Analyzing and Optimizing the Gaps among Hospital Beds Vacancy, Medicines and Oxygen Supply through Dynamic Plug-in Instrumentation

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Abstract

The research paper highlights information about the prediction and optimization of the essential services required in managing a hospital or a large healthcare centre. The essential services include facilities or services such as bed availability, Generic Drug availability, and medicated oxygen supply. Both primary and secondary research methods have been implemented by the researcher to attain the viability, and reliability of the data. A primary interview survey has been conducted on 115 participants. The research study identifies an urgent need for reverse engineering-based dynamic binary instrumentation for the synchronization of hospital bed management procedures, along with an adequate predictable supply of essential generic medicines and oxygen. This will help to cope with the emergency patients' healthcare needs in hospitals and large healthcare centres.

Keywords: Hospital beds, healthcare needs, medicated oxygen, reverse engineering, instrumentations.

1 Introduction

In the age of the rising population and costs with consequential pressure on the resources, it becomes crucial to use the proper healthcare resources to the optimum level. Given the difference/disparity between the available medical facilities and the population, a hospital bed category is a scarce commodity in the Indian community context [1]. In India, there is a shortage of beds in hospitals which is a big problem considering the ratio of the average bed population. The cost/expense incurred by hospitals is an important element for health expenditure and thus has been a major focus in catalyzing efficiency in the healthcare sector [2]. Moreover, the expense of making a bed available tends to incur additional costs for the healthcare infrastructure. The scarcity of beds is compounded by the improper or underutilization of healthcare/hospital resources. This research study will help in understanding the current scenario of the usage of hospital resources such as hospital bed availabilities, demand and supply of prescribed drugs, and medicated oxygen. The study will also help in determining the impact of fewer resources on the functioning of the healthcare facilities and also on the efficiency of the hospital administration and management of the clinical cases.

2 Literature Review

From the various research studies, it could be comprehended that the most essential element of the healthcare system in developing nations takes into consideration around 70% - 80% of the total healthcare cost [3]. The expense related to making a bed available tend to differ between INR 50,000 to INR 1,00,000 and then there are related additional expenses for maintenance purposes [4]. Increasing hospital bed occupancy was highly recommended although this has chances to lead to increased monitoring of cost/expenses andcomplexities[5]. In the Indian context, the complex disparity and interplay between the growing population and limited healthcare infrastructure (here, hospital bed utilization). Thus, it can be comprehended that the availability of hospital beds is deemed to be a significant factor when it comes to

deciding about hospital resources that will help in delivering health-related services and care to inpatients [6]. Moreover, the patients demanding intensive care, and comprehensive preventive and curative services might not be able to improve their health conditions due to the improper availability of hospital beds [7]. The number of beds per 10,000 is utilized as an indicator of healthcare infrastructure and poor availability of beds will not help India in expanding its health infrastructure [8]. This makes the policy makers guarantee proper bed capacity to ensure value for money and resilience consideration to the patients of the hospitals. Further, there are other resources such as oxygen and medicine which needs to be managed and distributed properly. Oxygen is considered to be a life-saving essential medicine with no substitution. Healthcare professionals use oxygen so that various respiratory diseases, trauma, and surgery. The health units that use oxygen include primary health care, emergency support, general wards, delivery rooms, surgical rooms, intensive care units (ICU), specialized hospitals, outpatient units, and hyperbaric chambers [9]. The oxygen system has sources, distribution, delivery, patient monitoring, regulation, and conditioning. Due to the complexity, it often becomes difficult for people to access oxygen. Oxygen systems require regular maintenance and power supplies to function properly. It also encounters challenges in its safety, resource capacity, supply, management, affordability, quality, and availability. Lack of oxygen demand has maximized from 100 – 200 (twice fold) amid the pandemic [10]. This can be done by enhancing oxygen usage with smart design and robust equipment, and supporting biomedical engineers so that it can optimize the existing oxygen supplies [11]. This needs an accurate comprehension of the oxygen required for the patients with their mentioned/diagnosed illness [12].Further, Hospital Pharmacy needs to ensure the timely availability of medicines at the lowest possible purchasing cost and ina variety of forms including generic and complementary compositions [13]. Research studies have also identified that there are areas where the usage of medicines has been diverted or misappropriated, thus creating a gap in the administration and consumption of medicines [14]. To cater to the gap, there is an urgent need for judicious management of the medical system is compulsory.

