PNEUMATIC TRANSPORT SYSTEM AT MEDANTA (MEDICITY) GURUGRAM

Dissertation Submitted to

The IIHMR University, Jaipur

for the partial fulfilment for the award of the degree of

Master of Business Administration (MBA)

in

Hospital and Health Management

by

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Under the Supervision and Guidance of

Dr Jagajeet Prasad Singh

2022

DECLARATION BY STUDENT

I hereby declare that this dissertation titled "**Pneumatic Tube system in Medanta-The Medicity Gurugram"** is the Bonafede record of my original research work. No other university or institution has been notified that I have submitted this essay for a degree or diploma. There has been due acknowledgment of information derived from published or unpublished works.

(Signature)

Dr Somya Guglani

Date:- 1-07-2022

ORGANISATION CERTIFICATE

Global Health
Limited

Date: 17th Jun- 2022

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Somya Guglani** has completed her **Internship** in the department of **Quality** from 23.03.2022 to 17.06.2022 with Global Health Ltd. (GHL) Medanta – The Medicity.

We wish her all the best for her future endeavors.

For GLOBAL HEALTH LTD

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ABSTRACT

Introduction

A hospital's service time is critical to patient care, especially from the moment a patient enters until the final process is completed. As hospitals implement new technologies and innovations, service and process times are reduced, especially in document and specimen transport, which used to be handled solely by messengers.

Objective

In this study, efforts were made to examine the problems, issues, benefits, and usefulness of using pneumatic transportation systems as opposed to human transport systems.

Methodology

It was a structured questionnaire based Observational cross-sectional descriptive study, data were collected among **352** users of the system from the main 19 departments to gather the opinions of staff on various aspects of PTS.

Findings

The results of the survey indicate that transporting objects by system makes medical support service faster by **58 %** and **87%** respondents felt that Pneumatic tube system has better accuracy than the messenger with less error, loss, and damage to the objects. **75%** respondents also agreed on that it maintains high confidentiality of the objects. Furthermore, It also boasts user-friendliness by **75%,** with user groups agreeing the system is faster per transaction than the messenger, thus, some users say the messenger's transaction speed is too slow, but manageable.

Conclusion

Medical support services still benefit from pneumatic transporting systems, but their use depends on several factors. In hospitals, there are several methods of transporting objects, and it is important to select one that will serve the hospital in the most efficient manner. In order to decide which system to implement, new or newly opened hospitals can use the results of this research as supporting information. Overall using PTS is a boon as it helps the medical support service quicker, more accurate, and causes less errors which saves time, cost and helps in betterment of quality of service provided to the patients.

Keywords

Hospital service time, medical support service, high confidentiality, user friendliness.

ACKNOWLEDGEMENTS

I learned a lot throughout my three months of employment at Medanta Hospital. They have aided in my personal development and broadened my understanding of the health sector. I'm grateful that I had the chance to be a part of a organisation where I learned something new every day. This project is the result of my experiences, knowledge gained, enthusiasm for the topic, and the faith in me that my loved ones have shown.

I would like to take this opportunity to show my genuine gratitude and respect to everyone who has supported me along the way. I'm grateful to Dr Pawan Kumar Gupta (Head of Quality Department) who has been my source of motivation and encouragement throughout my internship. This project would not have been finished so smoothly and on schedule without his great oversight, input, and ongoing encouragement.

I am grateful of Mr. Jagajeet Prasad Singh, a professor at IIHMR University and my mentor from IIHMR, Jaipur, for his prompt and clear advice. He has helped me with my project in a really courteous and professional manner. I also want to express my gratitude to Dr. P.R. Sodani, president of IIHMR University, for providing me with this learning opportunity.

The majority of this is for and because of my father, who has been a continual source of support and inspiration. I would not have succeeded in reaching this position without their support and faith.

Finally, I want to thank everyone who contributed to the accomplishment of this project and internship.

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LIST OF ABBREVIATIONS

S.NO	ABBREVATIONS	TERMS
1	PTS	Pneumatic tube systems
2	HBT	Human based transport
3	OSHA	Occupational safety and health administration
4	PFA	Platelet Function Analysis
5	TEG	Thromboelastographic
6	CSF	Cerebrospinal fluid
7	JCI	Joint Commission of India
8	GDA	General duty assistant
9	ERR	Error
10	ABS	Anti-lock braking system
11	BME	Biomedical engineering
12	ICU	Intensive care unit
13	AGV	Automatic Guided Vehicle
14	UAV	Unmanned Ariel Vehicle
15	MS	Microsoft Excel
16	OPD	Outpatient Department
17	CTVS	Cardiothoracic vascular surgery
18	OBS	Observation
19	AMC	Annual Maintenance Charge
20	GST	Goods and services Tax
21	IPD	Inpatient Department
22	GI	Gastrointestinal

CHAPTER-1

INTRODUCTION

1.1 ABOUT THE ORGANIZATION

This study was conducted in Medanta-The Medicity, Gurugram. Medical institute Medanta, situated in Gurugram in the National Capital Region of India, is an Indian chain of multi-specialty medical institutions. Medanta - The Medicity in Gurgaon was founded in 2009 by Naresh Trehan, a heart surgeon, and Sunil Sachdeva, a co-founder. Since then, the business has expanded to include Delhi, Lucknow, Indore, Ranchi, and Patna in its service area.

There are more than 29 super-specialty facilities on the huge 2.1 million square foot complex of Medanta, which can accommodate 1,600+ patients. In order to ensure that the floors work as autonomous hospitals within a hospital, each level is allocated to a specific specialisation. Multiple treatment choices are available to patients, and the most appropriate one is determined by a cross-functional, cross-specialization group like the Tumour board, which selects the best course of action.

The goal of the institution is to deliver the finest levels of medical treatment, clinical research, education, and training to India. It is Medanta's mission to treat patients with care, compassion, and dedication.

In total, six centres of excellence are housed within Medanta, each with a fully integrated and comprehensive information system that will give medical intelligence, cutting-edge technology, and cutting-edge infrastructure.

Medical researchers, scientists, and clinicians from around the world have gathered in Medanta – The Medicity in order to foster interdisciplinary research that will spur new ideas and discoveries, as well as more quickly translate scientific advances into better ways of diagnosing and treating patients and the prevention of disease. As the first facility in the world that combines contemporary and traditional medicine to provide inexpensive healthcare, Medanta is a pioneer.

Vision and Values

“The Institute is governed under the guiding principles of providing affordable medical services to patients with care, compassion, and commitment.”

Mission

“The Mission is to deliver world class healthcare services by creating institutes of excellence in integrated medical care, teaching, and research. We aspire to create an ethical, and safe environment to treat all with respect and dignity.”

Values of the Organization

Medanta has changed a lot over the years, but its core beliefs haven't.

- **Leadership & excellence**
  An unwavering focus on doing things better than anyone else and setting an example for others to follow.

- **Integrity & courage**
  Setting the interests of patients ahead of the institution's and showing fortitude to do just what is right to maintain high ethical standards.

- **Compassion & service**
  Patients and their carers should be treated as if they were our own family members.

- **Collaboration, learning & innovation**
  Improve our ability to attain our goals by encouraging cooperation and cooperation among team members, as well as by embracing change and creativity.

Figure 1.1- Medanta- The Medicity, Gurugram

1.2 INTRODUCTION THE SYSTEMS

Pneumatic tube systems have been used for decades for a variety of purposes, and they are the most reliable method of transporting vital supplies for hospitals. However, this method of transportation has not received enough attention. Pressurized air transportation was first imagined by Otto Von Guericke in the 1660s. His artificial vacuum would be the basis for the design of pneumatic tubing.(11) Engineer Josiah Latimer Clark developed the world's first operating system in 1850s, which was used at the London Telegraph Office in 1853. Letters, telegrams, and parcels were transported through tubes in cylindrical containers. Pneumatic tube systems were also used in retail trade, banks, and the chemical and automotive industries - primarily to transport samples to laboratories. Coloured markings were used to identify individual shipments. High quality was ensured. In the 19th and 20th centuries, the air system spread to other cities besides London, and mail was delivered through the Prague tube network until 2002 - the longest period of time that an air system was used for mail delivery. Nevertheless, transporting mail through the underground became increasingly challenging over time. (11)(9)

The hospital currently employs Human Based Transport (HBT), which makes use of Ward Boys / Orderlies, Patient's Attendants / Relatives, and Volunteers. Hospitals are now facing new challenges as a result of budgetary restrictions and a nascent competitive environment, including reducing the amount of time patients spend in the hospital without sacrificing the quality of their care, reducing staff costs, and simultaneously improving outcomes and efficiency. Because of these factors, optimising hospital logistics becomes increasingly crucial. (12)(2)

The term "pneumatics" refers to a fluid power system that uses air as a medium for creating, transmitting, controlling, and utilising power. The Greek word pneuma denotes air, wind, or breath. Pneumatics is the study of air flow and other air-related phenomena. Currently, it is impossible to try to picture modern manufacturing without the automation provided by pneumatics. It is used in many different areas of the industry. Pneumatics first started to be used in real-world industrial applications for manufacturing around 1950. (6)

The processes involved in providing healthcare services have numerous steps, each of which is particularly labour-intensive and time-consuming due to the transportation of samples and documentation. Historically, hospitals have moved paperwork, samples, medications, and other medical supplies both within and between structures by hand. By using innovations for item transportation, such as the pneumatic tube system, hospitals may better manage their time. This will increase patient happiness, speed up document processing, and make them more competitive. In order to increase competition in the current healthcare industry, management staff members look for a method or a new idea to speed up the service. The more time that is saved, the more time hospital staff will have to spend caring for patients.

