COMPARATIVE STUDY OF THE ROLES AND EFFECTS OF OBJECTS TRANSPORTING SYSTEM FOR IMPROVING MEDICAL SUPPORT SERVICES IN HOSPITAL

BY

MISS BOONTARIKA KIETBURANAKUL

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (INNOVATIVE HEALTHCARE MANAGEMENT)
CHULABHORN INTERNATIONAL COLLEGE OF MEDICINE
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on June 14, 2016

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ABSTRACT

Time management is very important for healthcare service, especially in hospitals. It takes a lot of time for patients from the first step entering a hospital until the last process finished. New technology and innovation are introduced and implemented in hospitals in order to reduce medical service and process time, especially in document and specimens transporting, which were transported only by messengers in the past.

This research is to study of problems, issues, benefit and usefulness of objects transporting system usage compare with using messenger. The data for this research is collected by conducting surveys, questionnaire and interview to system users and non-system users out of 460 samples of main 7 departments (131 system users and 329 non-system users). The data of surveys and interview are used for advantages and disadvantages of the systems usage analyzing. Another part of data are collected from monthly report of system usage and used for system errors and effectiveness analyzing. Also, technical information received from system providers are used for comparison of each system.

The result of survey shows that transporting object by system really helps speed up medical support service more than by messenger and also provides high accuracy with less error, lost and damage to the object and maintain high confidentiality of the object . Moreover,

user friendliness is another benefit of the system. Both groups of respondents agreed that speed per transaction of the system is faster than messenger. Thus, some users said that speed per transaction of transporting objects by messengers is very slow, but anyhow controllable.

However, implementation of object transporting system is still beneficial for medical support services. To use or not to use object transporting systems depends on difference reasons and decisions. There are several object transporting systems which can be used in hospitals and it is important to choose the most proper system with the most effectiveness for the hospital. This research outcome can be used as supportive data for other hospitals or newly opened hospitals before deciding to implement the most proper system.

Keywords : Time management, Speed up the service, object transporting system, supportive data, The most proper system.

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LIST OF ABBREVIATIONS

Symbols/Abbreviations	Terms
CSSD	Central Sterile Supply Department
ICU	Intensive Care Unit
IPD	In Patient Department
Kg.	Kilogram
Lbs.	Pounds
NICU	New Born Intensive Care Unit
OPD	Out Patient Department
PPE	Personal Protection Equipment
PTT	Pneumatic Tube Transport
PTS	Pneumatic Tube System
SDMC	Somdech Phra Debaratana Medical Center
SiPH	Siriraj Piyamaharajkarun Hospital
Sq. m.	Square Meter
THB	Thai Baht

CHAPTER 1

INTRODUCTION

1.1 Background and Significant

Whenever one would like his sickness to be healed or his health to be maintained in a good condition, an excellent service with shorter time such as a one-stop service is preferred. There are many steps in healthcare service processes which usually take a lot of time and each step is very complicated with documentation and specimens transporting as shown in figure 1.

In the past hospitals usually transport documents, specimens, medicine and other medical materials by hand, both inside the building and between buildings. It was clear that lost, false transfer, mishandling and time consuming occurred and caused the delay of services which led to lower patient satisfaction. It takes quite a lot of time for patients from the first step entering at a hospital until they finish all processes, including documentation processes. If each hospital can improve time management by implementation of innovations for objects transporting such as Pneumatics Tube System, Dumbwaiter Lift or Telecar, it will reduce the document process time, lead to more patient satisfaction and become more competitive.

To become more competitive in present healthcare business, management people of many hospitals try to find a system or an innovation to improve the service by time reduction. The more time reduce, the more time hospital staffs will have for patient care.

