuracies in Manual Collection and Software-Based Calculations

The reliance on manual entry introduces several potential sources of error, including:

1. Inaccurate reporting of MNT and SDD by the wards.
2. Mistakes in translating these values into reports generated at administrative levels.
3. Errors during the final entry of these values into the eIMMR.
4. Inaccurate recording of admission and discharge dates.

While some settings, such as WPDH in this study (Table V), have managed to avoid these errors through meticulous manual practices, many other settings encounter frequent inaccuracies. Achieving reliable manual counts (MNT – M/SDD – M) requires addressing all first three issues mentioned above. This process is resource-intensive and laborious. In contrast, achieving accurate software-based calculations (MNT – S/SDD – S) depends primarily on eliminating inaccuracies in admission and discharge dates. This emphasizes the efficiency and potential of a software-driven approach when combined with the SHMC.

Table **VI** illustrates the different date entry methods to eIMMR and their impact on the accuracy of MNT and SDD calculations. The table compares various scenarios in which the date of admission (DOA) and date of discharge (DOD) are entered, ranging from manual inputs to automated system entries, and outlines their corresponding effects on accuracy of MNT and SDD; and data entry frequency.

Table VI: Effect on change of date entry method to eIMMR

#	*Date of entry of DOA and DOD*	*DOA entry*	*DOD entry*	*TID Accuracy level*	*Minimum Data entry frequency per patient*	*Recommendation*
1	No change	Type the date	Type the date	↑	1	MNT/SDD - M ± MNT/SDD - S
2	Both on the DOD	Date picker	Default date	↑↑	2	MNT/SDD - M / MNT/SDD - S
3	On the relevant DOA or DOD	Default date	Default date	↑↑↑	3	MNT/SDD - S
4	At real time	Default date and time	Default date and time	↑↑↑↑	3	MNT/SDD - S
5	System date and time	By system	By system	↑↑↑↑↑	3	MNT/SDD - S

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The table outlines that options 3 to 5, which progressively increase automation, provide better accuracy and reduced errors in data entry. These options significantly enhance the reliability of the SHMC in generating accurate MNT and SDD data.

Interpretation of the Five Key Options Presented in Table 6

Table 6 compares the effectiveness of various date entry methods, highlighting their impact on accuracy and timeliness for calculating MNT and SDD.

Key points include:

Option 1: Fully Manual Entry

Option 1 reflects the current practice in Sri Lankan hospitals, where both the DOA and DOD are manually entered via a typing the dates. While this method enables software-based calculations of MNT and SDD, it is highly susceptible to human error. The reliance on manual entry diminishes the accuracy of these calculations, despite the SHMC being used for the final output. The errors in manual data entry limit the overall effectiveness of the software system.

Option 2: Partial Automation with Default DOD

In Option 2, a default DOD is entered at the time of discharge, reducing the chances of human error. Both DOA and DOD are entered simultaneously on the day of discharge, providing a more complete dataset for calculating Bed Occupancy Rate (BOR) and other indicators. Since discharges typically occur during the day when operators are available, the impact of operator availability on data entry is minimized. However, the late entry of DOA (on the day of discharge) reduces timeliness and limits real-time monitoring. If stakeholders accept the potential inaccuracies of delayed DOA entry, the manual collection of MNT and SDD could be discontinued, as in the more advanced options.

Option 3: Enhanced Accuracy with Dedicated Staff

Option 3 improves both the accuracy and timeliness of data entry by using default dates for both DOA and DOD, but the process is dependent on operator availability. Although dates are entered on the correct day, the lack of 24/7 staff support may result in delays, affecting the database's completeness and the precision of MNT and SDD calculations. Introducing dedicated staff for 24/7 coverage would resolve this issue, ensuring timely and accurate date entries, and significantly enhancing the method's overall effectiveness.

Option 4: Real-Time Entry with Timestamps

Option 4 implements real-time data entry for both admission and discharge dates, along with exact timestamps, ensuring high precision in MNT and SDD calculations. This method integrates seamlessly with SHMC, allowing for continuous, accurate monitoring. By deploying a dedicated team to manage this around the clock, hospitals can achieve real-time updates without introducing unnecessary system complexity, further improving operational decision-making and patient care.

Option 5: Full Automation

Option 5 represents the most advanced approach, fully automating the entry of both dates and times. This option requires significant system changes, such as integrating the issuance of Bed Head Ticket (BHT) numbers within the eIMMR system. While the upfront investment is higher, the automation ensures the highest level of accuracy and efficiency, completely eliminating the risk of human error

Transformational Impact of Options 2 to 5 with the SHMC

The Smart Hospital Metrics Calculator (SHMC) offers a transformative solution for calculating Midnight Totals (MNT) and Same-Day Discharges (SDD), particularly when paired with data from the electronic Indoor Morbidity and Mortality Return (eIMMR). The impact of this system can be best understood through the transition from Options 2 to 5, with each step improving upon both accuracy and efficiency in hospital data management.