2.1 Type object transporting methods

2.1.1 By messenger

- **Roles and Responsibilities:-**

  Laboratory Management: Will inform staff and service users on the need for sample packaging and shipping, and will see to it that this method is communicated to the users of the service.

  Sender: Considering that secure clinical sample collection and packaging are the sender's sole responsibility, it is crucial that all locations where clinical materials are produced stay informed of the most recent rules.

  Employees: must report any incident concerning the transportation or receipt of samples that comes to their attention, such as exposure to or release of a biological agent that could be dangerous to their health or safety.

- **Process:** The sample sent via messenger (human transport system) must guarantee that samples get at their destination on time, ideally, without endangering the health and safety of individuals who come into contact with the sample, and in a way that does so and that is compliant with all applicable laws. General practitioners and hospital workers bring samples from different departmental floors to the laboratory.

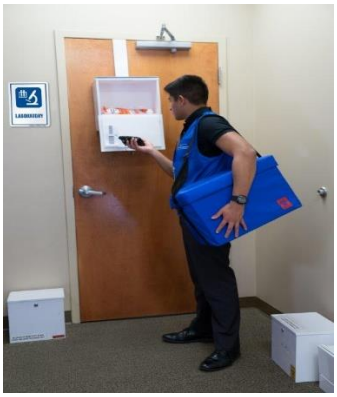


Figure 1.1 - Messenger carrying sample

Figure 1.2- Sample collection tubes

2.1.2 By Electronic system

- **Pneumatic Tube System**: -

Transporting small items or documents inside the hospital facility is done using pneumatic transport systems (PTS), which are essentially an internal logistics and transport system. In this method, the items or documents are put in a carrier (a structure resembling a capsule) and moved from one location to another via an air-pressurized tube network. The air pressure pump for the PTS, an air-operated system, is connected to the control station. This system is utilised for the transportation of paperwork, supplies, and medications. For documents, samples, materials, and medications, this is the most reliable, precise, and efficient route of transportation. In a hospital setting, PTS terminals are available at all significant receiving and transmitting locations. Moreover, these are also called stations.

Pneumatic tubes, often referred to as capsule pipelines, Lamson tubes, or Pneumatic Tube Transport (PTT), are devices that use compressed air or a partial vacuum to move cylindrical containers through a set of tubes. (1)(2)(11)

Figure 1.3- Pneumatic Tube station

Components of PTS

- **Carriers:** are which pass through tubes in capsules. They move the substance from point A to point B, as their name implies. Different systems and industries require different sized carriers. For hospitals and laboratories that need to carry delicate liquid components, leak-resistant and leak-proof carriers are perfect. Carriers offer safe but simple-to-use closure flaps and are composed of a sturdy, clear material. The carrier can move easily through tube systems and securely reach their destination because to the cushioned skirts on either end.

Figure 1.4- Pneumatic tube system Carrier or Capsule

- **Stations :** The ports that send and receive carriers are called stations. They have docks where carriers can be inserted, as well as user interface screens that direct carriers to the desired end-station. Depending on what the system requires, there are various station kinds. There are 40 easy-to-use, ergonomically designed tube stations at Medanta Hospital. The system identifies workers, carriers, and the content inside then authorises sending and receiving of the same. Due to their maintenance-free components, all stations only need little maintenance. On all stations, automatic sending and receiving is possible.

Figure 1.5- Pneumatic Telecom Monitor station

- **Diverter:** In a tube system, branching pathways are made using a diverter. A diverter is utilised at the intersection of several diverging paths when a complicated system necessitates multiple routes to and from a specific station. As the carriers pass through the diverter, their course is altered. In our pneumatic tube system, we have 3-way Diverter (16 No.) and 6-way Diverter (5 No.) that are used to link several tubes and system lines.

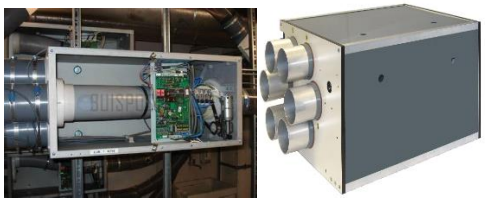


Figure 1.6- Telecom Diverter(14)

- **Blowers:** are what move the carriers through the pneumatic tubes. They are the fans. The blower efficiently suctions the carrier through the tubes by generating a differential in air pressure between two ends of the system. Around 25 feet per second is the speed at which carriers move through the system.Five heavy-duty 3-phase Blowers with a completely adjustable placement valve offer one system line with a changeable air volume in the pneumatic tube system plant room at Medanta Hospital (suction and pressure)

Figure 1.7-Telecom Blower(14)

- **Linear Coupler:** Hospitals typically employ the linear coupler with several lines, multiple stations, and high send frequencies. As a result, you can use the (current) lines more efficiently. It couples many lines. The linear coupler is unique in its class due to a design that ensures the best possible availability of all linked lines. The Telecom linear coupler dumps carriers in a holding area after removing them from the queue of carriers that are waiting. The line won't attract carriers in this way. Carriers won't congregate in the line this manner, keeping it open. reducing transit time

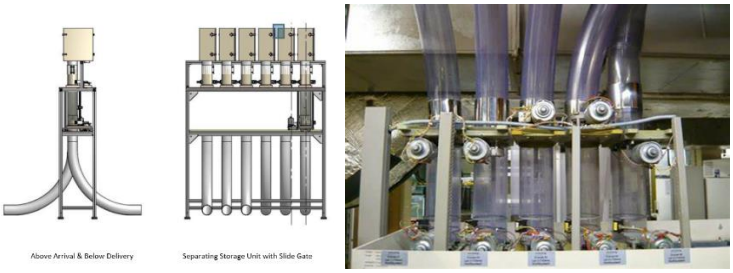


Figure 1.8- Linear coupler

- **Control System:** The sophisticated and user-friendliness of control system offers an intuitive graphical interface that is simple to set up and manage locally or remotely while the system is still in use. The control system has a computerised management system with a number of clever features, including authorised access, a complete track-and-trace database, simulation mode for training and testing, data export for reporting, and a direct connection to the technical department for immediate diagnostics and service. (1)(2)

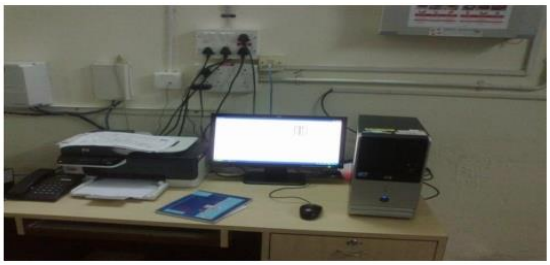


Figure 1.9- Control system

WORKING OF PNEUMATIC SYSTEM

A carrier is frequently sent from one station to another via the following series of actions. The user positions the entire carrier on the source station's "launching pad," chooses the destination station, and then clicks the "send button." The source and destination stations will be assumed to be in the same zone for the time being. The carrier joins a virtual queue in that it must wait until the blower for that zone becomes available. The queueing discipline is typically based on priorities, with precedence based on:

(1) the transmit and receive stations' identities;

(2) the time of day; and

(3) the length of time the carrier has been waiting in line.

Upon successfully capturing the blower, diverts position themselves to allow the queued carrier to pass the destination station. The blower changes to vacuum mode and suctions the carrier through the tube system when sensors detect that it has passed the destination station.When the blower exits vacuum mode, the carrier can float to a soft halt. After that, the diverter realigns itself to allow the carrier to reach the last station. If the source and destination stations are in separate time zones, the transaction is split into two parts. First, the carrier is obtained from the source station by a storage pipe that joins the two zones (there may be multiple storage pipes between zones). To achieve this, the carrier must simultaneously collect the blower in the source zone and a storage pipe connecting the zones.After entering the destination zone's blower queue when the carrier reaches the storage pipe, it will continue its journey to the destination station once it has successfully captured the blower. Computer software is used to centrally control and monitor the system. A thorough transaction record is written to a file for each transaction that the system processes. This record includes information on the send station, receive station, storage pipe, send button push time, blowers captured and released times, as well as other parameters. To control the carrier inventory at each station, empty carriers are also provided, even though the majority of transactions transmit loaded carriers between stations.

For example, a lab station may receive many more full carriers than it transmits. Unless the lab transmits empty carriers, the number of carriers will increase and there won't be any available at other stations.

A control parameter that the system administrator can specify determines when a station starts sending out empty carriers. This parameter's optimal setting and figuring out how many carriers are required to serve the system as a whole are challenging issues. (3)

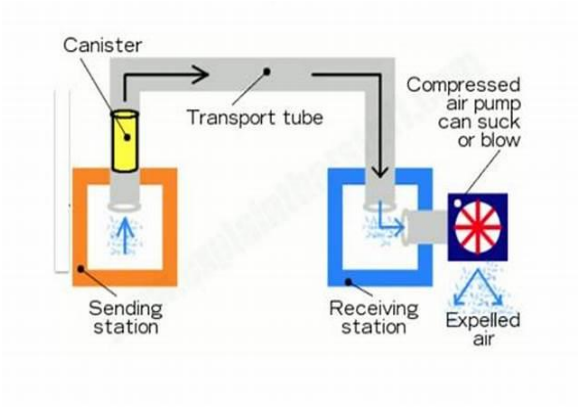


Figure 1.11-Working of PTS

1.3 SPECIFIC AIMS

The study's specific aim is to learn more about concerns and problems, including user and system errors, as well as to learn about crucial considerations for system installation.