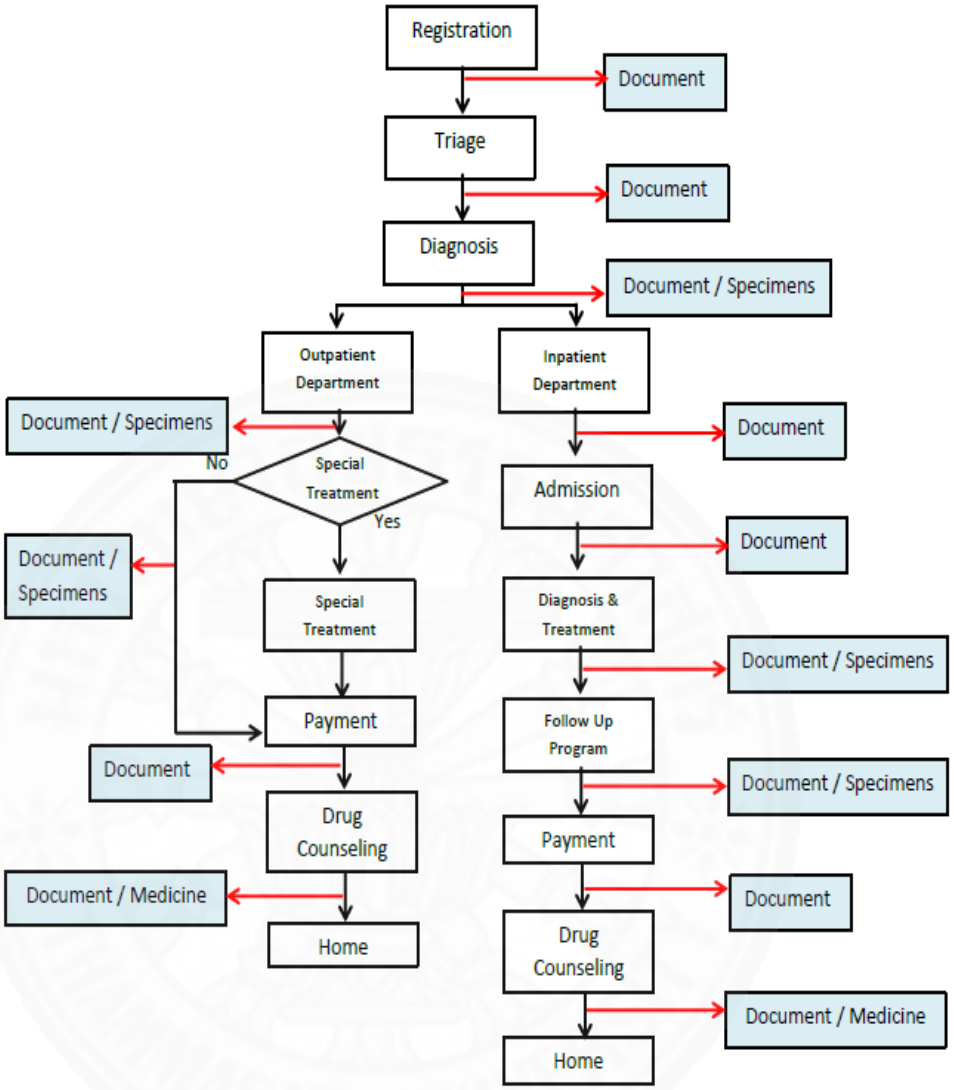


Figure 1.1 Patient Flow[1]

Hospitals are categorized by size and number of beds into 3 categories.[2]

1. First-level Hospital

- Small community hospitals (F3) refers. 30-bed community hospital beds.
- Medium community hospitals (F2) means. Community hospital beds 30-90.
- Large Community Hospital (F1) means. Community hospital beds 90-120 beds

2. Middle-level Hospital

- Hospital M2 server means the 120-bed community hospital
- Small general hospitals M1 means the hospital has a capacity to accommodate patients requiring complex treatment.

3. Standard-level Hospital

- The hospital has a capacity to accommodate patients who need specialized treatment complexity level.
- Hospitals Advance - level Hospital (A) is a hospital with a capacity to accommodate patient needs. To maintain the level of expertise and advanced technology complex and expensive (Advance & sophisticate technology).

(Bureau of Policy and strategy/Ministry of Health, 2012)

Previously hospitals used to transfer specimens, medicine, medical documents and other items by men walking in the building and between buildings. Many times that errors such as mishandling, lost or sending to wrong destinations occurred. After root causes were analyzed, causes of errors and occurrences are as listed :

1. Messengers do not have adequate knowledge of items to be sent or transferred and how to handle them properly.
2. It takes time transferring items on foot, especially when transfer from one building to another and leads to delay of services.
3. Lost or broken items occurred easily.
4. In case of sending specimens, it might cause infection to messengers if they ignore to wear proper PPE (Personal Protection Equipment) when handling those specimens.
5. Difficult to track back or keep record.

1.2 Concept of Logistic Innovation Implementation

The main task of all hospitals is the improvement of the Patient's state of health. The provision of the medical treatment and patient care – core processes of the hospital, create demand for patient-related support services. These secondary processes can be of medical or non-medical nature. Additional services summarized in tertiary processes are not directly linked to patients, but are necessary for proper operation of the healthcare facility and hospitals. The main concept of logistic innovation implementation is time reduction for overall service, especially for medical service.

1.3 Objectives

1. To comparatively study the evolution of various types of objects transporting systems used in hospital and explore the variable effects of the systems.

2. To study problems and issues of the system usage, provisions, factors for considerations, benefit and usefulness of proper system installation as supportive data for other hospitals or newly opened hospitals.

1.4 Research Questions

1. Why should hospitals implement logistic systems instead of transferring items by men?
2. Does the system help improving workflow and speed of services?
3. For which type of hospital will the system be fully benefit?
4. Any provisions or supportive information for decision of system installation?
5. Which system is the best match to a hospital?

1.5 Specific Aims

Refer to mentioned research questions, the specific aims of the study are to find out about issues and problems, both system errors and user errors, and to find out about important provisions for consideration of system installation.

1.6 Definition of Study Variables

Because of many human errors and delays that occurred when transporting medical items, scientists began to find the proper solutions, then several logistic innovations were invented. Such innovation aimed to reduce time and errors in order to improve medical services and to increase patients and hospital staff satisfaction. Logistic systems never get sick and are systematically controlled. Every transfer can be recorded and tracked back easily. Each type of logistic innovation is suitable for sending several types of medical items, both in liquid and solid form. However, logistic innovation system needs to be improved more and more to fulfill the needs of internal and external customers -patients and hospital staff.