3 Research Methodology

In this study, a primary survey was conducted among 115 respondents including admitted and OPD patients, medical professionals, and other stakeholders of different categories of hospitals in and around Kolkata, India sub-regions, and the responses were analyzed using analytical tools for finding insight and gauging the gaps among different essential healthcare resources availabilities and constraints. Further, this study also tries to observe the underline legacy information systems that are running as a part of various hospitals for admission, discharge, and medical diagnosis process through interactions with hospital staff, medical professionals, and vendors supplying drugs and medicated oxygen to the health care units.

4 Findings and Evaluation

The key findings of the study are listed below.

- 80% out of all respondents are in favor that there is a significant time elapsed between the discharge of a patient from a bed and to allotment of another patient to the same bed.
- 78% of respondents are in favor that the delay in hospital bed availability is either due to unorganized bed management systems or lazy updates/ lack of initiative of information by hospital staff. And among those respondents, 87% believe that hospital bed admission or discharge procedures are complex and time-consuming.
- 9% of all admitted patients complain that the treatments/procedures of the hospital were not satisfactory and 17 out of 69 admitted patients even claimed that they were not treated with generic medicines which are very cost-effective. 52% of those unsatisfactory patients even claimed the medicines were not easily available in pharmacies or medical stores.
- 75% of all admitted patients claimed that they faced medicated oxygen-relatedissues while hospitalized and among those 30% were general ward patients.

- Approx. 5%of Private hospitalsadmitted 13% Semi Government and 14%of Government Hospital wise admitted patients were not satisfied with the service for the specific issues on non-availability of medicine and medicated oxygen, the complex hospital admits and discharge procedures, etc.

On the evaluation of the result, the study finds that among admitted patients, most are male and middle-aged personswho prefer private health care admission for treatment rather than semi-govt or govt. hospitals(**deficit in Fig 1**). Further, a considerable population of admitted patientshas a fixed belief that there is a huge delay in bed allotment to them thou the beds are discharged or vacant by the earlier admitted patient and that is due to the lack of initiative among hospitalstaff and also due to the legacy hospital bed management system that fails to allot vacant bed to the patient on a real-time basis (deficit in Fig2).

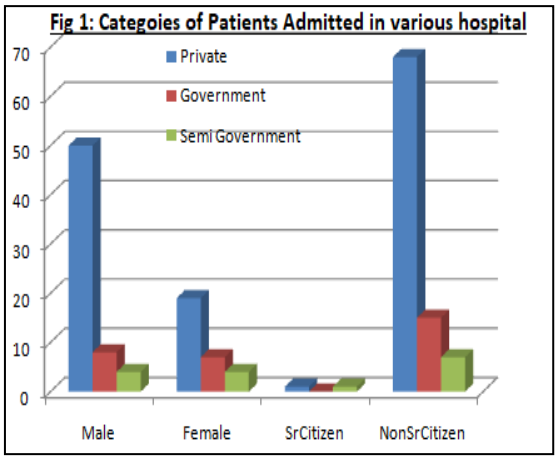

Figure 1: Categories of Patients Admitted in Various Hospitals(**Source**: Author's Creation)

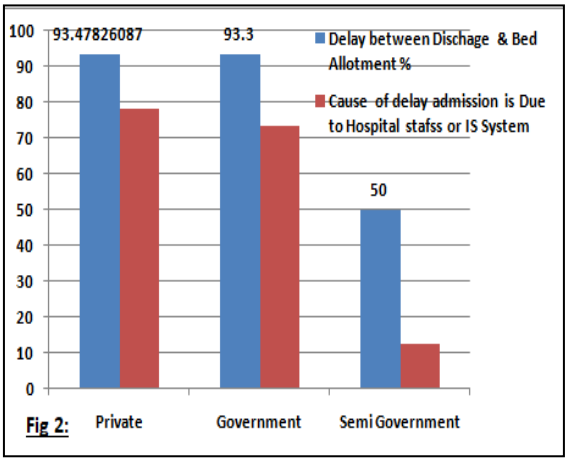

Figure 2: Patients preferring treatment in Private, Government, and Semi-Government Hospital(**Source**: Author's Creation)

A significant portion of respondents of our study also reported that they faced the availability of medicated oxygen during their treatment and among them, around 50% of the patients were hospitalized in semi govt. health care units (deficit in Fig 3). While inspecting the responses, the study finds that among different categories of wards for different types of hospitals, the bed occupancy rates are significantly

higher for the specialty wards and general wards for only private and government hospitals (deficit in Fig 4).