1.4 RESEARCH QUESTIONS

1. What is Pneumatic transport systems (PTS) and how was it implemented?

2. What are the opinions of staffs about benefits of Pneumatic transport systems (PTS) over human based transport?

3. What are the reasons of missing carriers deployed using Pneumatic tube system in various departments?

1.5 OBJECTIVES

1. To describe Pneumatic transport systems (PTS) and its implementation in the hospital.

2. To assess the opinions of staffs about benefits of Pneumatic transport systems (PTS) over human based transport.

3. To find out the reasons of missing carriers deployed using Pneumatic tube system in various departments.

CHAPTER 2

REVIEW OF LITERATURE

Related Research

1. "Comparative study of the roles and effects of objects transporting system for improving medical support services in hospital"
   Author - Miss Boontarika Kietburanakul
   Location - Siriraj Piyamaharajkarun Hospital, Thailand
   Year- 2017

   This Research study consist of different modes of object or sample transporting system in hospital of Thailand, the Author compared Pneumatic tube systems, Dumbwaiter lift, Automated Guide Vehicle System (Telecar/ Telelift) how beneficial these systems are their advantages, disadvantages, and which system best suited for the hospital.
   The Research method author used to compare these systems were data that is both qualitative and quantitative. The hospital staff was divided into two groups to answer the questionnaires: system users and non-users.

   Sample was calculated based on Simplified formula for proportions* (Taro Yamane)

$$n = \frac{N}{1 + N * (e)^2}$$

   n -the sample size N -the population size e -the acceptable sampling error * 95% confidence level and p = 0.05 are assumed and the average sample size was turned out to be 400.

   The study focused only on 7 departments with total number of SiPH staff is 1,622 was taken into consideration and out which 312 were system users and 1491 were nonusers' surveys/questionnaires were distributed amongst them, and analysis was done. Interviews were taken by the hospital medical staff thoughts and experiences with object transportation systems and which system they prefer and was a better investment, their comments on how the system helps to improve the medical services.

   The findings demonstrate that moving items by system actually speeds up medical support services more than moving them by messenger. There was disagreement in several of the survey questions between users of the two systems who said that messengers' pace per transaction while delivering things is extremely slow. On the other hand, who do not use the system said that messenger time is manageable. Because of this, non-system users favour using messengers over systems. Non-system users believe that faults could happen because the operation of the system is complicated. (7)

2. “Innovative Methods To Improve Hospital Efficiency- Study Of Pneumatic Transport Systems (Pts) In Healthcare.”
   Author- Dr. Arun. Mavaji. Seetharam1, Dr. Sudhakar.Kantipudi ,Dr.Somu.G , Mr.Jibu
   Location - Kasturba Hospital, India
   Year- 2013

   An investigation of the implementation of pneumatic transport systems (PTS), their use, and their superiority over traditional transport systems was done at a teaching hospital for tertiary care with over 2000 beds.

   The system was installed at Kasturba Hospital, and the author talked about the difficulties that arose because the system was being installed in a building that had previously been built. A Pneumatic Transport System with650 beds, including a post-op ICU, a multidisciplinary ICU, an orthopaedic triage unit, and a central medical ICU, was installed in two critical blocks of the hospital.

   The author addressed every topic, including early planning, project costs, implementation challenges, and the selection of vendors, among others. Additionally, he conducted an observational study on the pneumatic tube system is effective as it saves time compared to Messenger. The result of the study was saving of 94.6 minutes in labour and time for the full completion of the sample transportation process and the posting of the results online for consultation. (2)

3. “Improving the transport of urgent specimens to an off-site laboratory using a novel sticker-tracker”
   Author - Afsoon Sepahzad, Florence Ejiofor, Susan Giles, and Robert Klaber
   Location- Paediatric Department at a Central London teaching hospital.
   Year - 2013

   Based on an audit done in the paediatric department of a major teaching hospital, the study found that there were "missing" specimens and specimen transit delays that exceeded eight hours. As a result, the infection is treated empirically with antibiotics, the microbiological result is confirmed later, and an unnecessary, unpleasant repeat investigation is conducted.

   The creation of a sticker for the microbiology specimen bag was the first step in establishing accountability, tracking each stage of the transport procedure, and increasing awareness of the issue. The Paediatric department pushed and introduced the new sticker tracking system.

   The protocol wasn't well known at first, and there weren't any pods available for sending urgent specimens, which was a problem. Weekly completed sticker analyses were conducted by the team at regular meetings to identify on-going problems and to devise solutions.

   As a result, by September, the whole transport time had been lowered to an average of 69 minutes, within the desired 4 hours. The effectiveness and dependability of urgent specimen transport were enhanced with the aid of this study intervention. This has led to safer antibiotic use and reduced the need for additional research. (4)

4. “Analytical description of pneumatic tube system (published journal)”
   Author - Karan Dutt
   Location- HMR Institute of Technology and Management, G.G.S.I.P. University, Delhi, India,
   Year-2013

   The study mostly discusses the operation and parts of pneumatics. Its elements, functionality, and working were the key points of concentration. Technology's field of pneumatics is concerned with the study and use of pressured gas to generate mechanical motion.

   Compressed air or compressed inert gases are frequently used in pneumatic systems. This is due to the electrically powered compressor's central location and the fact that it frequently offers motive power that is more affordable, secure, adaptable, and reliable than many electric motors and actuators. The compressor powers cylinders and other pneumatic devices through solenoid valves. The electropneumatic system, together with all of its parts and corresponding symbols, is briefly discussed in this study. (6)

5. “Comparison of Hospital Logistics Systems”
   Author- Wadah Salah Mohamed Saleh, Zang Tie gang
   Location- College of Mechanical and Electrical Engineering Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China
   Year- February 2021
   The system logistics employed in healthcare are described in this paper. The most effective logistic system and methodology are described in detail, and they are compared to identify it, as well as the issues and challenges that have arisen in those systems. The following three items were once compared:
   1. Automatic Guided Vehicle (AGV)
   2. Unmanned Ariel Vehicle (UAV) transporting system
   3. Pneumatic tube system (PTS)

   AGVs are useful for heavy cargo deliveries that often have no time limit and within hospital transportation. Since many of them are autonomous, they can pick up the cargo, choose their own route, or deliver the package, then return to the station to prepare for the next task. It can also be used to move people with disabilities from one location to another. UAVs are useful for carrying cargo remotely when other forms of transportation are ineffective. It can be utilised in remote locations for quick reaction. It delivers freight more quickly than a person could, and it doesn't encounter issues like traffic jams, floods, or blocked roads, but weather conditions like rain, wind, and snow might pose challenges. PTS is highly helpful for deliveries between hospitals when prompt cargo delivery is required. When human errands to the blood bank or their location are time-consuming, some products, like blood or some other fluids, can be given immediately. In these situations, PTS is the ideal answer and it can save many lives. The notion It is still pretty new and difficult to adopt and manage, but the healthcare industry is currently using it more frequently. The author also examined three systems in terms of cost, length, accuracy, and challenges each system faced.(13)

CHAPTER 3

METHODOLOGY

The research strategy is to conduct surveys and questionnaires which are distributed as a technique of gathering quantitative data to gain information, feedback, and opinions from respondents.

3.1 Research Strategy

This study is a feasibility study, and the research questions make use of quantitative data. It is an Observational cross-sectional descriptive study. All questionnaires were completed by hospital employees who fall within the category of system users. The results revealed their preferences for and contentment with the usage of object transportation systems, as well as their views on how these systems influence service delivery speed, how valuable and useful they are, and whether they believe the system to be effective. Interviews will be conducted with hospital staff members who prefer to use messengers to transport goods and must interact with object movement systems directly.

3.2 Study Population

1) System vendors: for technical information

2) Hospital employees: for viewpoints and feedback as systems

3.3Study sample and data collection tools

- **Setting –** Tertiary care hospital Medanta- The Medicity Gurugram 1600+ bedded
- **Duration of study –** The duration of study was of 12 weeks from 23rd March 2022 to 17 June 2022.
- **Sample size-** 40 Pneumatic Tube stations present on all 14 floors -Number of users using the Pneumatic system on all floors- 300 + Nursing staff, Pharmacist and GDA staff.
- **Sampling technique –** Convenience sampling
- **Data collection procedure –** Interview, Questionnaire and Observational Audits

3.4 Sample calculation

Quantitative variables are analysed using frequency or percentage and also using mean and SD.

All the data, including survey responses, is imported from the Google form, and then entered an MS (Microsoft Excel) spreadsheet.

3.5 Data Collecting Process

- **Step 1: Interview**

  The purpose of the interview is to get information and comments from hospital workers about how object transportation systems aid to enhance healthcare services and streamline their operations. The interviewees include hospital employees from each department or division who can be classified into two groups: employees who prefer using messengers for object transfer and employees who use the system as a tool for their tasks.