This research is to study technical function, break even point for system installation, point of view and opinion of hospital staff on the usage of installed system. Their satisfaction will be measured and scored by using questionnaire. Also, any problems and errors occurred during the implementation of the systems will be asked and analyzed. Those comments, answers and scores received will become a fundament of provisions for consideration on the most proper system implementation in hospitals.

During the on-site observation, there are 2 main groups of hospital staff : the ones who do not use the object transporting systems due to some specific reasons and the ones who conduct direct usage of the systems.

The first group mostly is in-charge nurses or supervisors of each department or ward. They mostly handle confidential documents directly by messengers to receivers such as doctors, specialists or experts. Such confidential documents have to be handed directly to receivers as soon as possible and cannot be waiting or queue up in line to be sent by systems. Such confidential items are rarely occurred.

Another group is ward clerks and department secretaries. They are the frequent users of object transporting systems. They conduct a great amount of duties concerning documentations, medical records and lab specimen. Due to a great amount of items needed to be sent daily, they need a transporting system in order to decrease time consuming of such transactions.

The comparison of opinions and reasons of system users and non-users are needed for this research. In order to get such information, surveys, questionnaires and interview are conducted to system users and non-users.

1.7 Location of this study

At Siriraj Piyamaharajkarun Hospital and other Telecar equipped hospital.

1.7.1 Siriraj Piyamaharajkarun Hospital (Case study of Pneumatic Tubes System and Dumbwaiter Lift)

Siriraj Piyamaharajkarun Hospital (SiPH) is an advance – level hospital opened on April 26, 2012, and is the latest development on the premises. It is a part of Sayamindradhiraj Medical Institute, which is an enterprise to drive Siriraj to become a medical institute of excellence in the Southeast Asia. SiPH is a 345-bed, medical center with state-of-the-art facilities equipped with latest technological advances in a 14-story and 3 basement parking with an area of 259,630 sq. m. eco-friendly designed, building. SiPH offers comprehensive, interdisciplinary and quasi-luxurious medical services for patients, particularly those with complex health disorders. With an independent management as a private medical center under the Faculty of Medicine Siriraj Hospital, the profit derived from SiPH will return to the Faculty for supporting education, research and patient care.[16]

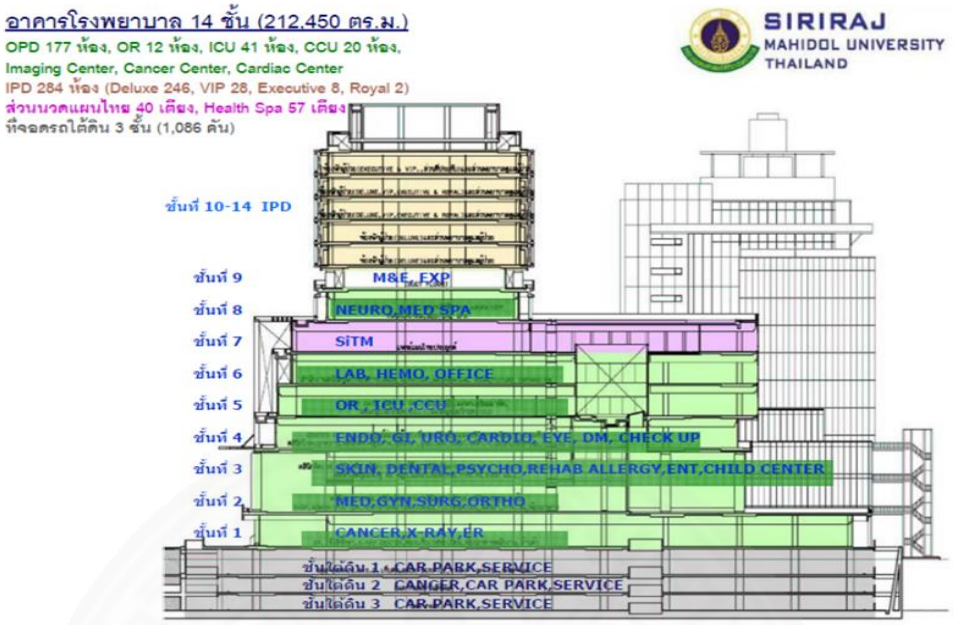


Figure 1.2 Floor Plan of Hospital Building (Siriraj Piyamaharajkarun, 2011)

Floor 11		
Deluxe Room	74	Rooms
Floor 12		
Deluxe Room	49	Rooms
VIP	6	Rooms
Executive	2	Rooms
Royal Executive	1	Rooms
Floor 13		
Deluxe Room	49	Rooms
VIP	6	Rooms
Executive	2	Rooms
Royal Executive	1	Rooms
Floor 14		
VIP	16	Rooms
Executive	4	Rooms

