

**ASSESSMENT OF THE TURNAROUND TIME (TAT) AND PROCESS FLOW OF
PNEUMATIC TUBE SYSTEM IN A HOSPITAL SETTING**

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**ANALYSIS AND OPTIMIZATION OF HOSPITAL BELL CALL RESPONSE TIMES:
A STUDY ACROSS MULTIPLE FLOORS IN THE HOSPITAL**

**Internship at-
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ASSESSMENT OF THE TURNAROUND TIME (TAT) AND PROCESS FLOW OF PNEUMATIC TUBE SYSTEM IN A HOSPITAL SETTING

INTRODUCTION

About Pneumatic Tube System (PTS)

- Pneumatic tubes, also known as capsule pipelines or PTT, are systems that use vacuum pressure or compressed air to push cylindrical containers through networks of tubes. Over time, pneumatic tube systems found applications across various industries, like in hospitals it effectively manage critical intralogistics.
- They ensure timely and secure transport of goods, which is crucial for maintaining staff productivity, patient care, and operational efficiency. These systems connect central pharmacy and laboratories along with wards, operating rooms, and departments, facilitating rapid delivery of essential medical supplies and diagnostic samples.



TAT is the total amount of time needed to finish a task or operation, including all stages from start to finish. Although having benefited from many advancements in medical technology, ineffective, delay critical operations like sample transfers and drug distribution, exhaust staff, and put relevantly high-risk patient care at stake. Efficient PTS is essential for delivering drugs and samples in time. Research in this area has oriented towards TAT evaluation, root cause analysis of delays, process flow analysis, and formulation of SOPs to enhance efficiency. The common causes of delay are system overload, operational inefficiencies, and labour shortages. Optimizing PTS and dealing with such concerns will help hospitals improve staff productivity, operational performance, and overall patient care delivery.

COMPONENTS OF PTS

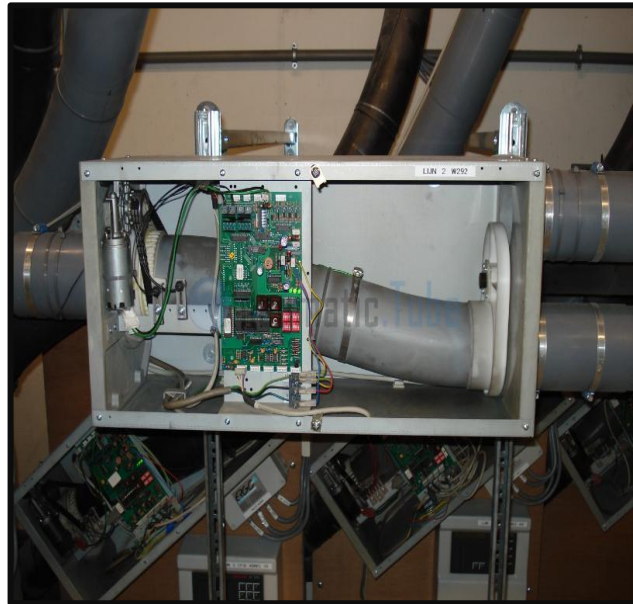
Carriers or Capsule

- Carriers are cylinder-shaped containers that are used to move goods from one place to another. They come in varied sizes to fit different types of items.
- Its Leak-proof, lockable containers with RFID chips provide hospitals a safe and secure way to transfer delicate goods.



Diverter

- They allow packages to change directions and navigate corners inside the tube network.
- They regulate airflow to guarantee that carriers follow the most efficient paths & it can also be operated remotely.



Station

- Pneumatic tube stations are used for transmitting or receiving carriers. Users are able to select the station as per requirements.
- Transport is made safe and secure with accessories including arrival indications, carrier storage, and receiving baskets.



Blower

- It acts as the primary power source by providing the air needed for operation.
- It refers to the fans that create air pressure and a vacuum inside the transport tubes to help carriers move by pushing or pulling the carrier.



LITERATURE REVIEW

Author/ Year of Publish	Study Location/ Sample Size/ Sampling Technique	Review Title	Abstract
Dr. Arun. Seetharam, Dr. Somu, Dr. Sudhakar. Kantipudi, Mr. Jibu (2013)	Location- Kasturba Hospital, Manipal Sample Size- 1500 samples from Women & Child block to Clinical Lab. 650 samples from Main Hospital to Biochemistry Lab. Sampling Technique- Convenience sampling over a three-month period	PTS in healthcare: A study of innovative ways to improve hospital efficiency.	The literature review highlights logistics inefficiencies in Indian hospitals, proposing PTS as a solution to complement HBT. HBT faces issues like errors, delays, and security risks. PTS, despite implementation challenges at Kasturba Hospital, proved to be fast, safe, and cost-effective, saving time and labor. The review recommends early adoption of PTS in large, vertical hospitals to enhance efficiency and patient care.
Mark W. Isken, Steven J. Littig (2002)	Location- Hospital in United States. Sampling Technique- Systematic Review	Simulation Analysis of PTS	Hospital PTS quickly move lab specimens and drugs but are costly and lack comprehensive evaluation tools. The article proposes improving efficiency by monitoring data like traffic patterns and delivery times, and developing a simulation model to optimize performance and reduce costs. A case study shows these strategies enhanced transaction speed and cut expenses in a large hospital's PTS.
C Wunder, G Langer (2019)	Location- University Hospital St. Polten, Austria Sample Size- 60 Sampling Technique- Purposive Sampling Technique	Is it safe to distribute medications using pneumatic tubes?	The article examines the stability and safety of drugs transported via hospital PTS. While effective for emergency delivery, the high-speed forces may affect drug stability. Tests using accelerometers revealed issues like formulation separation, leakage, and emulsion breakdown under worst-case conditions. Cytotoxic and protein-based drugs were particularly vulnerable. The study recommends hospital pharmacists create specific SOPs to ensure safe delivery and protect drug quality, as primary packaging may be inadequate.

METHODOLOGY

AIM- To analyse and improve the efficiency of the hospitals PTS, focusing on reducing turnaround times for medication delivery and addressing operational challenges through the implementation of standardized procedures and strategic enhancements.

OBJECTIVE

- Determine the TAT for pneumatic tube capsules in the hospital.
- To identify the primary causes of delays in the PTS.
- To analyse the current process flow of the PTS.
- To develop a SOP for the optimal use of the PTS in pharmacy.

RESEARCH QUESTION- How can the efficiency of the PTS be improved in the hospital to ensure timely and effective medication delivery?

STUDY DESIGN- The present study is an observational and analytical study.

STUDY SETTING- The study will be conducted in a hospital setting, specifically focusing on the pharmacy department and various hospital floors where PTS are installed.

STUDY POPULATION- Pharmacy staff and nurses utilizing the PTS.

STUDY TOOLS- Observation and transaction logs from Biomedical Engineering department were used as study tools. Also, informal interviews were conducted with the head of the Pharmacy of the hospital

DURATION OF STUDY- 2 months 18 days

SAMPLE SIZE- A total of 43 PTS will be observed and analysed.

SAMPLING TECHNIQUE- Data was collected on April 5th (3-5 pm), 6th (12-1 pm) and 12th (11 am-12 noon) as per the instructions from the authority. All the observations on these days were used for the analysis.

DATA COLLECTION PROCEDURE-

- Timed observations of Pneumatic Tube Transactions. Interview with the head of the Pharmacy.
- Analysis of transaction logs from Biomedical Engineering Department.

DATA ANALYSIS PLAN- Data was analysed using Microsoft Excel.

RESULT

TAT ANALYSIS- A total of 43 pneumatic tube transactions were observed and analysed to determine the TAT within the hospital setting. The recorded times were as follows:

Minimum TAT: 1 minute

Average TAT: 15 minutes

Maximum TAT: 56 minutes

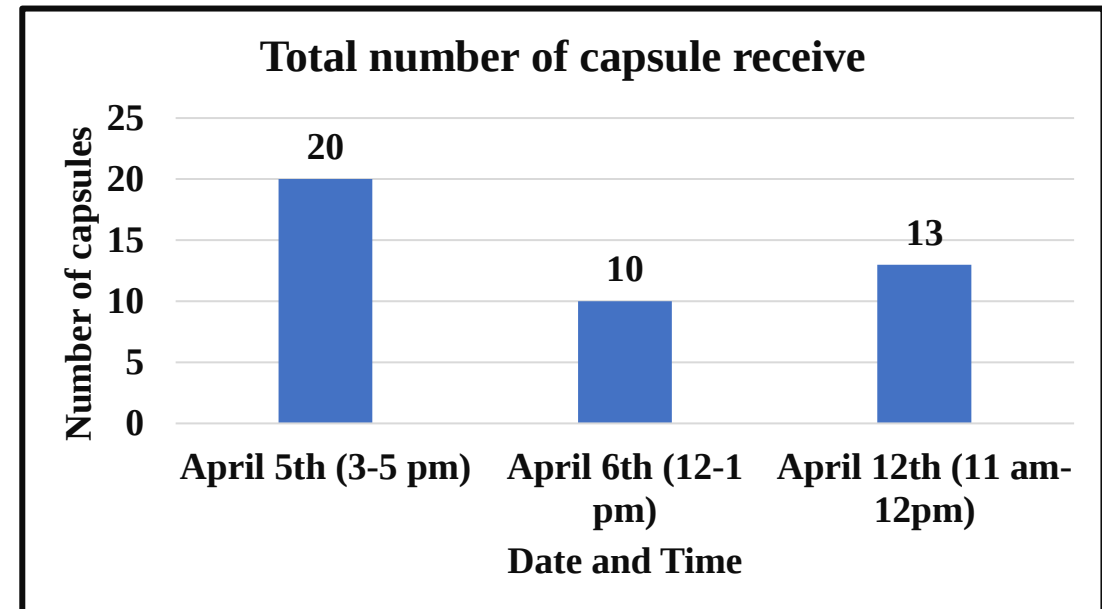
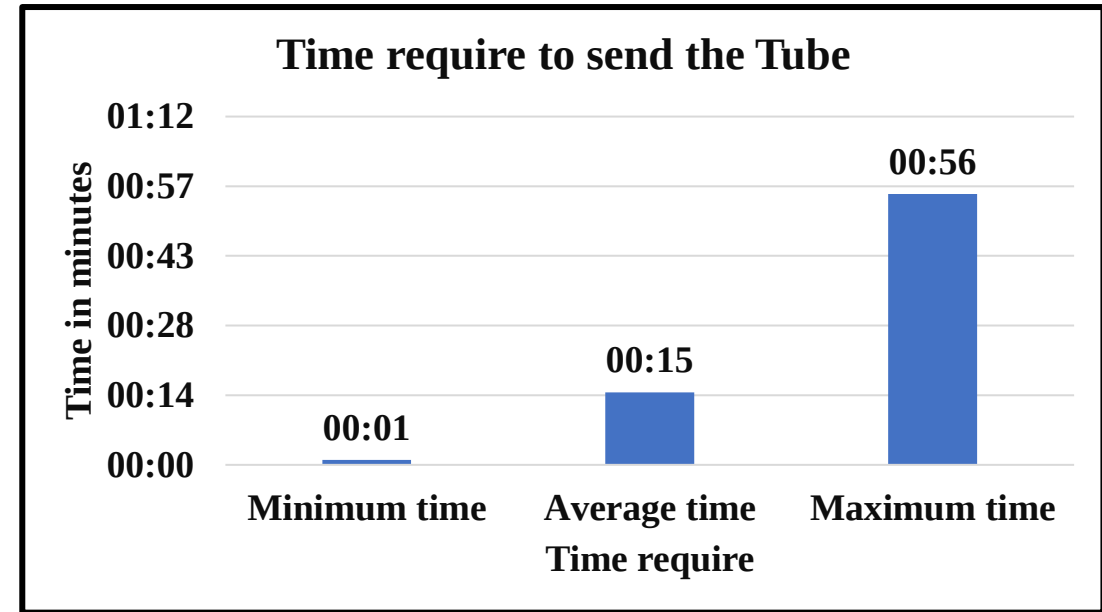
TOTAL NUMBER OF CAPSULE RECEIVE- The following data was recorded regarding the number of capsules received from an observation of 43 pneumatic tube samples:

April 5th (3-5 pm): 20 capsules

April 6th, (12-1 pm): 10 capsules

April 12th, (11 am-12 pm): 13 capsules

During these periods, a total of 43 capsules were received- an average of approximately 10 per hour.



Process flow of PTS



CAUSES OF DELAYS

System Overload- When there is heavy traffic, particularly during rush hours, the system becomes overloaded and delays the capsules delivery and dispatch.

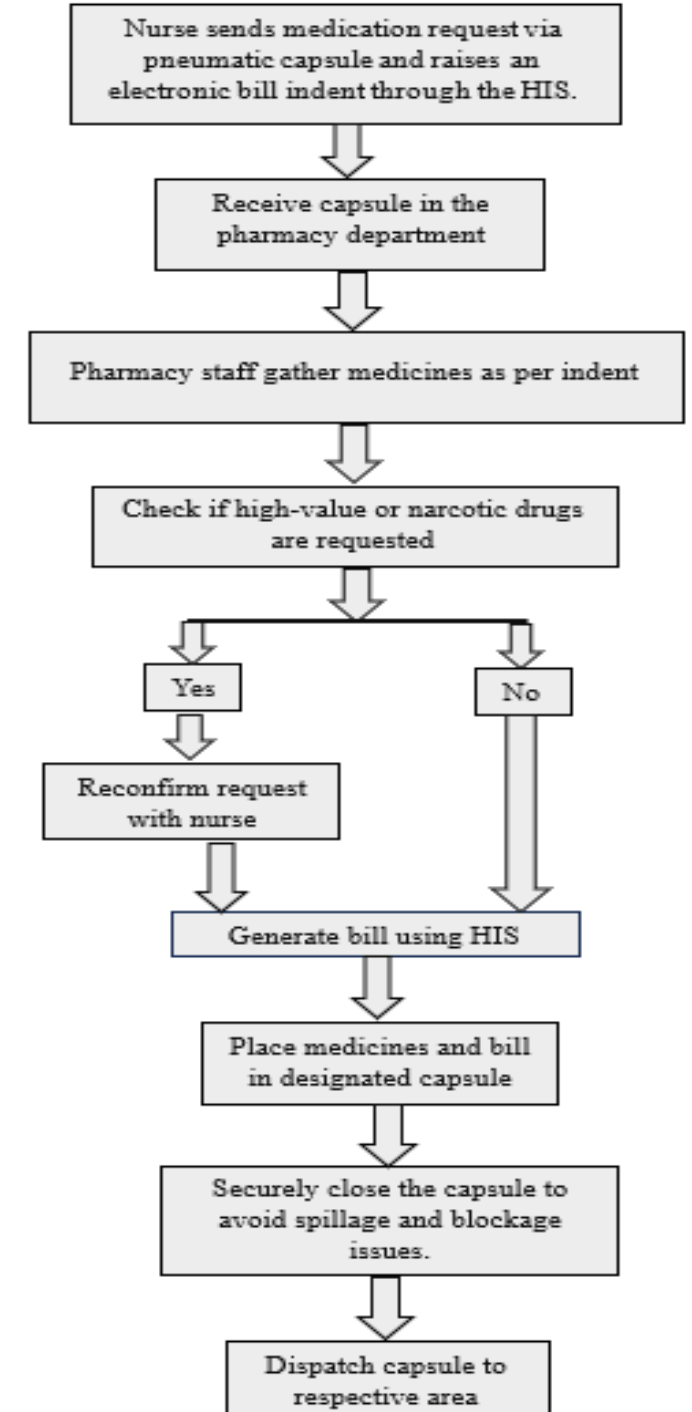
Operational inefficiencies- Lockage's and system failures were caused by incorrect capsule loading, which included going beyond weight limitations or sealing them improperly.

Problems with Staffing- Processing and shipping of capsules were delayed during periods of high demand due to a shortage of personnel. Inadequate training was another factor in the system's incorrect use.

Technical Malfunctions- Occasionally, the system's operation was interfered with by technical problems including mechanical breakdowns or blockages in sensors.

Pharmacy Dispatch- During peak hours, there were delays at the pharmacy dispatch unit because of a high volume of requests and insufficient manpower.

Receiving Units- A number of receiving units reported delays, especially when capsules were misdirected or encountered obstructions.



SOP DEVELOPMENT

Purpose: In order to ensure the safe transportation of medical products while reducing related hazards, a standardized process for the effective and safe use of PTS in the pharmacy department needs to be established.

Scope: This SOP is applicable to pharmacy staff and nursing personnel involved in the transport of medications via the PTS within the facility.

General handling guidelines

- Medications must be packaged in accordance with the manufacturer's instructions and placed into the canister with adequate packing to avoid breakage.
- Make sure the capsule weighs no more than 1.5 kg, with 1.2 kg allowed for medication weight to avoid tube clogs.
- A carrier can be loaded without the need to wait for a previous transaction to reach its destination.

Items Not to be Sent via Pneumatic chute System

- | | |
|--|---|
| ➤ Items weighing more than one kilogram. | ➤ Expensive products. |
| ➤ Glass objects that are not sufficiently padded or secured to prevent breaking. | ➤ Virus vaccinations in live form. |
| ➤ Radiopharmaceuticals, cytotoxic medications, and hazardous compounds. | ➤ Items that need to be refrigerated. |
| ➤ Narcotic drugs (substances under supervision). | ➤ Items with a "Do Not Shake" label on the packaging. |
| ➤ Substances with carbon. | ➤ Items that foam or froth when shaken; if shipped, they should be given time to settle before being opened |

Handling Challenges

Container opening - Make sure the nursing and pharmaceutical divisions are correctly closing containers. But get in touch with the BME department if there's a spill or obstruction.

Receiving Sensor Blocked- Get in contact with BME if the receiving sensor is blocked. There's a chance that a transaction from a different department is ongoing, or some other channel is the source of the block.

Maintenance- The pneumatic tube system should have routine maintenance performed by BME every six months.

Decontamination

Immediate Response- Securing down the area to stop more contamination and Notifying BME and Infection Control, along with all other relevant departments

Personal Protective Equipment- Make sure that gloves, masks, and gowns, among other required PPE, are used by all persons handling the contaminated material.

Procedure for Cleaning

Minor Contamination- Use a suitable disinfectant that has been approved by the infection control team to clean the contaminated area.

Major Contamination- The system might need to be temporarily shut down if the contamination is severe. Use cleaning services with expertise in biohazard decontamination.