  The installed technology, Pneumatic Tubes System, is being used in Medanta- The Medicity Hospital Gurugram, which has 19 primary departments that may be divided into 40+ stations.

- **Step 2: Survey/Questionnaire**

  Open-ended questions are one type of question seen in questionnaires.

  Hospital employees who utilise the system and those who prefer to use messengers both responded to questionnaires.

- **Step 3: On Site Observation**

  The observation offers in-the-moment observation of usage problems, faults, and errors. Included is customer satisfaction with system utilisation.

3.6 Data analysis and interpretation

Surveys for this research are designed to gather views and opinions from Medanta- The Medicity Hospital workers. A group called system users comprises the entire hospital staff Prior to distribution, survey questions are double-checked for validity and appropriateness. To read and comment on whether the questions are clear or not, certain users are given samples of surveys. Overly complicated questions are eliminated, and their place is taken with simpler, clearer questions.

- **Quantitative data analysis**

  The demographic satisfaction rate of hospital staff, encompassing both users of in-hospital object transporting devices and users of messenger-based object transport, is described using descriptive statistics. As a key factor in choosing the best system for the hospital, it will be considered how the installed item carrying system speeds up the medical support service.

Important information is provided by the process and method of data collection, which must be comprehended and researched. More information and opinions from responders will increase the usefulness and benefit of the system. Additionally, the provisions will be more logical, useful, and trustworthy.

3.7 Ethical Considerations

Verbal consent was taken from each employee before recording their data. All respondents were made aware of the confidentiality and Survey and questionnaire responses were kept completely confidential.

CHAPTER 4

FINDINGS AND RESULT

4.1Pneumatic transport system for an establishing set up:

The system can be installed within or outside of the walls, depending on the different structural circumstances. Other elements, such as in addition, system capacity, load size, and weight are considered.

Specific demands of a hospital:

A hospital's pneumatic tube system must meet a number of strict requirements because it is not a regular workplace:

- The carrier speed may be modified to ensure the secure transportation of laboratory samples. By selecting a certain dispatch or receiving station, low-speed transport can be chosen manually or automatically.
- The carriers can be adapted to fit various insert pocket holder. Arriving carriers are gently slowed down and then put directly into the tube without being jolted. The technology is patient-friendly and operates quietly.
- A code can be used to secure transport loads with restricted access.
- The carriers will be manually or automatically sterilised using thermochemical processes.
- Hermetically isolating the system.
- For detailed cost analysis and billing, statistical assessments of the traffic data, such as the number of transportations, are made possible by the computerised control system.

Installation of Pneumatic transport system at Medanta- The Medicity Gurugram: -

The hospital, which has more than 1600 beds, aimed to establish a pneumatic transport system throughout its 14 floors, including the ICU, triage/emergency rooms, post- and pre-operative ICUs, outpatient departments, and intensive care units, among other areas.

Steps in implementation:

1. **Initial Planning:** A study of the current transportation system and the time required for transports was initiated in March 2022. Sample transportation, manpower use, and time taken over a three-month period were investigated.

2**. Process for vendor selection:** Tenders were requested for the hospital's installation of a pneumatic transport system. Vendor was selected based on technical superiority and speedy completion of the project. A team from the hospital visited different hospitals were the system was installed by the chosen vendor to assess the functionality and feasibility of the system. Telecom Systems were opted out of the options provided.

3. **Pre implementation challenges:**

- The hospital has a sizable area with connected blocks at different levels. Such a design makes it difficult to route pipes.
- Operational issues were caused by the distance between the laboratory and the hospital.
- Manpower hired to install 4-5 people.
- During installation challenges faced included: - Pipe alignment, sharp bends due to the architecture of the building , Divertors didn't work , software configuration problem.
- The system was installed in April 2010, took 2 years to do trial and run and caused many problems at first like Carriers broke, tubes broke, motors got electrocuted, Electronic and operational difficulties were to be seen and then were corrected later on to successfully run the system.
- Moving plumbing and electrical fixtures required care.
- Additionally, maintenance caused a cost increase of between 10 and 20 percent.
- Preventive maintenance is done Half yearly and corrective maintenance is done whenever needed.

4. **End user issues:**

Personnel training took close to 20–30 days, and it took another 30 days for staff to get used to the new system. The incorrect dialling of stations was also frequently reported; if the station number is entered incorrectly, there is a potential that the carrier will become trapped at the junction, obstructing the movement of other carriers.

Table 4.1- Project cost

Total installation and equipment cost of PTS	Rs. 2,2300000

Total Estimated Cost of Functioning of PTS in Financial Year (2021-2022)

Electricity charge	Rs. 7,56,000
Maintenance	Rs. 4,16,397
Repair charge	Rs. 9,63,660
Total AMC and Repair charge with GST	Rs. 16,28,000
Total	**Rs. 23,84,000**

Floor plan

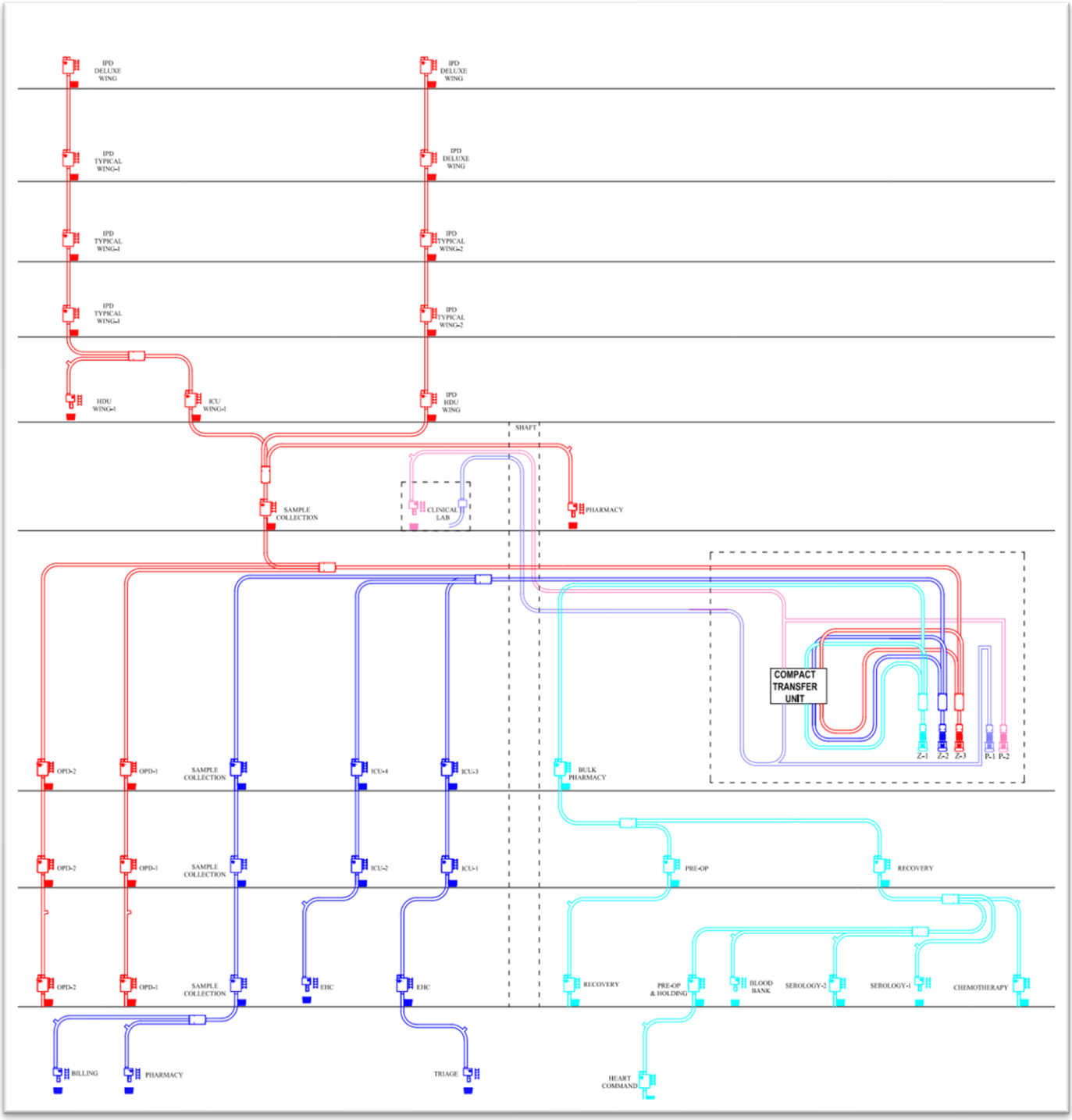


Figure 4.1 - Schematic floor plan of PTS

4.2 Comparison: Advantages and disadvantages of each system

Pneumatic Tube system:-

ADVANTAGES:

- In a healthcare setting, a pneumatic tube delivery system makes it possible to transport medications, lab samples, blood products, and supplies quickly, safely, and reliably to and from hospitals' clinical laboratories, pharmacies, waiting areas for patients, operation rooms, and other places.
- PTS can offer a secure, effective, and quick way to transfer specific pathological specimens throughout hospital departments, from the operating room and outpatient clinics to the pathology labs. These systems are more frequently used because they can decrease the turnaround time for specimens, allowing patients and hospital staff to receive test results more quickly. By eliminating the need to physically transport samples from one department to another, they also enable more efficient time management for messenger employees.
- Simple to handle and use
- Recordable transfer information
- Simple to trace back
- Minimize human error
- An improvement in output
- Saving time
- Reliable and secure
- An increase in capability
- Quick and simple (5)

DISADVANTAGES

- Noisy
- Installation of a transportation tube and station requires a large open area.
- Difficult to maintain
- Larger samples can't fit in the small size container; messenger is required.
- A maximum item weight restriction of 10 kg
- Employed within buildings as well as between them.
- High expenditure

Human Based Transport (HBT):

DISADVANTAGES

Human Based Transport logistics involves a number of risks and issues, including:

- Delays: Hospital workers bringing the goods may get diverted, losing valuable time that could have saved lives; staff not being available when needed.
- While physically carrying tube samples, the carrying personnel could trip, which would lead to the samples and supplies falling off and breaking. This results in wasting critical time that could have been used to save lives by having to repeat the entire exercise from obtaining the sample at the origin. These typical procedures also frequently mix up

samples and materials, which can have negative effects and be confusing for the patient while receiving treatment.