Figure 1.3 Room Type in Ward 11th-14th floor

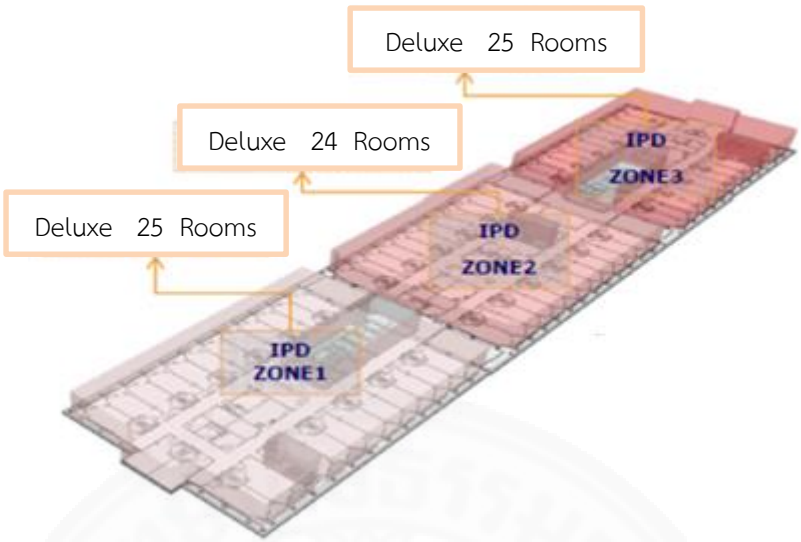


Figure 1.4 Room Types of Each Zone

Ward 10th-14th Floor

Deluxe Room (36 m^2)	246	Rooms
VIP (75 m^2)	28	Rooms
Executive (105 m^2)	8	Rooms
Royal Executive (175 m^2)	2	Rooms

Figure 1.5 Room Types and Room Numbers (Siriraj Piyamaharajkarun, 2011)

1.7.2 Somdech Phra Debaratana Medical Center, Ramathibodi Hospital (Technical study of Telecar/Telelift System)

Somdech Phra Debaratana Medical Center, Ramathibodi Hospitalprovides Strategic Segmentation Super-tertiary care for wide variety of patients with integrated wards, ICU, OR, and private care. SDMC opened for service on April 26, 2011 and is a 9-story and 3 basements building with a usage area of 99,553 square meters and provides services of 280 exam rooms for OPD, 283 beds for IPD, 12 OR, 22 beds for ICU, 32 beds for NICU and 40 beds for Radio Therapy.[9]

Figure 1.6 Somdech Phra Debaratana Medical Center, Ramathibodi Hospital

Figure 1.7 Somdech Phra Debaratana Medical Center, Ramathibodi Hospital

1.8 Limitation of the Study

1. It is difficult to compare different systems used in different type and size of hospitals.
2. There are only few related researches on object transporting system used in hospital. Only few related data and information are found.
3. There are only a few type of systems used in hospitals in Thailand. Only few options of systems are available.
4. New users might not want to learn to use the new system due to their fear of complications and difficulties.
5. Some new hospital staffs do not know about object transporting systems in hospitals.
6. Some hospital staffs don't have any idea how the system can help improve services in hospitals.
7. The sample of the study group for survey, questionnaires and interview is limited to several departments which have to use the system for services (OPD, IPD, Clinic, Lab and medical records)

1.9 Basic Assumption

The basic assumption of this study was to collect technical information from systems providers, interview and conduct survey by questionnaire asking about their experience and opinion comparing between transporting documents and specimens by man and by object transporting system. The data provided are used and analyzed for provisions and supportive reason for consideration on system implementation for more convenient and faster medical support service.

1.10 Chapter Summary

This research data show the duration and time consumed in each step of hospital service. The concept of Logistic Innovation implementation will be mentioned. In this chapter the background and significance, research questions, objectives, definition of the study variables and the limitation of the study will be written about.

CHAPTER 2
REVIEW OF LITERATURE

This chapter introduces 3 new types of logistic innovations for object transporting mostly used in hospital in Thailand technically and practically. After that 3 object transporting systems used in hospitals in Thailand will be written about, focus on functions and effectiveness of the system. Moreover, several theories and models used for analyzing of Consumer Surplus, Producer Surplus and Transaction Cost are written about.

2.1 Type of medical related objects transporting method

2.1.1 By messenger

2.1.2 By systems

1) Pneumatic Tube Systems

According to documentary information from Olympia Thai Ltd., Pneumatic Tubes System provider, Pneumatic tubes (or capsule pipelines; also known as Pneumatic Tube Transport or PTT) are systems that propel cylindrical containers through a network of tubes by compressed air or by partial vacuum. They are used for transporting solid objects, as opposed to conventional pipelines, which transport fluids. Pneumatic tube networks gained acceptance in the late 19th and early 20th centuries for offices that needed to transport small, urgent packages (such as mail, paperwork, or money) over relatively short distances (within a building). Some installations grew to great complexity, but were mostly superseded. In some settings, such as hospitals, they remain widespread and have been further extended and developed in recent decades.