Verification- Before beginning regular activities again after cleaning, be sure the area is clear of contamination. Swab tests and visual inspections by the infection control staff could be part of this.

RECOMMENDATIONS

To enhance PTS effectiveness and reliability in hospitals:

Maximize Training and Staffing

- Ensure enough staff during peak times.
- Train pharmacy and nursing staff on proper PTS usage.

Regular Maintenance and Support

- Schedule biannual maintenance checks.
- Create a rapid response team for technical issues.

Standardize SOP's

- Develop and implement uniform SOPs.
- Regularly update SOPs based on feedback and changes.

Improve Coordination and Communication

- Use PTS for clear communication and coordinated dispatches.

CONCLUSION

- This research evaluated PTS - TAT and process flow in a hospital, identifying major inefficiencies such as personnel constraints, operational issues, and system overload causing delays. To enhance PTS effectiveness and reliability, the study suggests optimizing staffing, conducting routine maintenance, standardizing SOPs, improving real-time monitoring, and boosting departmental coordination.
- Implementing these recommendations will likely improve hospital logistics, reduce delivery delays, and enhance patient care. Regular maintenance and ongoing training will ensure smooth operations, while better communication and monitoring will facilitate timely problem-solving. An effective PTS is crucial for hospital operations, ensuring prompt and safe delivery of medications and supplies, ultimately improving operational efficiency and patient care outcomes.

ANALYSIS AND OPTIMIZATION OF HOSPITAL BELL CALL RESPONSE TIMES: A STUDY ACROSS MULTIPLE FLOORS IN THE HOSPITAL

INTRODUCTION

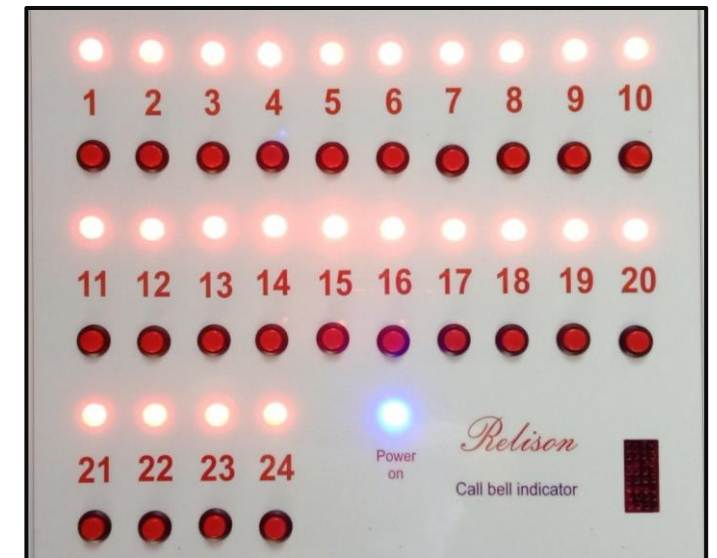
The hospital call bell systems, otherwise known as nurse call systems, are essentially electronic communication devices installed in healthcare institutions to communicate directly between patients and healthcare workers. Such devices are normally mounted beside beds and in bathrooms, thus allowing a patient to call for assistance at any time. They assist by raising an alarm to put in a call to a nurse, healthcare worker, or porter with the press of a button.

Components

Call Button- This is the button normally placed beside a patient's bed, which generates a call signal upon being pressed to seek help. State-of-the-art systems combine handheld devices or wearable technologies easily for its operation.

Indicator Panels

These panels are mounted at nurses' stations and other locations generally within a hospital. They indicate the room number or bed number originating the call and visual indicator with an audible alert.



LITERATURE REVIEW

Author/ Year of Publish	Study Location/ Sample Size/ Sampling Technique	Review Title	Abstract
Robin Digby, T. Howard, Melissa J Bloomer (2011)	Location- Mornington Centre, Peninsula Health, outer metropolitan Melbourne, Australia Sample Size- 41,460 call bell activations (control period); 47,478 call bell activations (post-intervention period) Sampling Technique- Convenience sampling	Improving call bell response time	The study compared call bell response times in two geriatric wards before and after interventions to reduce patient falls. Interventions included staff awareness campaigns, rescheduling nurse breaks, and hourly rounds. Despite increased call congestion, response times improved, with a 5.21% increase in calls answered within five minutes. While falls and call activations didn't decrease significantly, the findings highlight the importance of leadership and teamwork in improving patient safety and response times in senior care settings.
Capt. Valsa Thomas, Pankaj Punjot, Binu Gigimon Varghese (2019)	Location- Dr. L.H. Hiranandani Hospital, Powai, Mumbai, Maharashtra, India Sample Size- 16,543 call bells Sampling Technique- Universal sampling	Study to assess the nurse call response monitoring - proximity contributory Factor	The literature review highlights the crucial role of hospital call bell systems in patient contact, emphasizing the need for immediate nurse responses to ensure patient satisfaction and safety. Dr. L.H. Hiranandani Hospital tracked 16,543 calls over three months, achieving a 94.88% response rate within a minute. Effective call bell responses are vital for good nurse-patient relationships, patient safety, and overall satisfaction with hospital care.
Nancy Martin, Gloria Cardosa (2003)	Location- Cambridge Memorial Hospital Sample size- 140 Sampling technique- NA	The Patient Connection: Improving Call Bell Response at Cambridge Memorial Hospital	Improving call bell response times enhances patient satisfaction in healthcare. Cambridge Memorial Hospital reduced response times with feedback-driven interventions. Staff prefer face-to-face communication over portable phones despite their potential for faster responses, highlighting efficiency versus patient satisfaction challenges. More research is needed on perceived versus actual response times to prioritize patient-centered care improvements.

METHODOLOGY

AIM- The objective of this study is to evaluate and improve the response times for the hospital's bell calls.

OBJECTIVES

- Analyse response time by floor and date.
- Compare response times for nurses, HCA and porters.

STUDY DESIGN- The present study is a cross-sectional and analytical study.

STUDY SETTING- The study was conducted in a hospital setting, on different floors which are 9th, 11th, 12th, 13th, 14th, 15th

STUDY POPULATION- Patients using the bell call system, nurses, HCAs, and porters.

STUDY TOOLS- Bell call system records, hospital records

SAMPLING TECHNIQUE- Convenient sampling was used to conduct the study.

DATA COLLECTION PROCEDURE- Secondary data was used for this study. As mentioned earlier, bell call system records and written records by nurses were used.

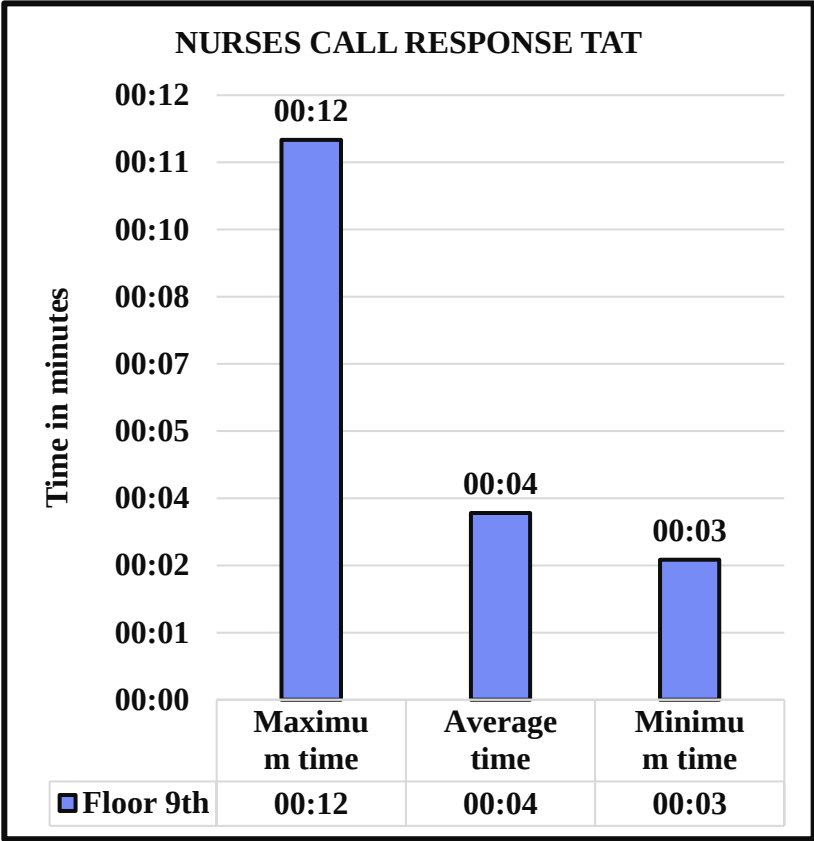
DATA ANALYSIS - Data was analysed using Microsoft Excel.