- Theft is a worldwide issue that is more prevalent while transporting drugs, instruments, and other materials, etc.
- Exposure: When people moved between departments at a hospital, sensitive information and classified documents are frequently exposed to unwelcome staff members or patients.
- Bio-Hazard: Transporting samples (blood, tissue, etc.) personally entails a high risk of exposing the carrier to diseases and subsequent cross-infections, as well as many other hazards and issues.
- Personnel: The hospital needs to designate a number of staff members for only moving and carrying samples and materials inside the hospital, as opposed to hiring employees exclusively for patient transportation, patient care, etc. (2)

The most significant issue that frequently affects medical services is service delay. In the past, messengers were used to deliver supplies to hospitals. Due to a variety of factors, the production was relatively low, which primarily causes service delays. For a comparison study with other systems, the fishbone diagram is used to analyse the underlying reasons of object conveying via messengers.

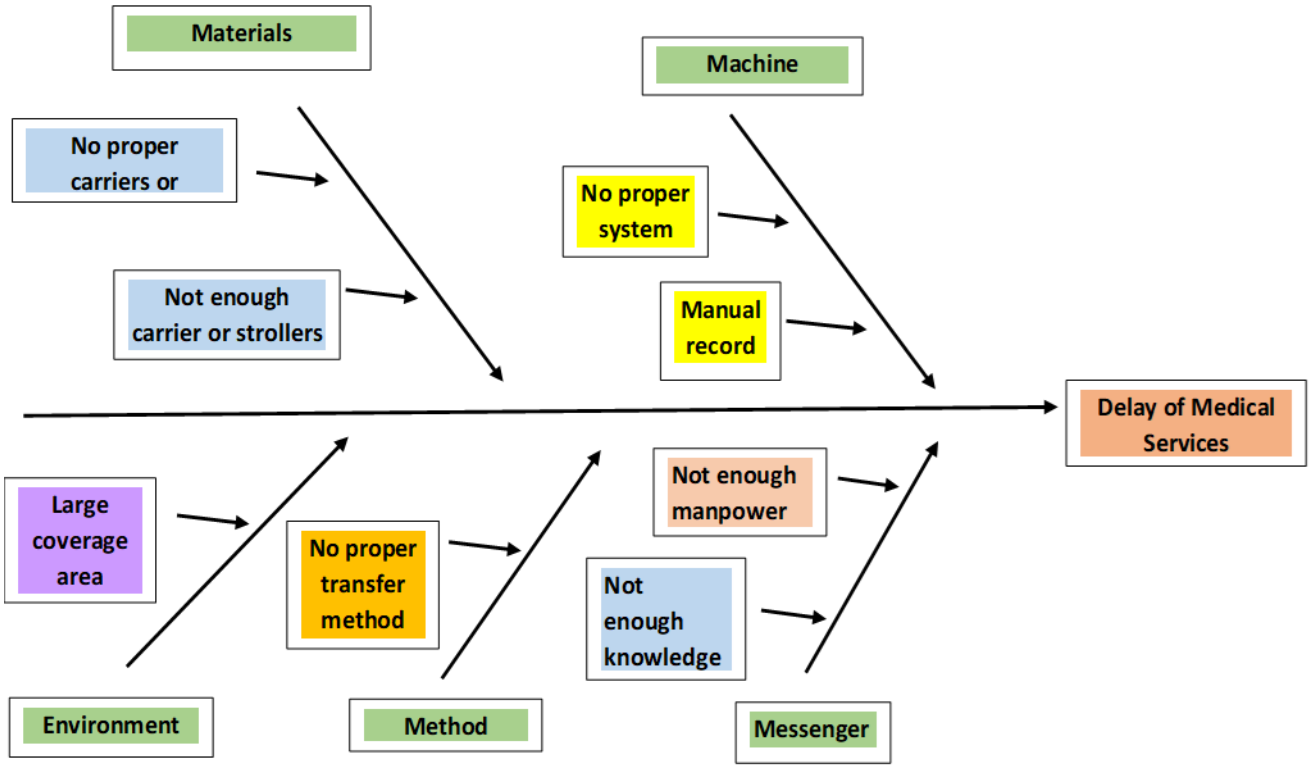


Figure 4.2- The causes and effects of medical treatment delays in hospitals are depicted using a fishbone diagram.

The study demonstrates using a fishbone diagram that the previously employed method of having messengers deliver objects increases medical treatment delays and can be characterised as follows.

- **Man:** Messengers lack sufficient expertise. Most messengers have only a minimal level of schooling.
- **Machine:** Transferring objects by hand with a manual report or record that is simple to misplace and challenging to find again.
- **Materials:** Messengers typically use small carriers or strollers. The number of things determines the frequency of transferring. Walking around will take longer and occur more frequently as there are more objects to move.
- **Method:** Messengers are ill-equipped to transfer specified objects using the right procedure.
- **Environment:** Walking to transfer objects in a large, complex region takes time.

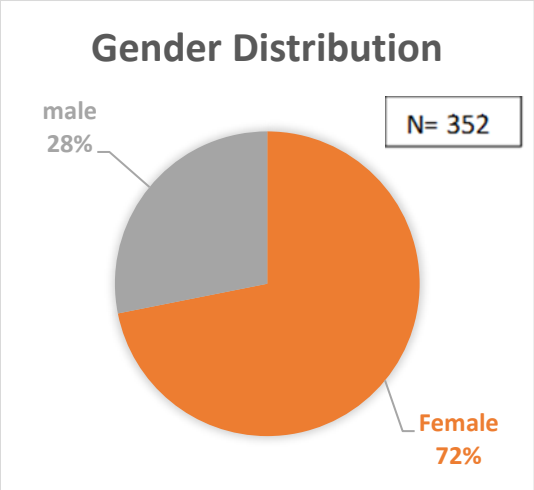
Comparative difference of time taken by Human Based Transport and Pneumatic Transport System

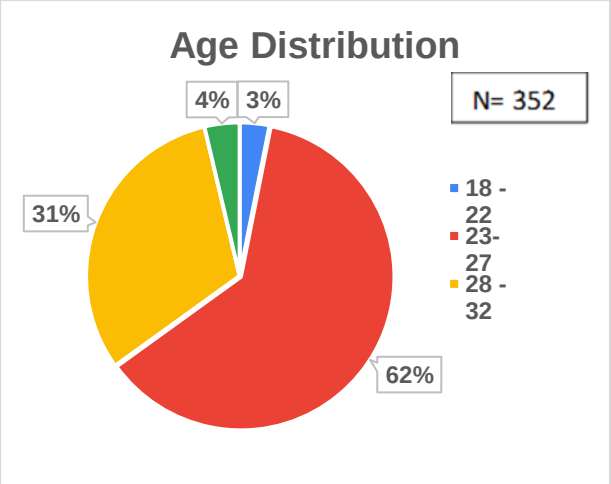
Table 4.2:- According to the below table, the entire sample transportation process was completed in 68.0 minutes less than originally planned.