Figure 2.1 Interchange Station Source : Swisslog

Figure 2.2 Sending and destination station Source : Swisslog

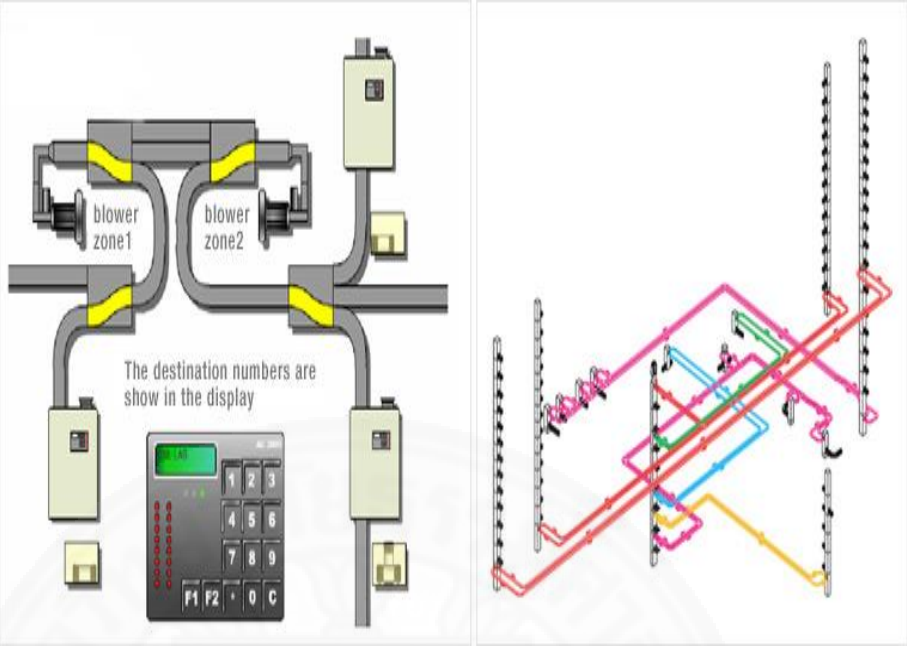


Figure 2.3 Pneumatic Tube System Diagram Source : Hyundai Elevator Co.,Ltd.

Figure 2.4 Carriers Source : Swisslog

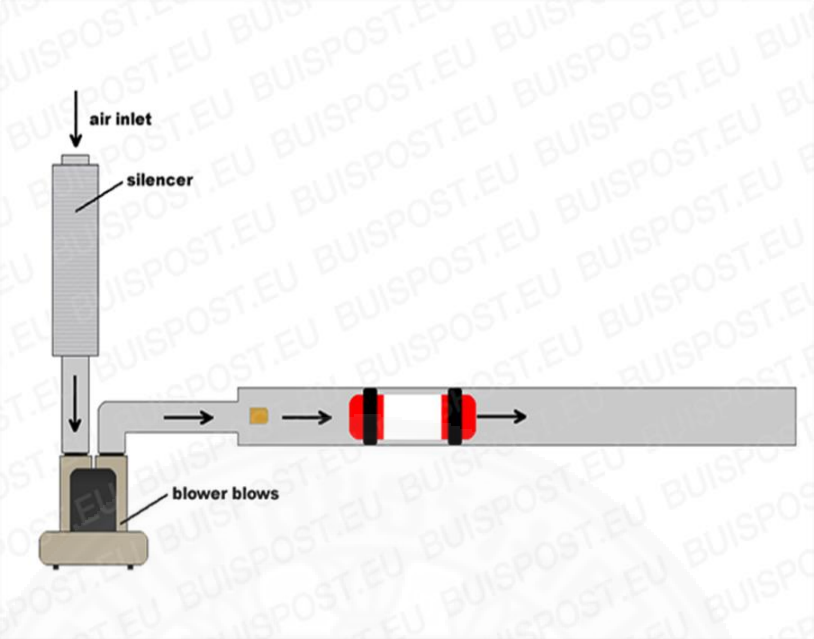


Figure 2.5 Pneumatic Tube System Diagram Source : Swisslog

A pneumatic tube carrier has cuffs and will have a good fit in the transport tube. When we connect the end of the tube to a blower and we let the blower blow, an excess pressure is created in the tube. The pneumatic tube carrier will post pattern on the pressure and will move away from the blower. Letting the blower suck will create a vacuum in the tube, through which the carrier will move into the direction of the blower again. This way the carrier moves through the transport tube. The tube switch detects the carrier in the tube and in this case will give a signal to the central processing unit to switch off the blower. An air brake is built with two ducts and two air valves. If one valve is open, the other is automatically closed. The pressure of the blower will do this automatically, there is no need for an external control. The valves are placed in such a way that when a carrier is sucked to the blower, the air will go through the bypass pipe. The carrier will pass the tube switch, which shall switch off the blower.

The carrier will be stopped by the air buffer in the tube. The rest of the air will flow through the bypass tube, and has no longer affect to the carrier. The blower is going to blow, and the position of the valves will change. The bypass valve is closed and the air will blow the carrier to the destination station.