9th Floor

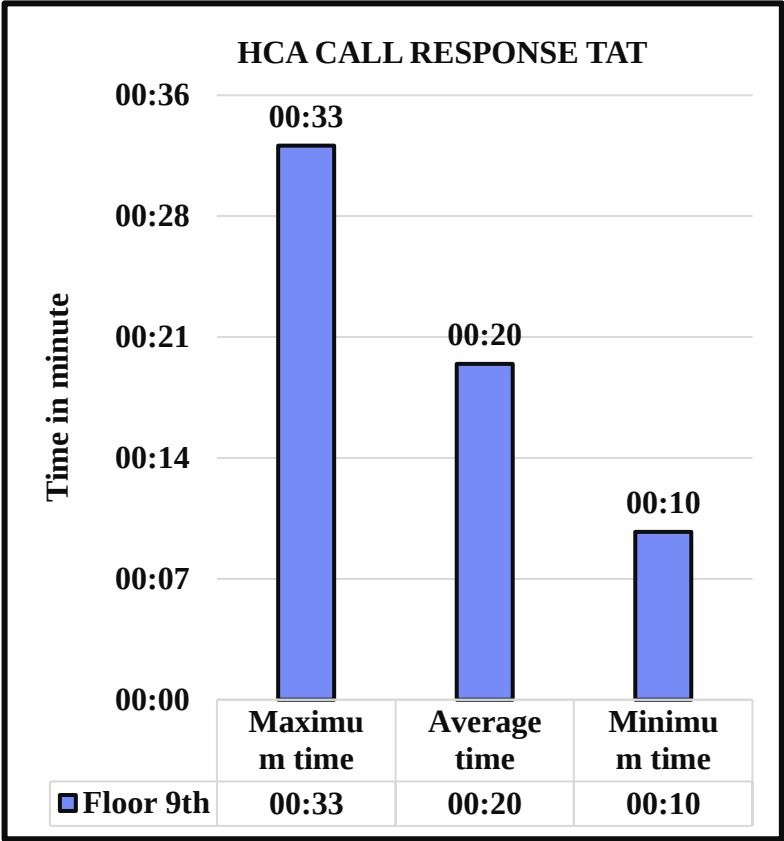
Date- 14th & 15th May 2024

Floor departments- IPD- Twin Share, BMT Unit

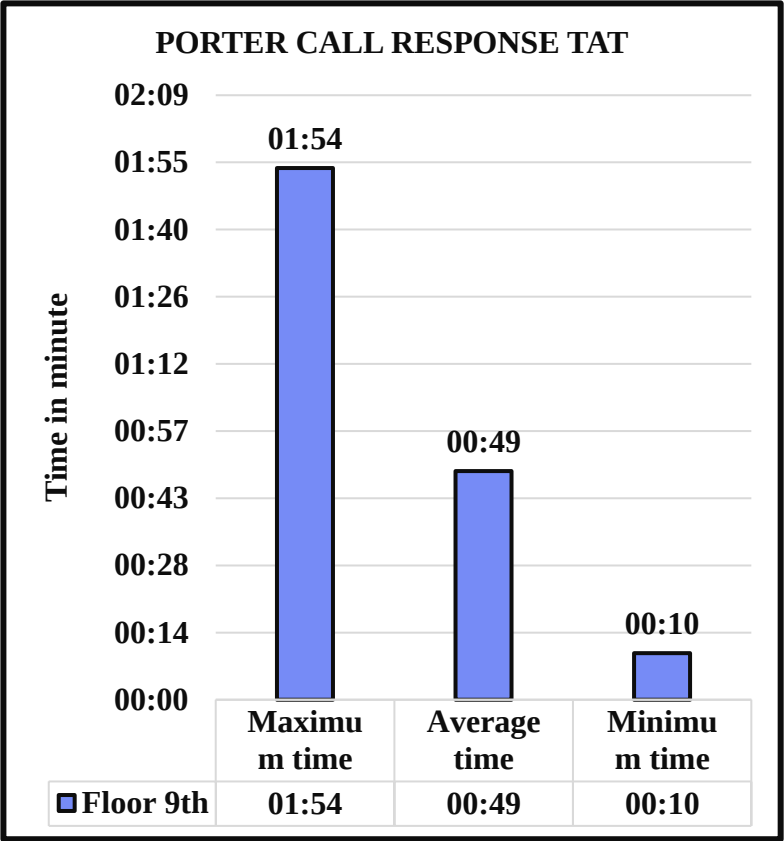
Total Number of Beds- 40



Sample size- 14



Sample size- 14



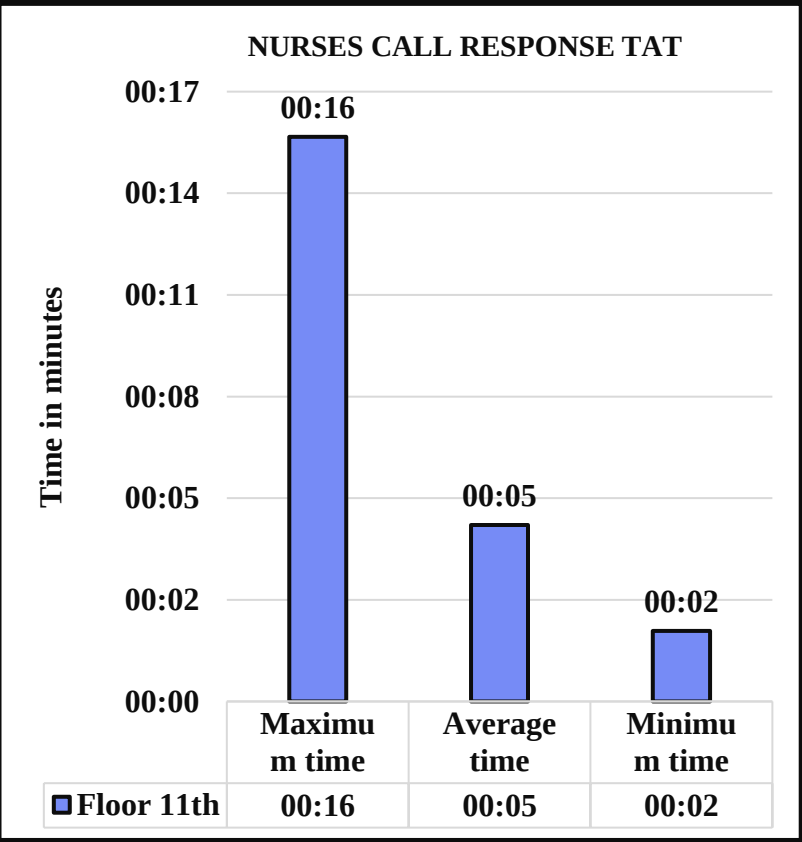
Sample size- 19

11th Floor

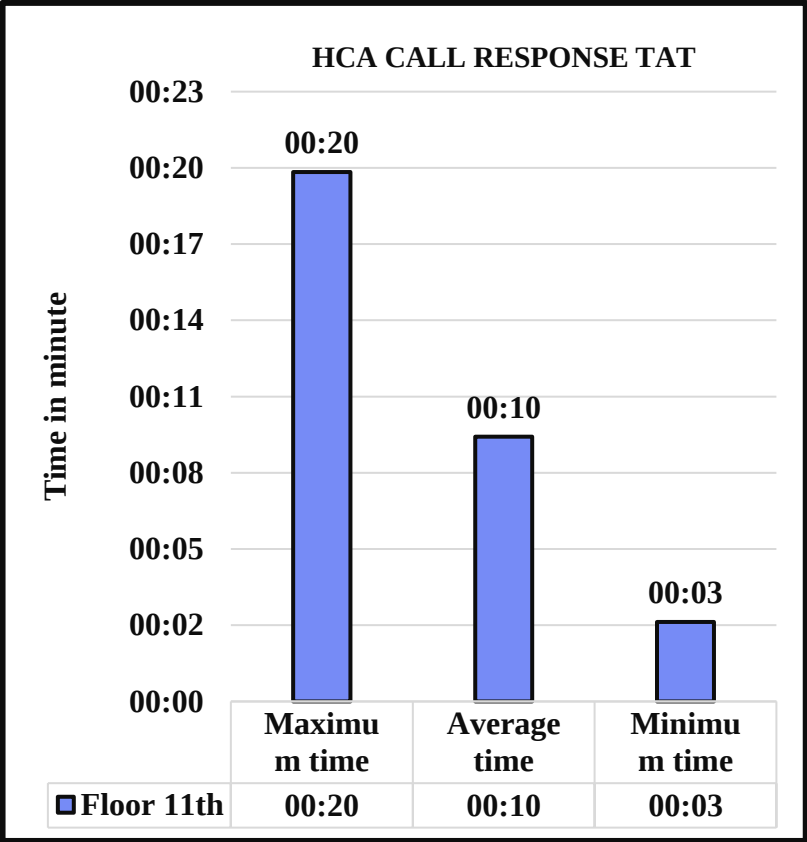
Date- 13th & 16th May 2024

Floor departments- General Ward+ BPL Ward

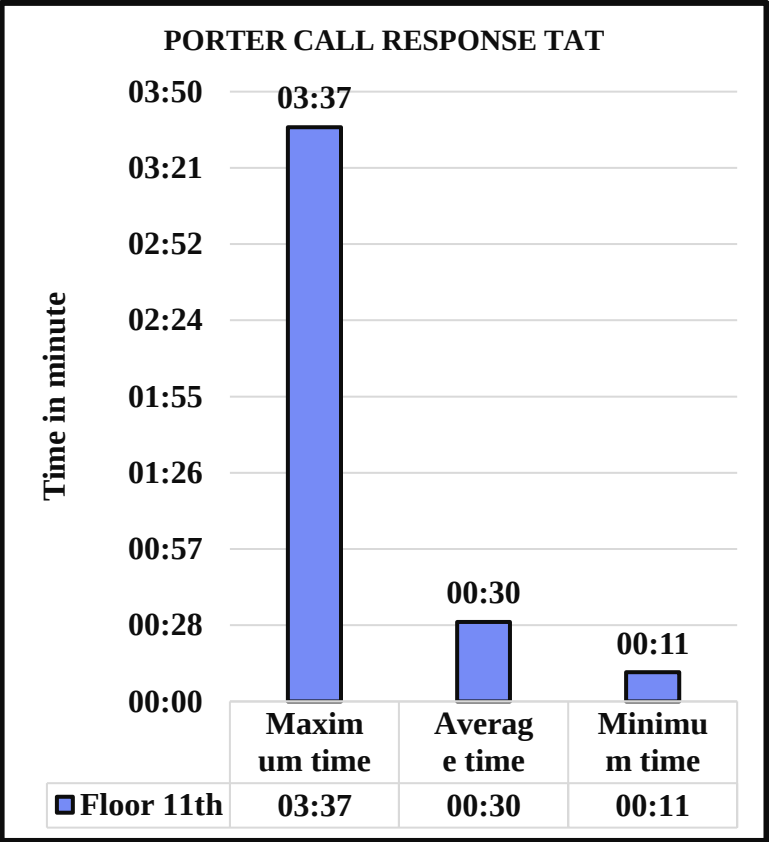
Total Number of Beds- 145



Sample size- 28



Sample size- 19



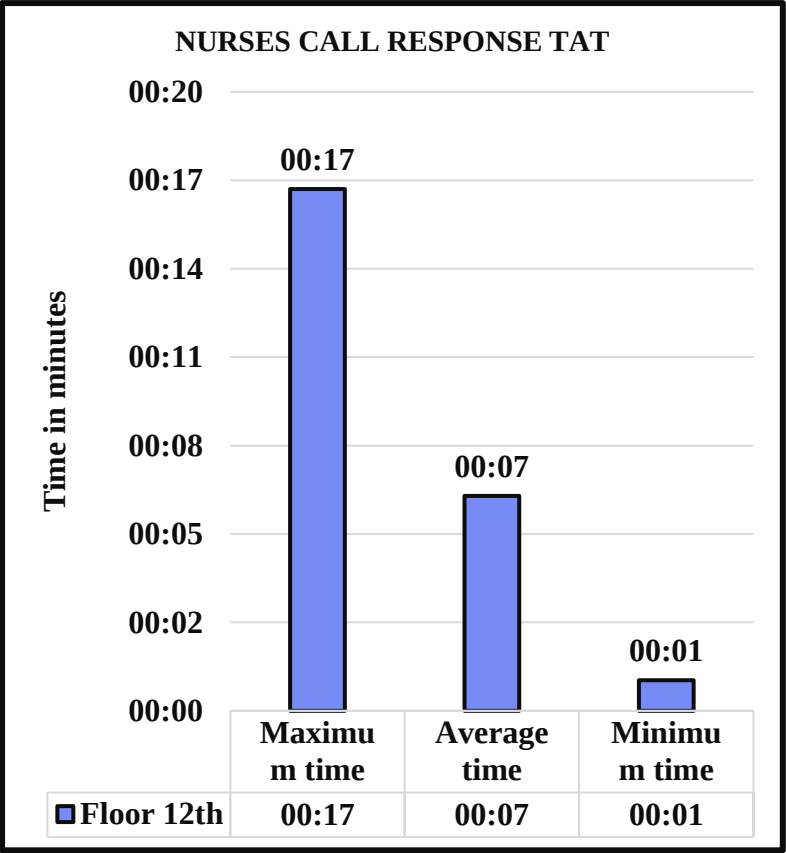
Sample size- 21

12th Floor

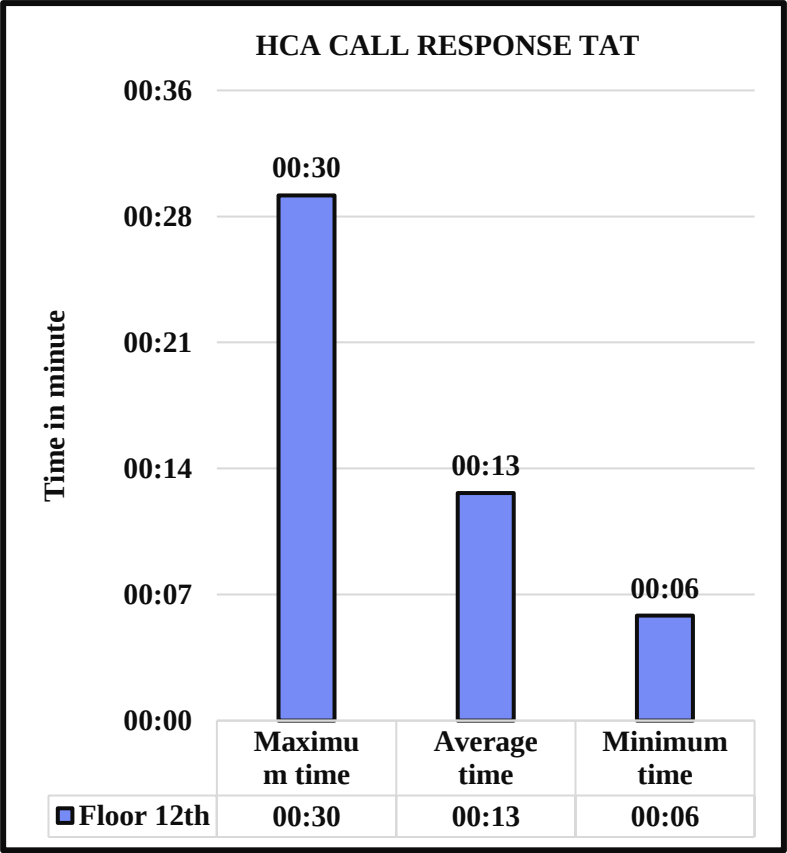
Date - 14th & 15th May 2024

Floor departments- IPD- Twin Share

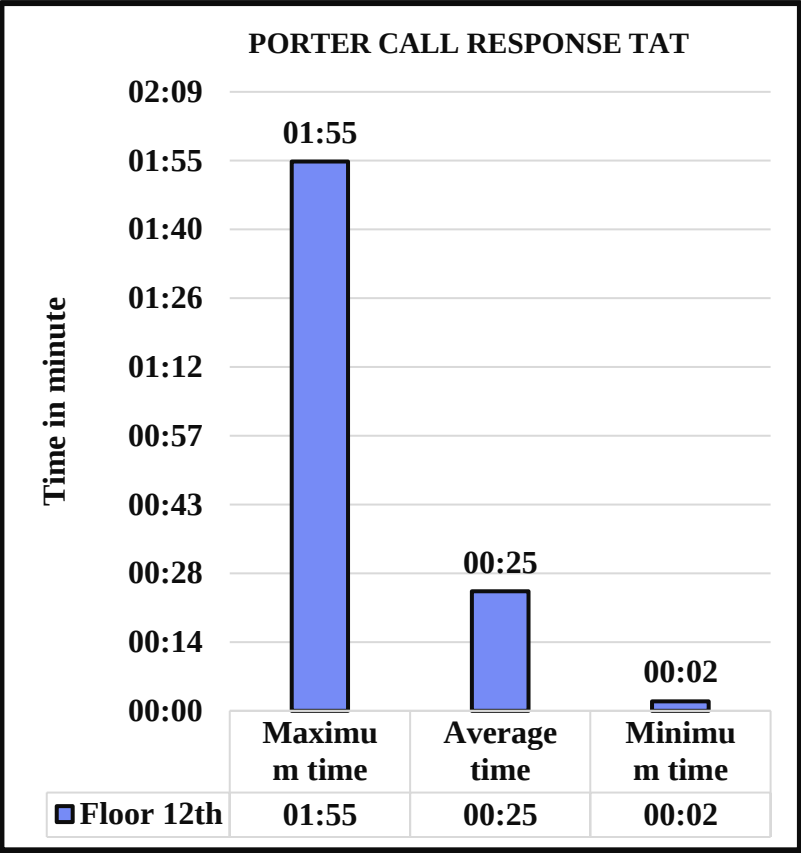
Total Number of Beds- 59



Sample size- 39



Sample size- 10



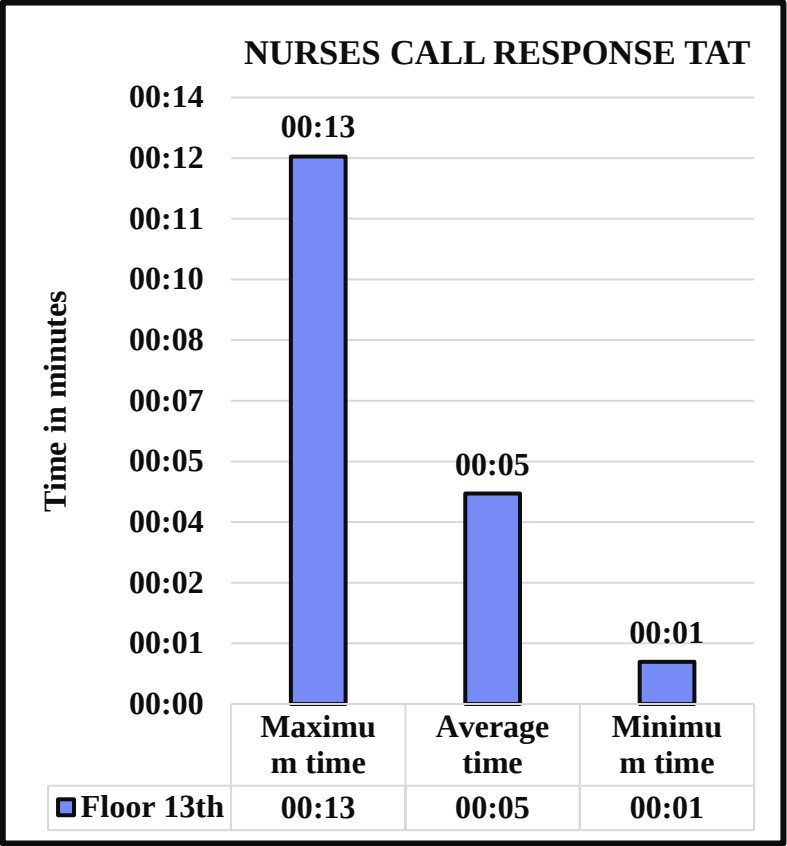
Sample size- 10

13th Floor

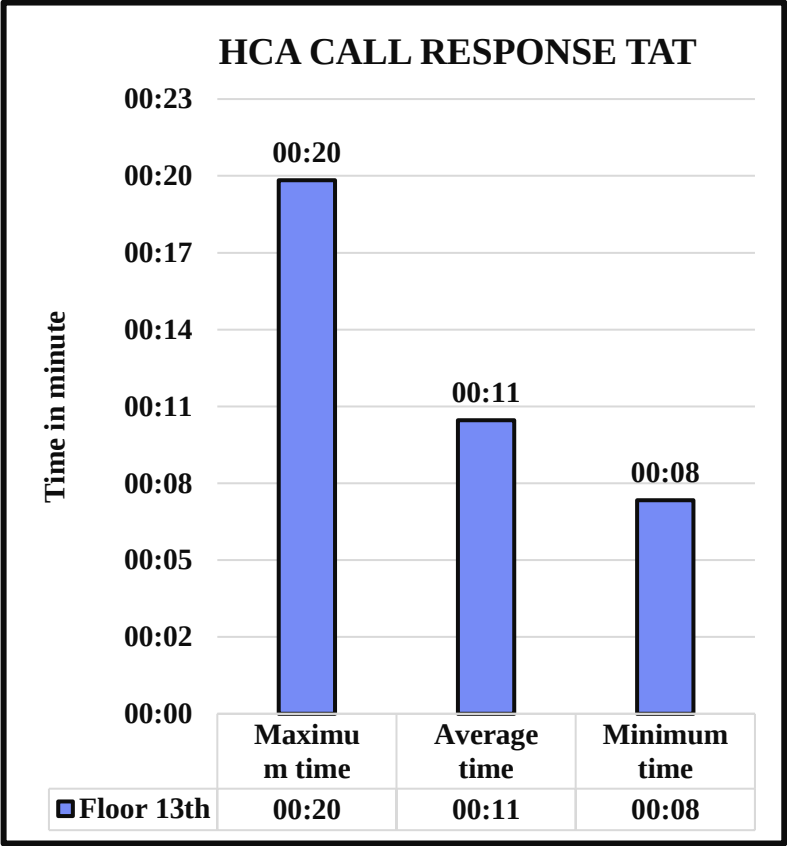
Date - 13th & 16th May 2024

Floor departments- IPD- Twin Share

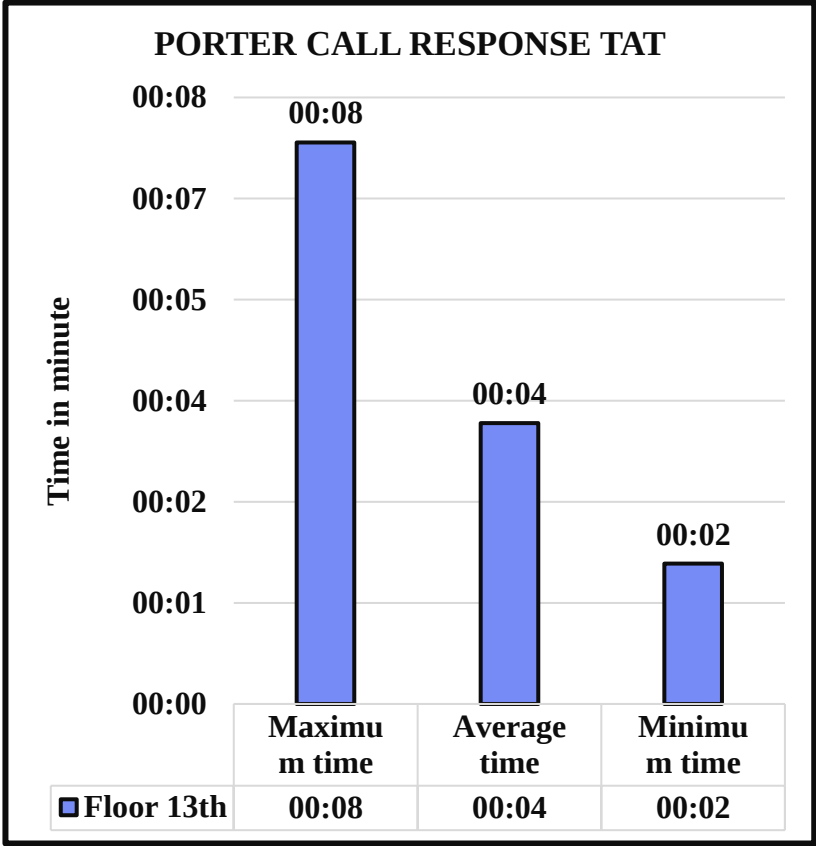