Type of Object transport system	Drawing of a patient sample	Slips and arrangements made by lab staff to transmit to laboratory	Manpower planning and packing	Delivering samples to the GDA team along with a dispatch slip.	Transportation to clinical lab and taking receipt slip	Reporting of test findings	Amount of time the patient will receive following sample collection
HBT	2.0 min	5.0min	20.0 min	10.0 min	50.0min	35.0 min	112.0min
				PTS transporting time taken			
PTS	2.0 min	5.0 min	NIL	2.0 min		35.0 min	44.0 min
				Difference/Saving of Time			**68.0 min**

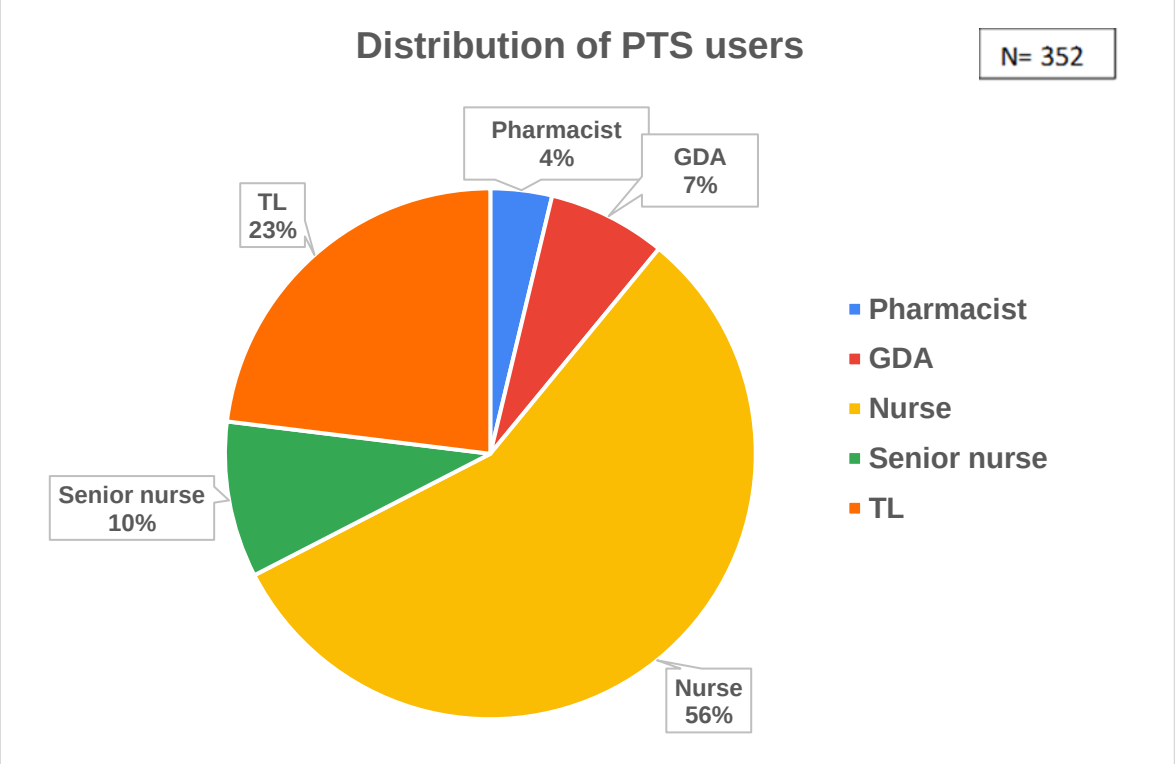
4.3 Demographic & Background characteristics distribution of respondents

The sample size is 352 samples, which are 814 system users, according to the sample size calculation in Chapter 3. (Randomized from total number of hospital staff users). Quantitative data from the same number of surveys distributed can be summed up as in the chart below.





Distribution of staff according to Pneumatic Tube system users

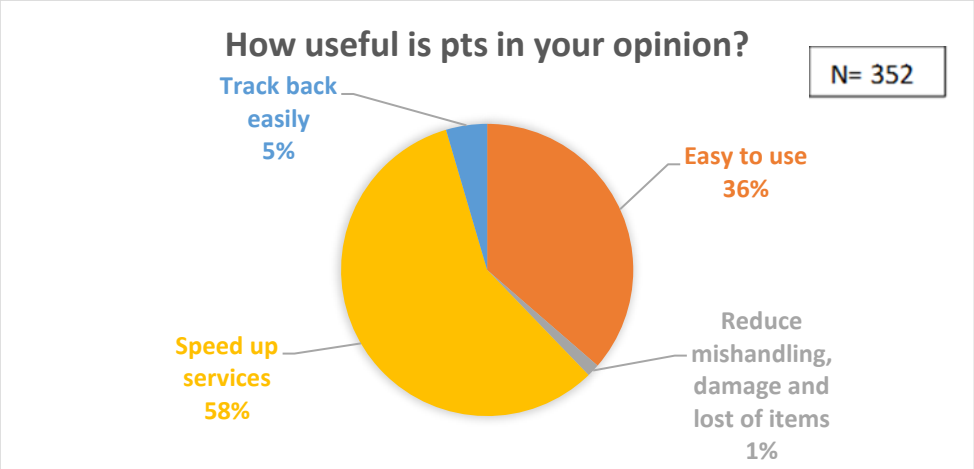


This study's quantitative data came from interviews with object transport system users. Current users are asked questions concerning system usage issues and problems, their experiences with the system, its usefulness and efficacy, their suggestions for system enhancement, and system references.

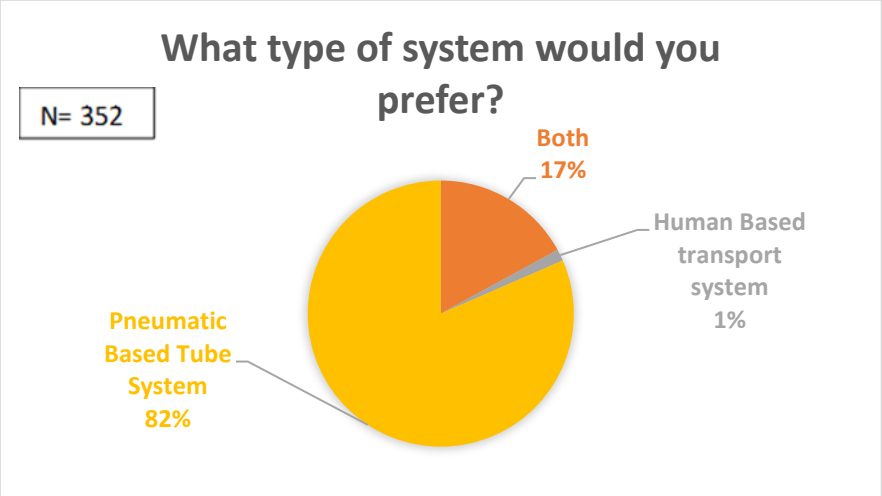
Survey, questionnaire, and interview data reveal a range of remarks and thoughts from respondents.

- The total number of system users who responded to the survey were the females (72%) and males were (28.1%).
- The majority of responders lied between the age range of 23-27Y approximately 62% .
- Distribution of PTS users showed that 56% of nurses , 23% of Team Leader, 10% of senior nurse, 7% GDA, 4% pharmacist use the Pneumatic tube system in daily basis.

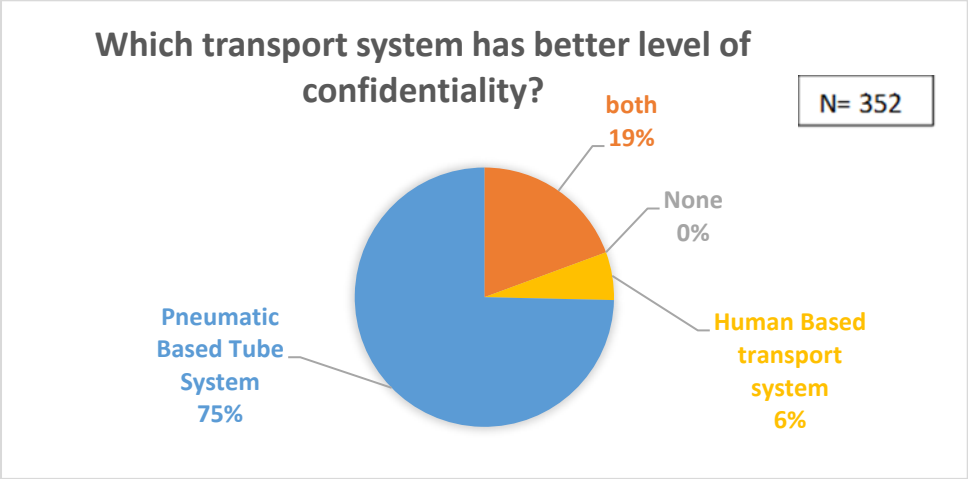
Opinion of staff about different aspects of PTS system



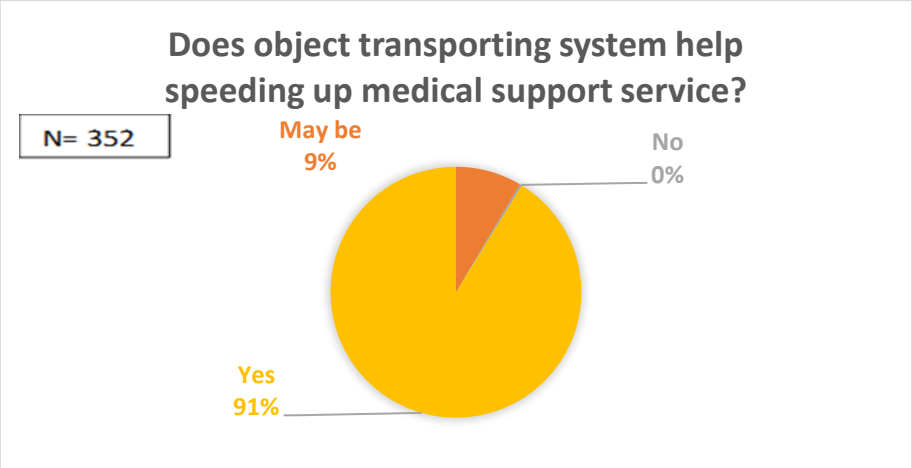
- The results demonstrate that moving items via system speeds up medical support services by 58% percent, and system users also believe that system is easier to use than messenger by 36%.
- The system offers high accuracy with little error, loss, or damage to the item and upholds high object secrecy.