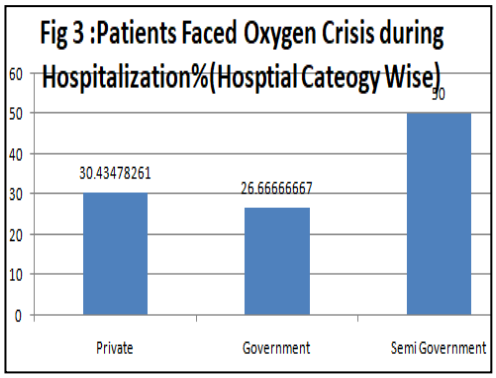

Figure 3: Percentage of Patients who encountered Oxygen crisis during Hospitalization (Hospital Category wise) (**Source**: Author's Creation)

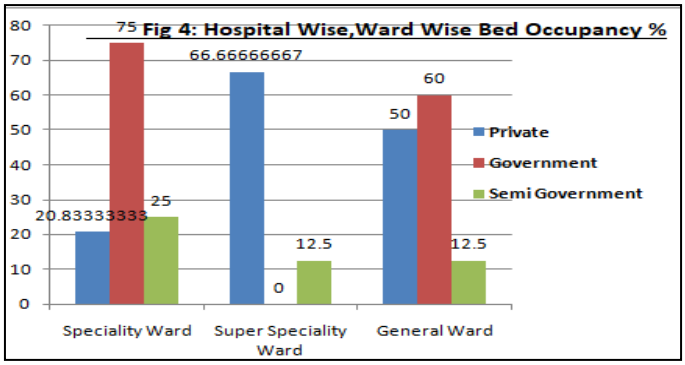

Figure 4: Percentage of Hospital Wise and Ward Wise Bed Occupancy (**Source**: Author's Creation)

On further evaluation of the results, our study evidences a significant decrease in patient satisfaction rate and the major causes of such dropping rate is due to non-availability of prescribed medicines at hospitals in-house pharmacies or near my medical stores and patient party also reported that they were not treated with generic medicine composition and also faced oxygen supply related issues (deficit in Fig 5). Such a negative correlation rate between patientsatisfactionvs. drug non-availability is not at all derisive from the societal and ethical point of view. The study also analyzed the patient's feedback about the efficiency of standard operation procedure (SOP) of the hospital and hospitalization admission/discharge process which strongly indicates that thou patients acknowledged the SOP but the majority of them faced problems during hospital admission (deficit in Fig 6).

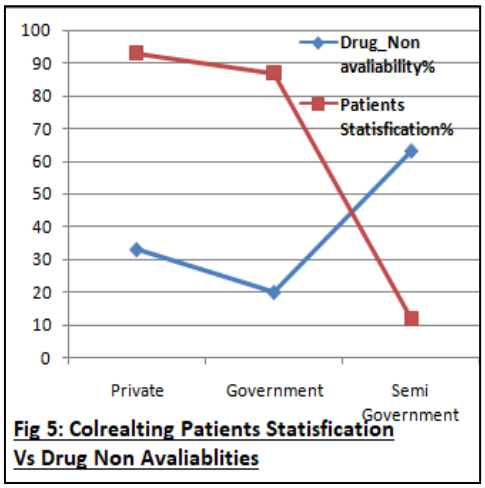

Figure 5: Correlating Patients Satisfaction Vs. Non Availability of Drugs(Source: Author's Creation)

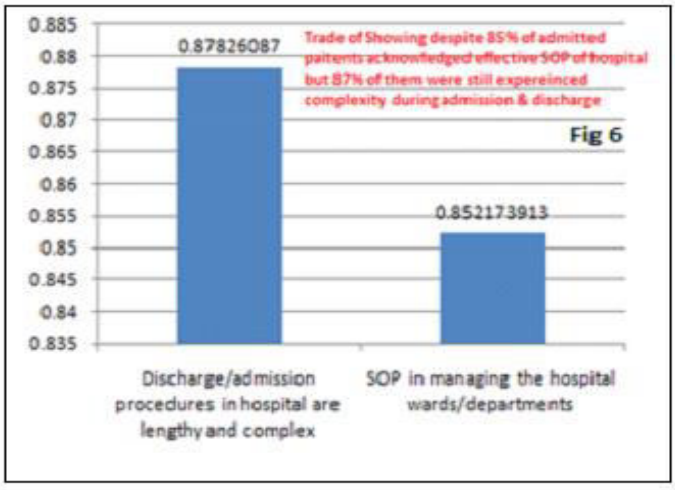

Figure 6: Problems Faced during Hospitalization (**Source**: Author's Creation)