Option 2: Minimizing Errors but With Manual Entry Delays

In Option 2, both the Date of Admission (DOA) and Date of Discharge (DOD) are manually entered at the time of discharge. This approach improves the completeness of the database, as all necessary data for calculating Bed Occupancy Rate (BOR) and other indicators are present. However, the late entry of DOA reduces the timeliness of the data, and potential inaccuracies in manual entry remain. Despite these limitations, if stakeholders acknowledge that the previous manual method also contained errors, Option 2 represents a step forward. The manual collection of MNT and SDD can be discontinued, as the SHMC still improves overall accuracy, even if timeliness is compromised.

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Option 3: Correcting the Timeliness Issue

Option 3 resolves the shortcomings of Option 2 by ensuring that both the DOA and DOD are entered accurately on the relevant day. This is achieved by investing in a dedicated team for real-time data entry, which incurs additional costs but significantly reduces errors related to delayed entries. The SHMC is thus able to generate MNT and SDD values with much higher accuracy, making manual methods redundant. Although this approach requires an investment in staff, it offers a balance between technological enhancement and operational feasibility, ensuring that the elimination of manual MNT and SDD collection can be justified.

Options 3 to 5: Transformational Potential in Accuracy and Efficiency

The transformational impact of Options 3 to 5 is evident when considering their integration with the SHMC. By utilizing accurate admission and discharge dates from eIMMR, the SHMC eliminates the need for error-prone, labour-intensive manual methods (MNT – M/SDD – M), and automates the generation of reliable MNT and SDD values.

- Option 4 provides a practical balance between technological advancement and ease of implementation. In this model, real-time entry of both DOA and DOD is implemented, allowing the SHMC to achieve data completeness at any given moment. This real-time data access enables hospital administrators to make timely decisions, improving overall hospital operations, decision-making, and patient care. Moreover, Option 4 can support real-time monitoring of bed occupancy and BOR, making it a highly functional solution without excessive system complexity.
- Option 5, while more advanced and complex, offers the highest level of accuracy and the most comprehensive automation. This approach involves system-level changes and the use of timestamps for both admissions and discharges, enabling the SHMC to operate with near-perfect accuracy. Although implementation may require significant upfront investment and technical adjustments, the long-term benefits in streamlining hospital data management are substantial. Option 5 also satisfies the demand for real-time bed occupancy and BOR measurements, which are increasingly required by modern healthcare standards, as suggested by Silver (2013) and Delia (2006) (2,3).

The transition from Options 2 to 5, when integrated with the SHMC, reflects a significant shift from manual to automated methods for calculating MNT and SDD. While each option offers improvements over manual methods, Options 3 to 5 represent a profound transformation in hospital data management. These options eliminate the need for labour-intensive processes, enhance the accuracy and timeliness of key performance metrics, and ultimately pave the way for more efficient, data-driven decision-making in hospital settings.

Broader Impacts of Real-Time Data and the SHMC

By implementing option 4 or 5 and integrating the SHMC, hospitals can achieve the following:

1. Eliminate the manual collection of MNT and SDD: The outdated manual methods can be replaced by automated, accurate software-based calculations.
2. Access real-time hospital dashboards:
   a) Patient monitoring,
   b) ICU bed availability,
   c) Patient transfers,
   d) Outbreak surveillance.
3. Monitor bed occupancy in real-time: This provides administrators with instant insights into hospital resource utilization, allowing for more efficient management.
4. Reduce redundancy in parallel systems: Systems such as DenSys – Dengue Surveillance System, FluSys – Influenza Surveillance System, and NISS – National Injury Surveillance System, which collect similar data, can be phased out in favour of consolidated, accurate data within eIMMR.
5. Automated notifications for communicable diseases: The system can generate real-time alerts for communicable disease outbreaks, enhancing public health response

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CONCLUSION

The study clearly demonstrates the inefficiencies and inaccuracies associated with the manual collection of MNT and SDD, particularly due to human error during data entry and reporting. While certain hospitals, like WPDH, have managed to mitigate these issues through resource-intensive manual methods, others continue to face significant challenges with accuracy.

The implementation of software-based methods, specifically the SHMC developed in this study, presents a transformative solution. By leveraging existing patient admission and discharge data within the eIMMR system, the SHMC can significantly improve the accuracy and reliability of MNT and SDD calculations without the need for major financial investment. Options 3 to 5 outlined in Table 6 provide practical pathways for implementation, requiring only workflow adjustments and minor revisions to the eIMMR system to ensure that admission and discharge dates are properly entered. Option 4, in particular, offers a feasible solution that promises real-time data entry and enhanced accuracy without extensive system overhauls.

The most significant potential outcome of this proposal is the elimination of manual collection of MNT and SDD. If options 3 to 5 are implemented, hospitals could replace labour-intensive manual processes with a real-time, accurate, and efficient system for hospital data management. These proposed solutions have the potential to improve data completeness, enabling real-time monitoring and reporting in critical areas such as patient transfers, ICU bed occupancy, and outbreak surveillance.

In conclusion, transitioning to software-based methods—using the SHMC and accurate eIMMR data—has the potential to represent a pivotal transformation in hospital data management in Sri Lanka. This proposed shift could eliminate outdated, resource-heavy manual processes and pave the way for more accurate, efficient, and timely data-driven decision-making, all while utilizing most of the existing resources**.**

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