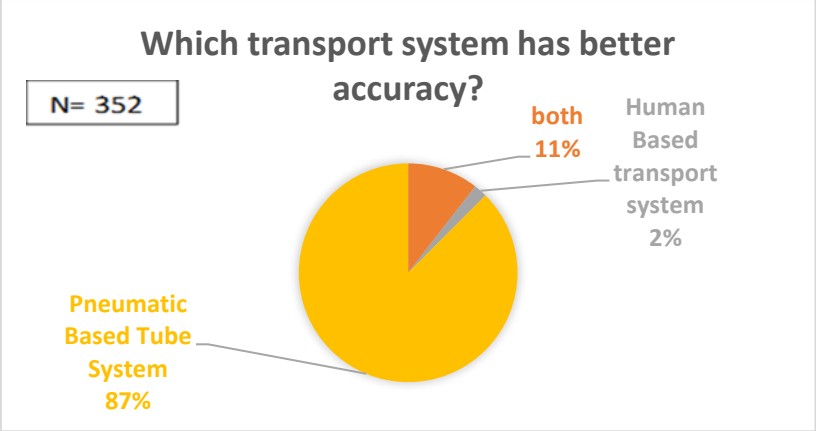
- The result showed that majority (82%) of respondents preferred using PTS system for sending or receiving samples in day to day basis as it helps speeding up the process.
- • In addition, the system's operation is not as challenging or convoluted as the respondent anticipated.



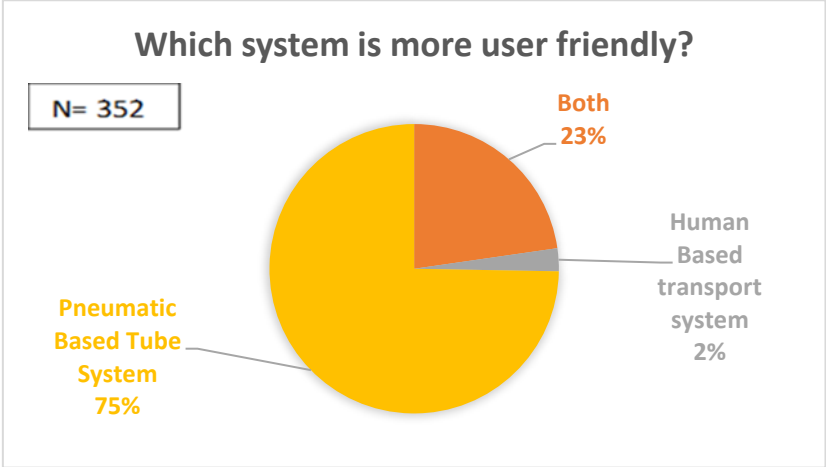
- When asked about which system has better confidentiality 75% of respondents opted for PTS system whereas only 6% of people opted for HBT in comparison.



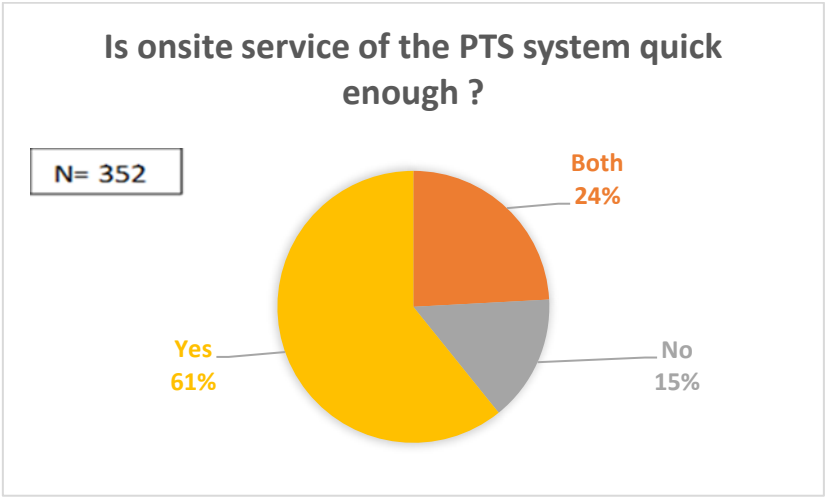
- When asked about if PTS system helps in speeding up the medical support services 91% agreed upon that YES it helps speeding up the process.
- Responders concurred that the system has a faster speed per transaction than messengers, however messengers' speed per transaction for moving things is incredibly slow.



- The result showed that 87% respondents felt that Pneumatic tube system has better accuracy than the messenger.
- Users of the systems have confidence in their accuracy, and using the systems results in very few losses, damages, or errors.



- 75% respondents thought that PTS is more user friendly whereas 23% users thought both PTS and messenger are equally easy to use.
- System operation it is quite convenient and easy.



- 61% respondents said that onsite service is quick whereas 15.1 % denied.

- A system repair service is also available on-site in the event of a system error.

The following groups represent the issues and incidents that were reported by the respondents:

Points to be concerned of system usage

Users –

- Speed:
  1) Concerning the rapid service available there
  2) How long it takes to perform maintenance and replace parts
  3) Users might have to wait if there are a lot of transactions that are still open.
- Budget:
  1) Maintenance expenses could be substantial.

  2) Expensive installation budget.

- Confidentiality:
  1) The transferred object was easily accessible to everybody in the department.

- Other:
  1) Being concerned about system failures

Points to be concerned of Human transport (messenger) usage

A group of responders shared the same views and concerns about sending an object by messenger.

- Speed: Regarding the amount of time spent sending the sample
- Confidentiality: Concerning the possibility of an object being sent to the incorrect recipient.
- Other:

  1) A scarcity of personnel may result from sick leave for messengers

  2) In relation to lost or damaged objects

  3) For the object being transported, the handling technique is improper.

Errors encountered while transferring through PTS

Table 4. 4 :- Pneumatic Tubes System Errors Statistics

Pneumatic Carrier Deployment								
S.No	**Department**	**Floor**	**Speciality**	**Station code**	**Carrier as per Inventory (Feb)**	**Carrier Physically found (April)**	**Short**	**Reason**
1	5 Th B Wing	5th floor	Thoracic Surgery	501	2	1	1	Breakage of carrier
2	6 Th B Wing	6th floor	Neurology	601	2	1	1	Wrong Code entered by nursing staff
3	7 Th B Wing	7th floor	Mix speciality	701	2	2	0	
4	8 Th B Wing	8th floor	CTVS	801	2	2	0	
5	9 Th B Wing	9th floor	CTVS & Pediatric	901	2	1	1	Breakage of carrier
6	10 Th B Wing	10th floor	Oncology	101	2	2	0	
7	11 Th B Wing	11th floor	Gastroentrology	111	2	2	0	
8	12 Th B Wing	12th floor	Gi surgery	121	2	1	1	Wrong Code entered by nursing staff
9	14 Th B Wing	14th floor	Liver transplant	131	2	0	2	Operational defect/System malfunction
10	15h Th B wing	15th floor	Mix speciality	141	2	2	0	
11	6 Th A Wing	6th floor	Neurosciences	606	2	2	0	
12	7 Th A Wing	7th floor	Orthopaedic	607	2	2	0	
13	8 Th A Wing	8th floor	CTVS	608	2	1	1	Wrong Code entered by nursing staff
14	9 Th A Wing	9th floor	CTVS	609	2	2	0	
15	10 Th A Wing	10th floor	Pedaitric	610	2	2	0	
16	11 Th A Wing	11th floor	Endoscopy	611	2	2	0	
17	12 Th A Wing	12th floor	Nephro and urology	612	2	1	1	Wrong Code entered by nursing staff
18	14 Th A Wing	14th floor	Liver transplant	613	2	2	0	
19	2 nd OPD	2nd floor	Dental sciences	902	3	3	0	
20	4 rd OPD	4th floor	Pediatric Cardiology, Pediatric Neurology,Pediatric surgery	904	2	2	0	
21	10 th OPD	10th floor	Medical oncology, hematology, pediatric hematocology	910	2	1	1	Wrong Code entered by nursing staff
22	12 th OPD	12th floor	Nephrology,urology, OP dialysis, Lithotripsy	912	2	2	0	
23	ICU 1	1st floor	Cardiac Surgery	102	2	2	0	
24	ICU 2	1st floor	Cardiac Surgery	107	2	2	0	
25	ICU 3	1st floor	Neurosciences	108	2	2	0	
26	ICU 4	1st floor	Pediatric Cardiac surgery and cardiology, Renal transplant	103	2	2	0	
27	ICU 5	3rd floor	Neurology, Pediatrics	303	2	2	0	
28	ICU 6	3rd floor	Post cath	302	2	2	0	
29	ICU 7	2nd floor	Mix speciality	201	2	2	0	
30	ICU 8	2nd floor	Mix speciality	202	2	0	2	Wrong Code entered by nursing staff
31	ICU 9	2nd floor	Gastro and GI surgery	203	2	1	1	Breakage of carrier
32	ICU 10	2nd floor	Liver transplant	204	2	2	0	
33	ICU 11	2nd floor	Mixed	304	2	1	1	Operational defect/System malfunction
34	Ortho ICU	2nd floor	Ortho	106	2	1	1	Breakage of carrier
35	Triage OBS & HOLD	UG	Emergency OBS & HOLD	56	2	1	1	Wrong Code entered by nursing staff
				58	2	2	0	
36	Heart Command Center	UG	Heart Command Center	57	2	2	0	
37	Sample Collection	UG	Sample collection	62	2	2	0	
38	Pharmacy system 1	LG	Pharmacy	82	35	35	0	
39	Pharmacy system 2	LG	Pharmacy	83				
40	Medical Store	LG	Medical store	81	2	2	0	
TOTAL					**114**	**99**	**15**	

Samples that were transmitted through PTSs but were lost or delayed in transit. Most of these specimens needed to be redrew or had to have the sample recollected. Not all specimen transport errors could be accounted for, but after speaking with the staff, it was discovered that the following were the root causes:

- Specimens were not sent in a timely manner, denotes that the item was either sent too late to be processed at the lab or was delayed for so long that it was deemed contaminated.
- Specimens were sent to the incorrect department by mistake, either as a result of a system flaw or human error (wrong station code was dialled by the nursing staff)
- There was poor inter- or intra-departmental communication, for example, between the laboratory staff and the nursing team.
- Unlabelled or incorrectly labelled specimens were sent to the laboratory.
- Inappropriate use results in carrier breakage and loss, which could result in contamination.