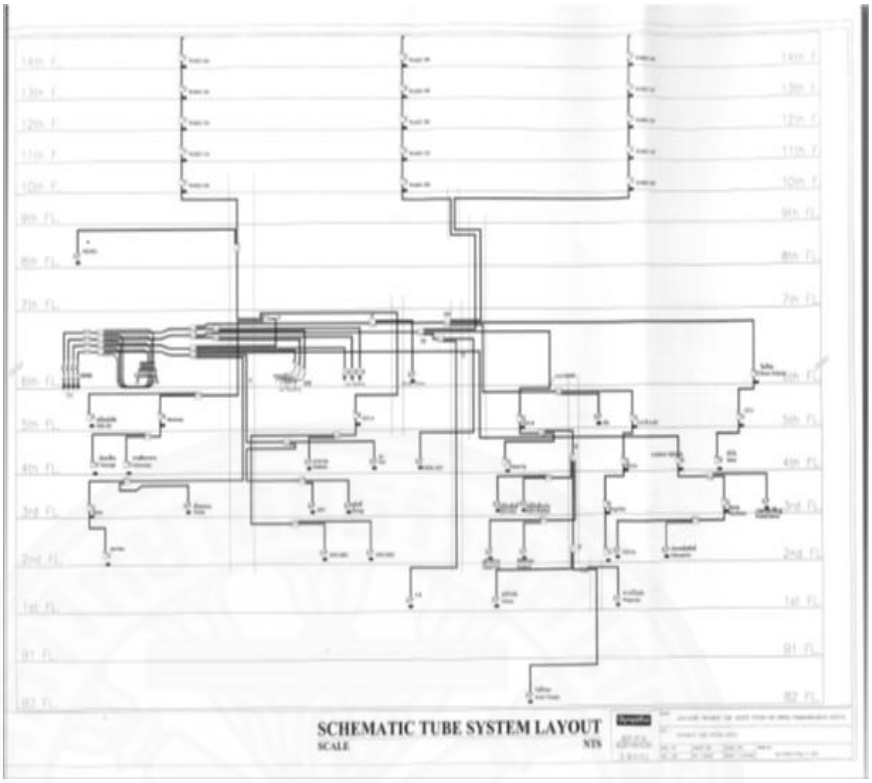


Figure 2.6 Pneumatic Tube System Layout Source : Olympia Thai Ltd., 2011

2) Dumbwaiter Lift

Dumbwaiters come in two types: manual and electric (as shown in the pictures below). Traditional manual dumbwaiters have aluminum tracks installed along the corners of the shaft. The tracks run from the lower floor to at least halfway up to the top floor. A rope or cable pulls the dumbwaiter cart from one level to the other. Some dumbwaiters go down to the basement of a building. When the cart reaches the top level, manual locks engage to hold it in place. Electric dumbwaiters operate on the same principle. The cart runs along tracks attached to the walls of the shaft. When a button is pressed, a motor moves the cart to the desired level and then locks it in place once it has reached its destination.

Figure 2.7 Manual Dumbwaiter Source : Herbie T. Mann

Figure 2.8 Electric Dumbwaiter Source : Vertex Lifts (India) Pvt. Ltd.

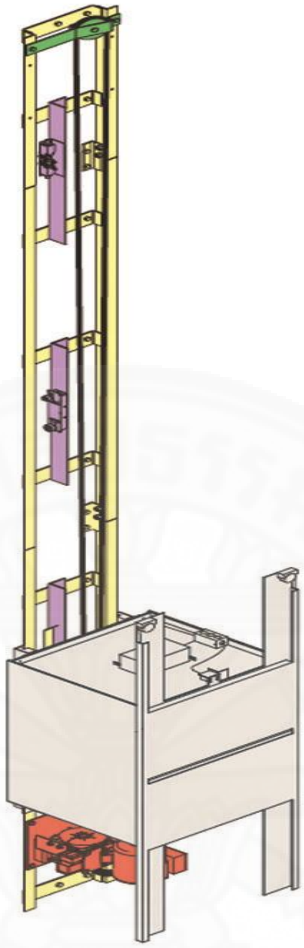


Figure 2.9 Dumbwaiter Perspective

Figure 2.10 Dumbwaiter Door Source : Niche Elevator Sdn. Bhd.