Hence, we find that there is an urgent need to co-relate the bed discharge, and admission process of the hospital ona real-time transparent basis and to integrate and steam line the various services like predicted demand and real-time supply of medicated oxygen and drugs prescribed to patients using a hybrid information system and such patched software module or application need to be dynamically plug-in instrumentation [15] with the existing legacy hospital management system to speed up the hospitalization process and to real-time synchronize among various essential resources like the supply of medicated oxygen and life-saving drugs that patient may need during treatment. The block diagram of our proposed model is shown in Fig 7.

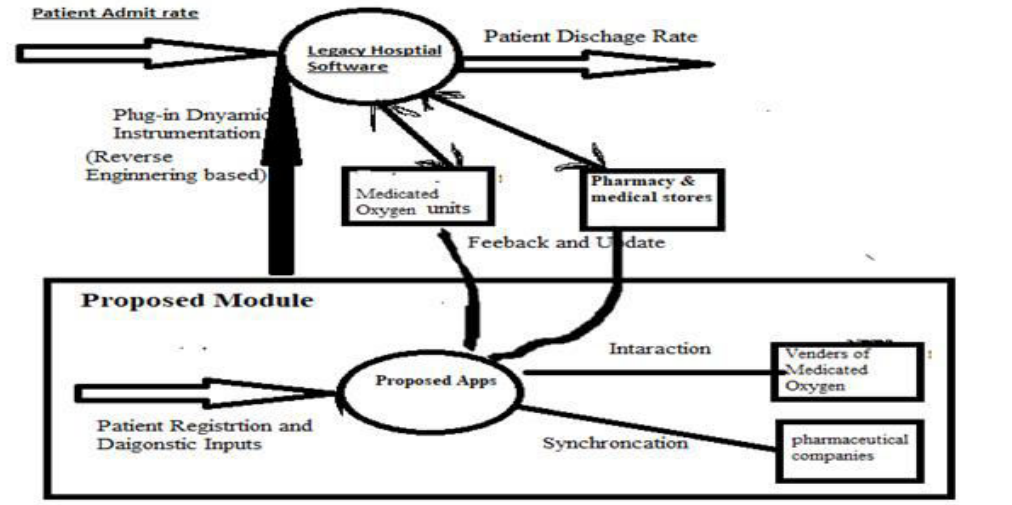

Fig 7: Proposed Application which may plug in with existing legacy hospital system to speedup and synchornize variouse services by collaborationg with various stackholders

Figure 7: The Proposed Model (**Source**: Author's Creation)

5 Conclusion

Various factors such as categories of hospitals, types of beds, bed turnover ratio and intervals, the average stay of patients, etc. play a significant role in predicting hospital beds availabilities and therein synchronizing the supply of adequate drugs and medicated oxygen as per the changing demands are real challenges to be addressed for the better service to the patients. Existing healthcare systems are mostly legacy in nature and operate in a standalone manner with little or no scope to integrate various external supplementary stakes sub-systems like pharmaceutical units or oxygen supply agencies. This issue can be well addressed by using our earlier dynamic plug-ins [16] to add additional moduleswith the existing hospital software to streamline and synchronize various life-saving services together under a common system.

6 Limitations and Future Scope

The underline challenges of the proposed prototype are that very few hospitals will agree to allow external modules to be integrated with their binary executables for the sake of security and confidentiality. Also, dynamic binary instrumentations have their overheads. Further, the varying nature of demands of beds, drugs, and oxygen supply at different time points are also very unpredictable.

Despite such limitations, we are hopeful our framework will help future research in healthcare resource synchronizations using reverse engineering-based dynamic binary instrumentation as its novelties include runtime plug-ins and customized patches when required without disturbing the normal operations of an existing hospital software system.

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7 Author Contributions

All authors contributed to the study's conception and design. All authors read and approved the final manuscript.

7.1 Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

7.2 Availability of Data and Materials

The data that support the findings of this study are available on request from the corresponding author. For privacy and ethical issues, the data are not publicly available.

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