Some of the specimens that are carried over the PTS report specimen breakage or leakage. Transporting samples that are not on the hospital's permitted material list or using the incorrect carrier are examples of improper use of the PTS.

Breakage and leaks not only jeopardise the sample's integrity, delaying treatment, but they may also pose a biohazard concern, endangering employees and necessitating the PTS's shutdown and decontamination.

The types of things that hospitals consider appropriate for transport can vary, thus facilities may think about putting warnings at PTS stations.

Sending specific drugs through the PTS is yet another improper use of the system. Again, restrictions vary from facility to facility, but many hospitals prohibit the delivery of unstable pharmaceuticals and controlled substances through the PTS.

The Main causes of Missing Carriers were found to be: -

- Wrong dialling of code by the nursing staff causing the specimen to be lost or routed to the other department and not returned to the desired destination.
- Breakage of carrier due to inappropriate use of PTS.
- System Malfunction which can be an operational defect causing the carrier to be stuck within the tubes and failing to be retrieved at the desired destination.

CHAPTER 5

DISCUSSION

Importance of Pneumatic Tube System Study

Most technological developments have not yet affected intra-facility logistics and material management. A health care system depends on intra-facility logistics, which include spontaneous transports like those of drugs, common errands, billing paperwork, prescriptions, reports, samples, etc. For these impromptu transports the health care facilities rely on family members, ward boys, and patient attendants as their primary means of transportation.

Ineffective intra-facility logistics have also lately been revealed to have increased the cost of human resources as well as other costs like healthcare. Along with this, it has led to a number of issues at hospitals, including a rise in treatment-related hazards and a decline in the calibre of patient care provided there.

Because of these factors, optimising hospital logistics is gaining importance. An integrated healthcare system is increasingly necessary to provide patients with seamless care, cut down on manual labour, and boost productivity. One such cutting-edge microprocessor-based transportation system that combines speed and dependability in a variety of logistical needs is the pneumatic tube system (PTS). These systems are quite complex and used for a variety of small and medium-sized tasks.

Strengths of Pneumatic Tube System study

Due to the numerous advantages they offer, pneumatic tube systems are becoming more and more popular in modern hospitals.

1. Quicken medical services like sample delivery to a larger level.
2. Pneumatic tube systems conserve a great deal of time and space.
3. Increase workforce effectiveness
4. Guard against harm to the given pathology specimen.
5. Shorten the average turnaround time
6. More dependable than conventional methods

The pneumatic tube system is a useful substitute for traditional workforce-dependent transportation. The workforce and operating costs have definitely been reduced. The approach indicated above can be implemented in the healthcare facility department to increase overall efficiency and aid in the provision of high-quality medical care.

Limitations of the Pneumatic Tube System study

1. As an intern, I lacked access to confidential information.
2. There aren't many studies that pertain to the hospital object transporting system. There aren't many relevant facts and figures to be found.
3. The hospital uses only two different kinds of systems. There aren't many different system options. The hospital uses only two different kinds of systems. There aren't many different system options.
4. The fear of complications and challenges among new users may prevent them from wanting to learn how to utilise the new system.
5. Some newly hired hospital staff members are unaware of the facility's object carrying mechanisms.
6. Some hospital staff members are unsure of how the system can help hospitals provide better services.
7. A random selection of respondents had to be made because it was difficult to reach the sample of the study group at one specific time in the several departments that must use the system for services in following areas (OPD, IPD, Clinic, Lab and pharmacy, medical store, ICUs).

CHAPTER 6

CONCLUSIONS

The pneumatic transport system (PTS) is a useful substitute for traditional human-dependent transportation. The goals of this study were to compare the functions and outcomes of object transportation systems for enhancing hospital medical support services. Additionally, factors and guidelines for selecting the appropriate system installed in a hospital are researched. By accelerating services, offering a one-stop-service or using other appropriate tactics, many hospitals make an effort to increase client satisfaction and become more competitive.

One of the creative approaches to increase service efficiency is to implement any logistic system for the transportation of goods, documents, and samples. In hospitals, a variety of technologies, including the human-based transport system and the pneumatic tubes system, can be utilised to move objects, documents, and specimens.

According to this analysis, there is a significant reduction in both the amount of labour and the travel time by almost 68 minutes. Modern hospitals and healthcare facilities should transition to employing these technologies because of the growing emphasis on resource efficiency in order to reduce operational costs in hospitals.

The analysis also highlights the cost growth associated with putting PTS in the structures.

Therefore, it is preferable to take these facilities into account throughout planning for a hospital. And lastly, PTS systems are a boon for any hospital building type.

RECOMMENDATIONS

A PTS might encourage quick sample and drug delivery to remote areas of the hospital. To prevent tube system downtime due to negligence or misunderstanding, it is crucial that all users receive proper education. Consider whether forcing functions or visual signals at the tubing stations could promote better adherence to protocols. Expectations may be set through hospital-wide and department-specific policies and procedures.

Take into account the following extra PTS improvement tactics:

- To create a process control that makes sure the deadline for material delivery is always met. When used effectively, the PTS can be a useful strategic tool for delivering prompt and effective patient care.
- Staff from the pharmacy services department to ensure that the patient identity on the substance being transported is accurate.
- State clearly how often workers must check the station to help with the rapid removal of material in tubes. Think about packing any tubed materials with labels and documents, as well as a routing sheet in case the delivery gets diverted.
- Display a list of prohibited items that should not be transported at tube stations. Avoid using the PTS for anything other than what is was intended for. The integrity of the PTS is compromised by improper use, which also limits the capability of the institution to deliver excellent patient care.

- Display a timetable detailing when approved items can be delivered to addresses.
- A sticker tracker should be applied to the PTS system's canister so that any samples that are misplaced or delivered to the wrong location can be brought back to their original location. This technology could make it possible to identify missing canisters for future use.

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ANNEXURES

Annexure 1:- Survey format provided to the system users

Opinions of hospital staff and satisfaction with medical logistics (Users)

Objective: In order to compare and contrast preferences between the pneumatic transport system and the human transport system, this questionnaire seeks to gather information, thoughts, and comments from respondents on the item transporting system in hospitals (messengers).

Directions: Please fill out the following information, or enter the information that relates to your response, as appropriate.

Part I Personal Profile

1. Name …….

2. Gender ☐ Male ☐ Female

3. Age …….

4. Department of work ……

5. Floor ……

6. Your job position (please specify) ……

7. How useful is the system in your opinion?

☐ Speed up services ☐ Easy to use ☐ Others

☐ Track back easily ☐ Reduce mishandling, damage and lost of items

8.What type of the systems would you prefer?

☐ Human transport system ☐ Pneumatic Tube System

☐ Both ☐ None

9. Which transport system has better level of confidentiality?

☐ Pneumatic tube system ☐ Human transport system

☐ Both ☐ None

10. Which transport system has better accuracy?

☐ Pneumatic tube system ☐ Human transport system

☐ Both ☐ None

11. Does object transporting system help speed up medical support service?

☐ Yes ☐ No

12. Which system is more user friendly?

☐ Pneumatic tube system ☐ Human transport system

☐ Both ☐ None

13. Is on-site service of the Pneumatic tube systems quick enough?

☐ Yes ☐ No

Annexure 2:- Survey result table representation

Gender		**Female**	**male**		
		253	99		
Distribution of PTS user	**Pharmacist**	**GDA**	**Nurse**	**Senior nurse**	**TL**
	13	25	196	33	80
How useful is the Pneumatic tube system in your opinion?	**Easy to use**	**Reduce mishandling, damage and lost of items**	**Speed up services**	**Track back easily**	
	128	5	203	16	
What type of the systems would you prefer?	**Both**	**Human Based transport system**	**Pneumatic Based Tube System**		
	60	5	287		
Which transport system has better level of confidentiality?	**both**	**None**	**Human Based transport system**	**Pneumatic Based Tube System**	
	68	0	21	262	
Which transport system has better accuracy?	**both**	**Human Based transport system**	**Pneumatic Based Tube System**		
	37	7	308		
Does object transporting system help speed up medical support service?	**May be**	**No**	**Yes**		
	30	1	321		
Which system is more user friendly?	**Both**	**Human Based transport system**	**Pneumatic Based Tube System**		
	80	9	263		
Is on-site service of the Pneumatic tube systems quick enough?	**Both**	**No**	**Yes**		
	85	53	214		