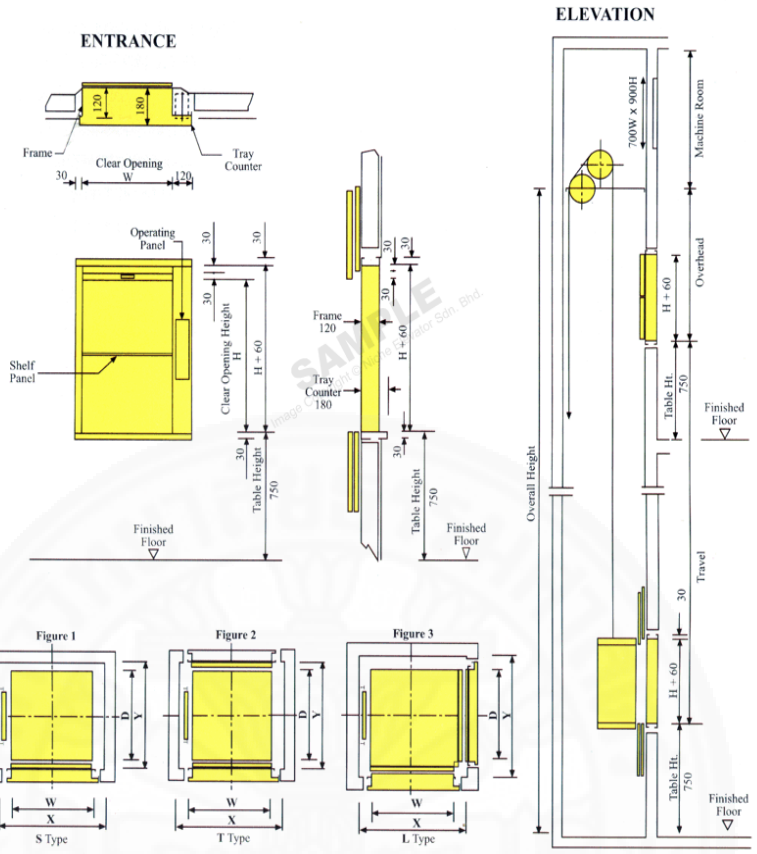


Figure 2.11 Dimension of Dumbwaiter Source: Niche Elevator Sdn. Bhd.

A dumbwaiter is a small freight elevator for carrying objects rather than people. Dumbwaiters are connected between multiple floors. Dumbwaiter Lift provides small freight elevators in various buildings with the prompt, economical and convenient vertical transport. It greatly saves time and labor resources. It requires only small space and it's economical design can be provided both to new construction and to old ones as well. A simple dumbwaiter is a movable frame in a shaft, dropped by a rope on a pulley, guided by rails; most dumbwaiters have a shaft, cart, and capacity smaller than those of passenger elevators, usually 45 to 450 kg. Most dumbwaiter has external fixtures which contains floor destination buttons, floor position indicator, and built-in interphone or normal telephone. When a person is using the dumbwaiter, he/she opens the doors manually, load the goods, and closed the doors again before operating the dumbwaiter. After that, he/she pushed the floor buttons to send the dumbwaiter to the desired floor. Sometimes, the person may also use the interphone or telephone to contact other person on the other floors.[8]

2.1) Types of Dumbwaiter by design

a) Floor Type

Floor type dumbwaiter is installed on the same horizontal level with the floor of the passage way to facilitate carriage of goods normally carried on handcarts. This type of dumbwaiter is normally found in hotels, or corridor areas and normally used to carry large items.

b) Window Type

Window type dumbwaiter is installed at the height of a man's waist, so that users can conveniently use the dumbwaiter. This type is commonly found in libraries, offices, restaurants, kitchens, and other places. It is normally used to carry books, documents, kitchen utensils, food and beverages, and other goods.

c) Large Type

This type of dumbwaiter has a large cab with an external manual gate and it is similar to a normal freight elevator, but there are no button inside the car. Some large dumbwaiters may have an interior light. Passengers are usually not allowed to enter or ride it for safety reason. Button panel is located on the outside, often has a digital floor indicator.

3) Automated Guide Vehicle System (Telecar/Telelift)

Technical information from Technical Support and Service Co.,Ltd. states that Telelift system is comprised of fully automatic container lifts for vertical transport between building floors and belt and/or roller conveyors for horizontal movement at any floor level. Standard containers have a maximum payload of 25 kg (55 lbs.) and specialized containers have a maximum payload of 70 kg (150 lbs.). The Telelift system is used primarily in libraries for book returns as well as hospitals for the transport of medicine, blood products, sterile goods and documents. The Telelift system offers flexibility in conveyor transport options depending upon your requirements.[19]

Automatic vertical transport offers various payload capacities with loading and unloading stations located either side-by-side or on either side of the shaft. Horizontal movement is achieved with belt and roller conveyors with supply and return tracks placed either side-by-side or above one another. The system also enables prompt turning with 90-degree corner turns, controlled 90-degree switches and controlled 180-degree turn around devices. Fire doors are installed at wall openings as well. The Telelift container transport system is quiet, requires minimal maintenance, and benefits from long life and reliability. The compact, flexible construction of Telelift meets the high demands of the user. The Telelift system enhances the operational efficiency of banks, libraries, industry, retail stores, hospitals and commercial applications.[19]

Figure 2.12 Automated Guide Vehicle System (Telecar/Telelift)
Source : Telelift GmbH.