Total Number of Beds- 74



Sample size- 40



Sample size- 11



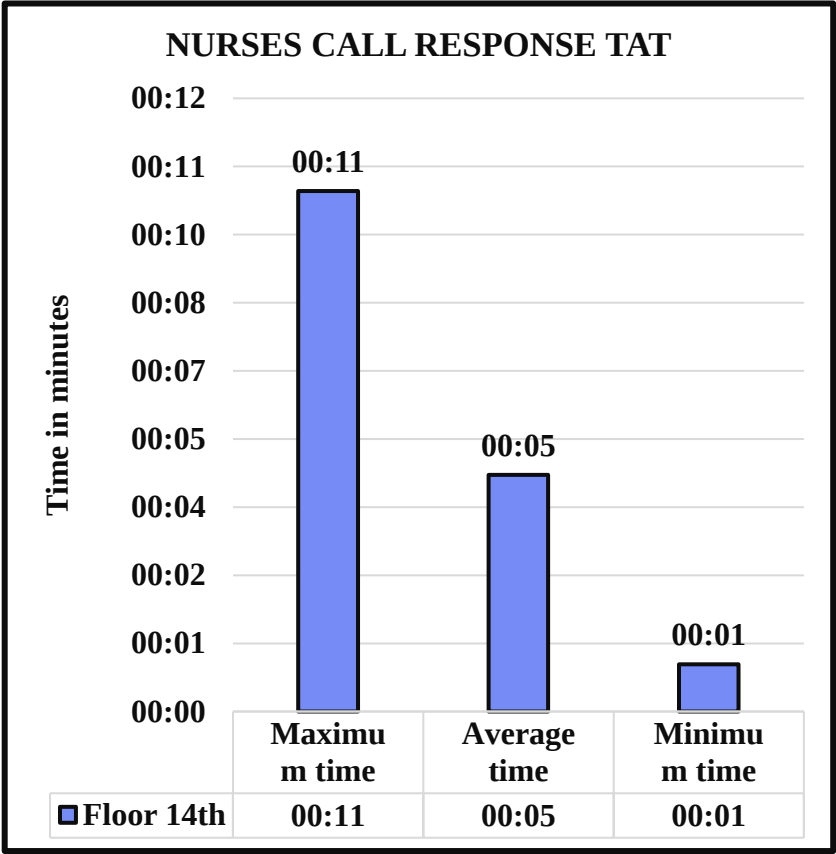
Sample size- 5

14th Floor

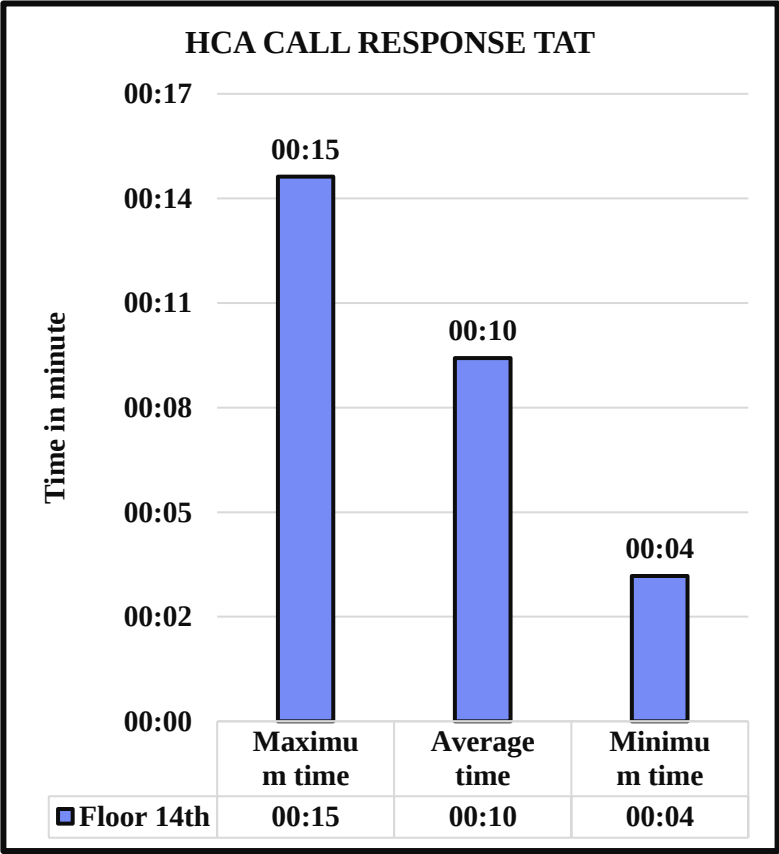
Date - 13th & 14th May 2024

Floor departments- IPD- Single Share

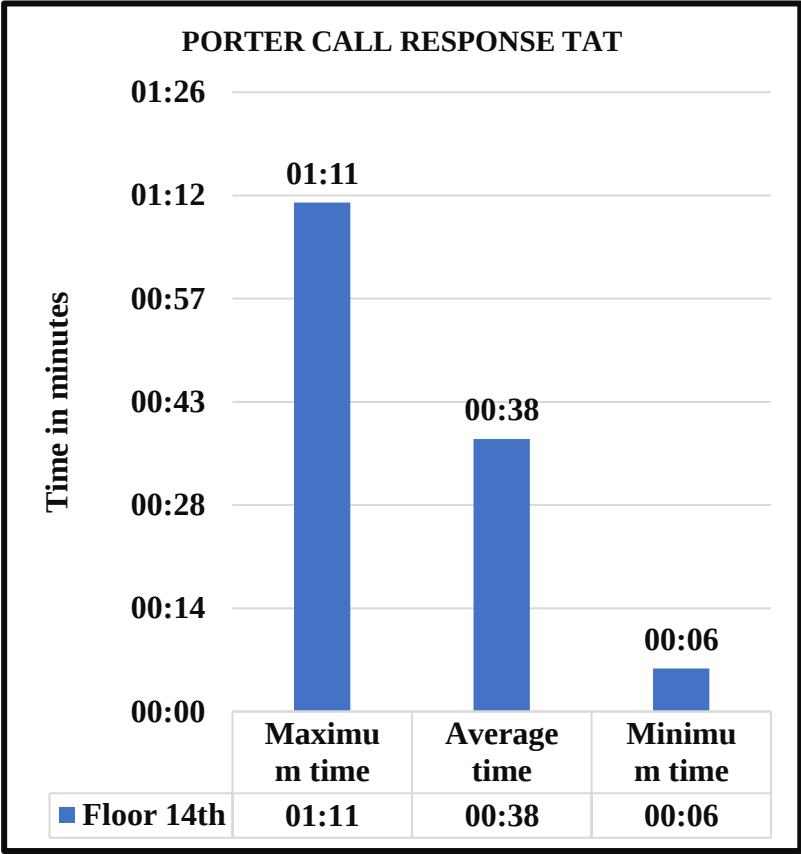
Total Number of Beds- 37



Sample size- 33



Sample size- 12



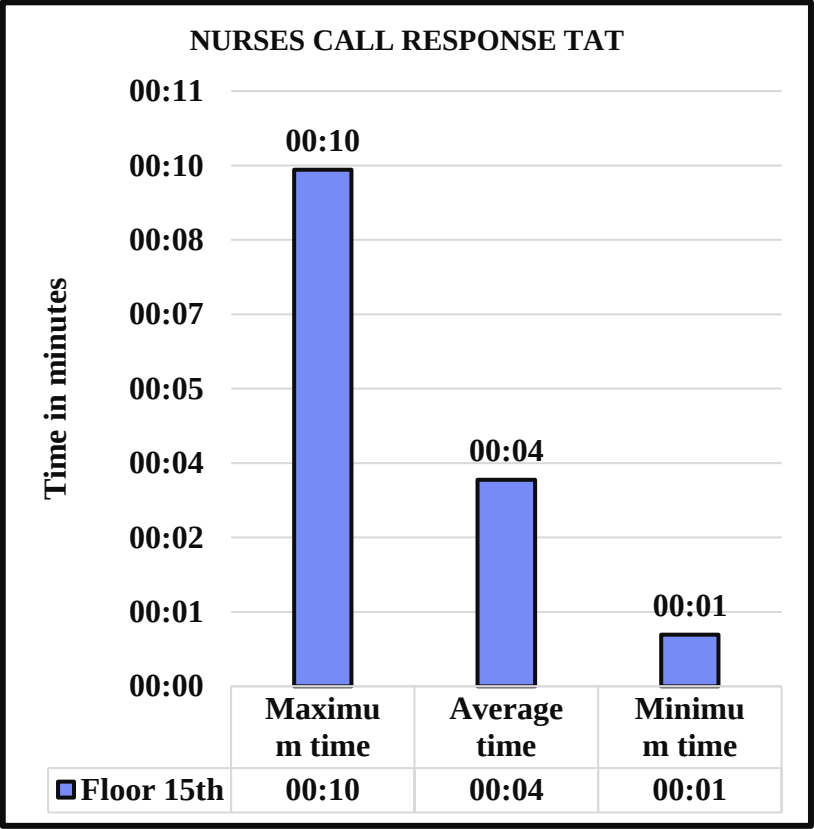
Sample size- 6

15th Floor

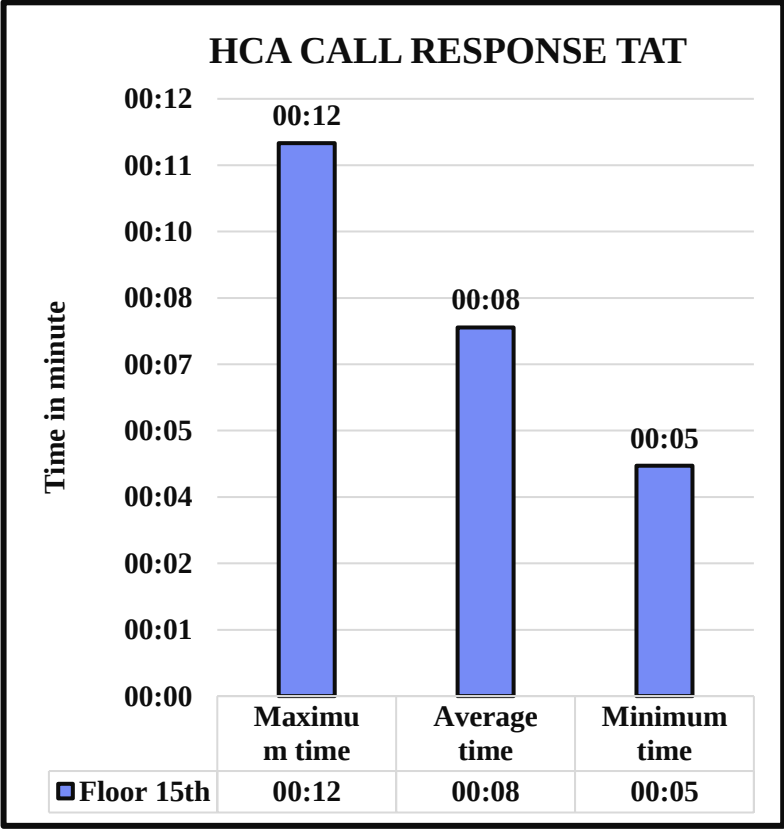
Date - 13th & 14th May 2024

Floor departments- IPD- Single Share

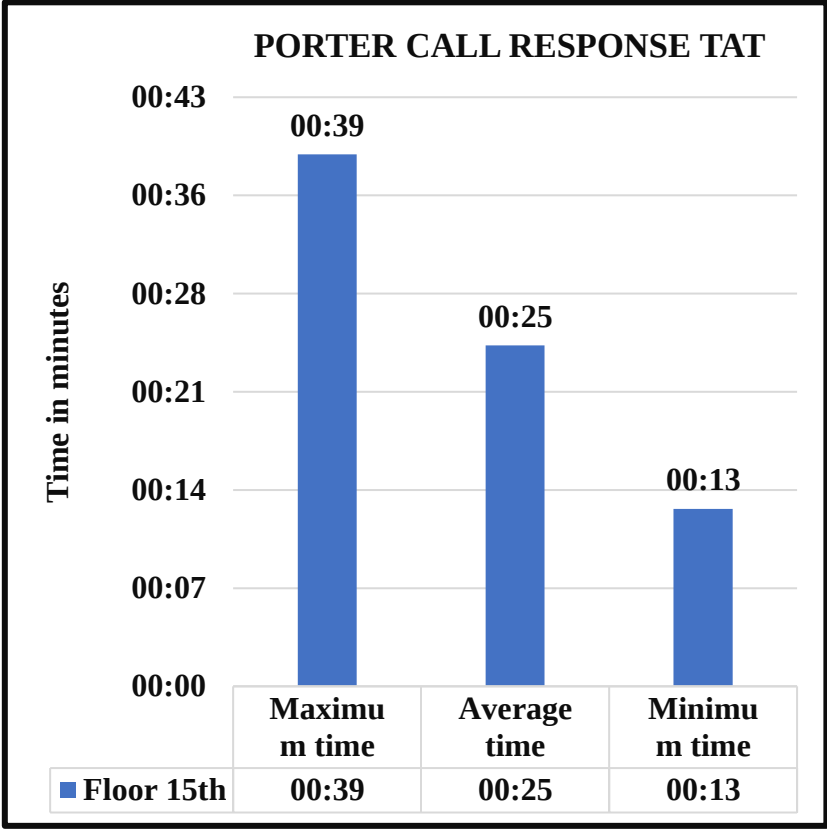
Total Number of Beds- 37



Sample size- 42

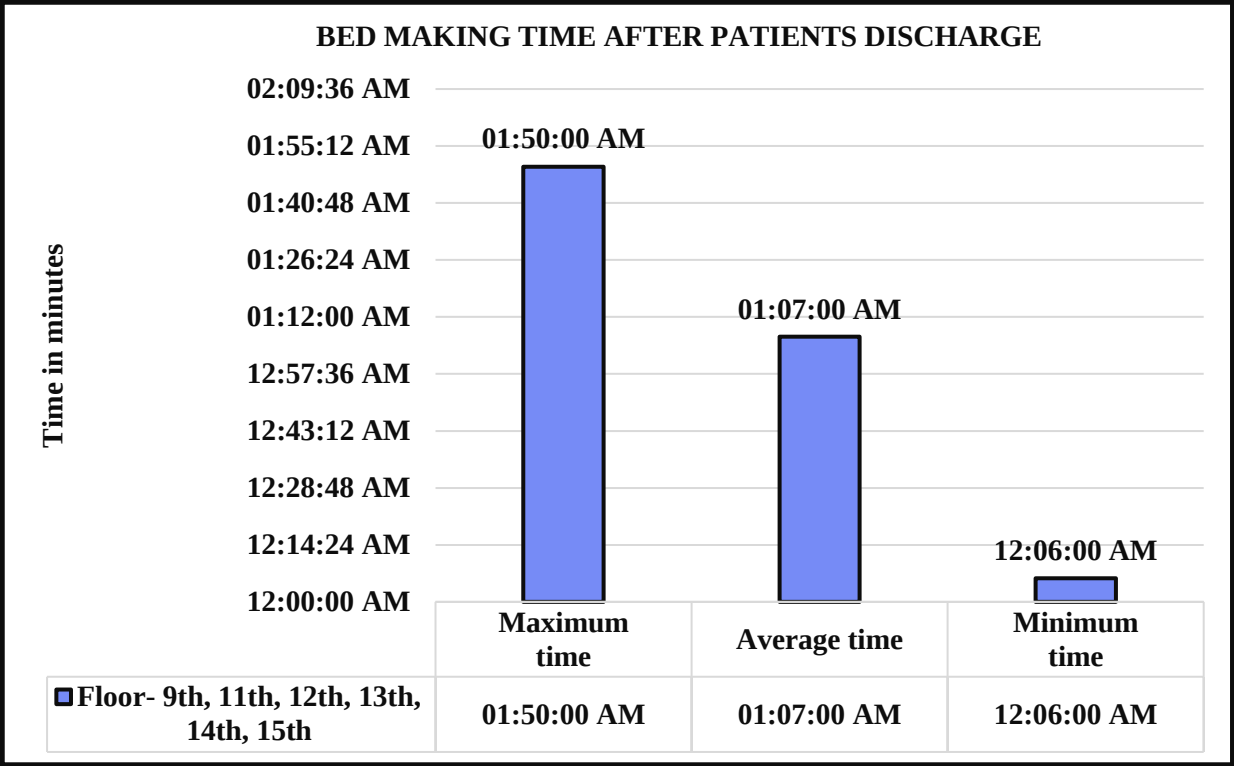


Sample size- 11

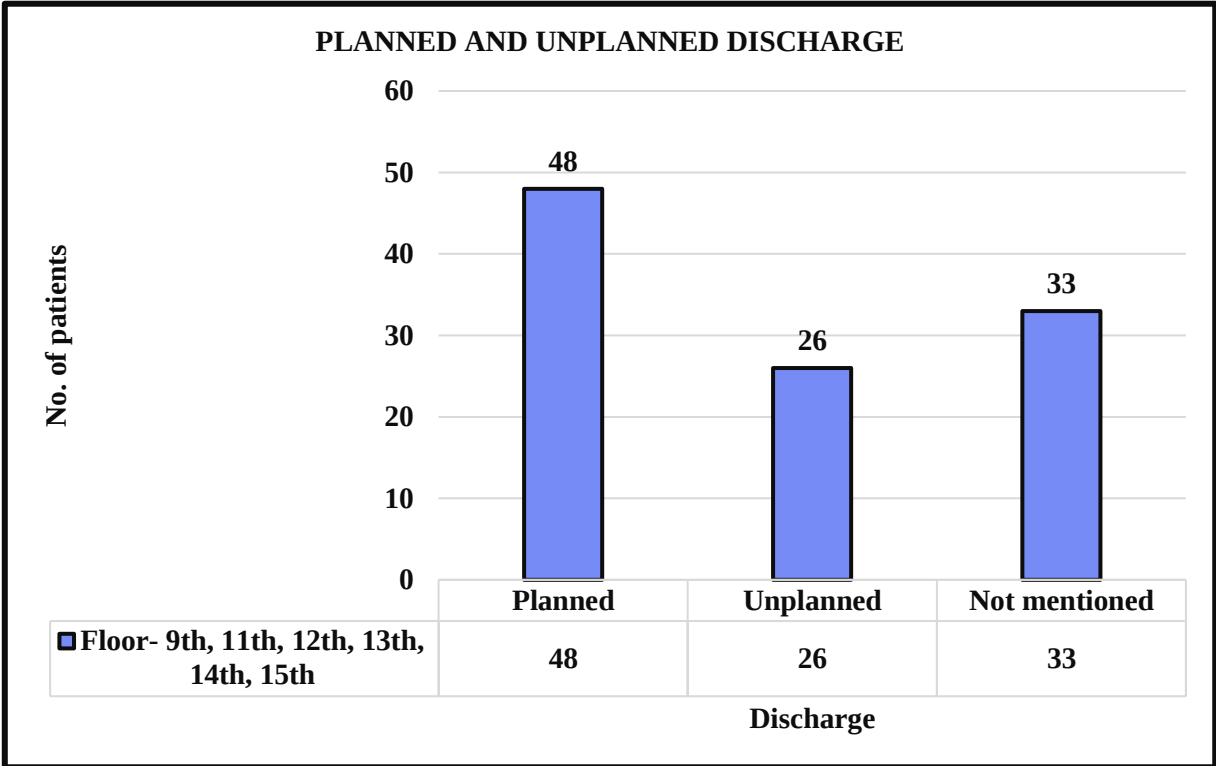


Sample size- 11

Date- 13th- 16th May 2024



Sample size- 14



Sample size- 107

The times for bell call in this hospital varied greatly from floor to floor and within staff roles. On the 12th floor, the maximum response time by a nurse was 17 minutes, with the quickest response time at 1 minute. HCA followed a pattern with the 9th floor having the maximum response time 30, and their minimum response time was 3 minutes. For the 11th floor, the porters had the longest response time of over 3 hours and the shortest time was 2 minutes. These results manifest that there are inconsistencies in the response time depending on the floors, number of beds, and patient-to-nurse ratio, HCA ratio and the porter staff that may affect patient care and satisfaction; highlighting areas for potential improvement in staffing, training, and workflow management.

RECOMMENDATION

Based on the findings, recommend strategies to optimize hospital bell call response times, which may include:

- Adjust staffing during peak hours.
- Conduct training on the strategies for effective reaction of health professionals and the -timely care of patients.
- Implement cross-training opportunities so that staff can perform job duties outside their normal skill areas, lessening the reliance on specific roles during times of critical response.
- Reduce time required in making a bed to improve the efficiency of the flow of patients.
- Ensure that nurses are keeping records for both planned and unplanned discharge patients for better management.

CONCLUSION

- This study identified significant variability in hospital bell call response times across different floors, underscoring the need for targeted improvements. The findings suggest that optimizing staffing levels, conducting regular training, and enhancing workflow management can significantly improve response times. The implications of these improvements include better patient care, increased patient satisfaction, and reduced risk of adverse events. Improved response times ensure that patients needs are promptly addressed, reducing the risk of adverse events such as falls or medical emergencies, and leading to higher satisfaction rates and better patient outcomes. The variability observed, such as nurse response times ranging from 1 minutes to 17 minutes across different floors, highlights operational inefficiencies that need addressing to ensure a safer and more reliable care environment.
- To address these issues, the hospital should implement strategies such as adjusting staffing levels during peak hours, conducting regular training focused on efficient response protocols, and enhancing workflow management through streamlined processes and cross-training opportunities. Regular monitoring and evaluation of response times, along with improvements in communication systems, will further ensure continuous improvement. The study's limitations, including reliance on secondary data and a short study period, are balanced by its strength in providing a detailed understanding of response time discrepancies across multiple floors. Future research should explore the long-term effects of these interventions and investigate additional factors influencing response times to develop more effective strategies for enhancing patient care and satisfaction.

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THANK YOU