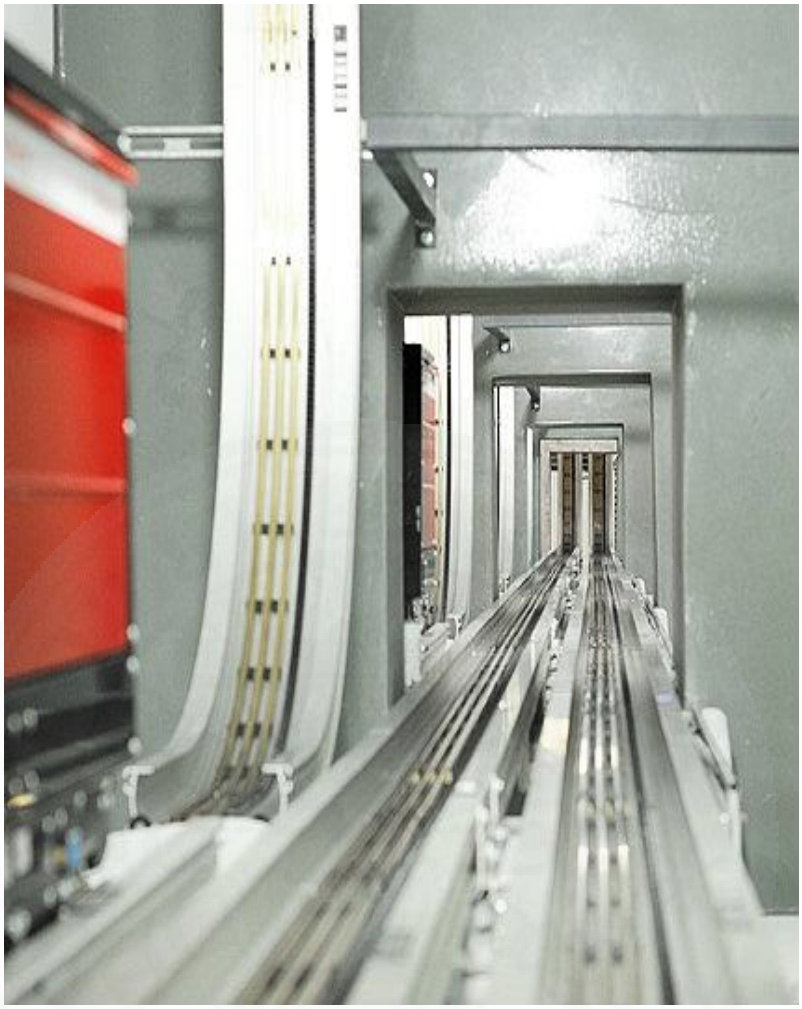


Figure 2.13 Track of Telelift System Source : Telelift GmbH.

Figure 2.14 Telelift used in library Source : Telelift GmbH.

2.2 Research Methods and Theories

2.2.1 SWOT

Figure 2.15 SWOT Analysis Model (Outsource2india, 2016)

SWOT Analysis Model is used for comparison strengths, weaknesses, opportunities and threats of each object transporting systems which can be implemented in hospitals.

2.2.2 Fishbone Diagram (Cause & Effect Diagram)

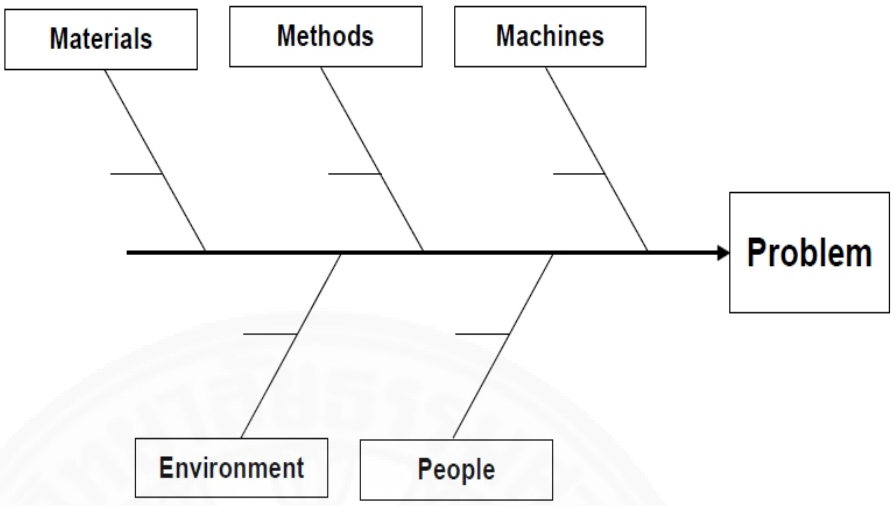


Figure 2.16 Cause and Effect Diagram (ReliabilityWEB, 2016)

Fishbone Diagram is used to identify causes and effects of main problems. Causes are grouped into major categories of "4M 1E" as follow:

M – Man /People: Anyone involved with the process

M – Machines: Equipment or tools required to accomplish the job

M – Materials: Raw materials used to produce the final product or service

M – Methods: How the process is performed

E – Environment: The conditions in which the process operates, such as location, time, temperature, and culture

2.2.3 Consumer Surplus Diagram

This diagram is used to explain the exchange value or price of goods and services. The result is useful for "Social Benefits and Cost" analysis.

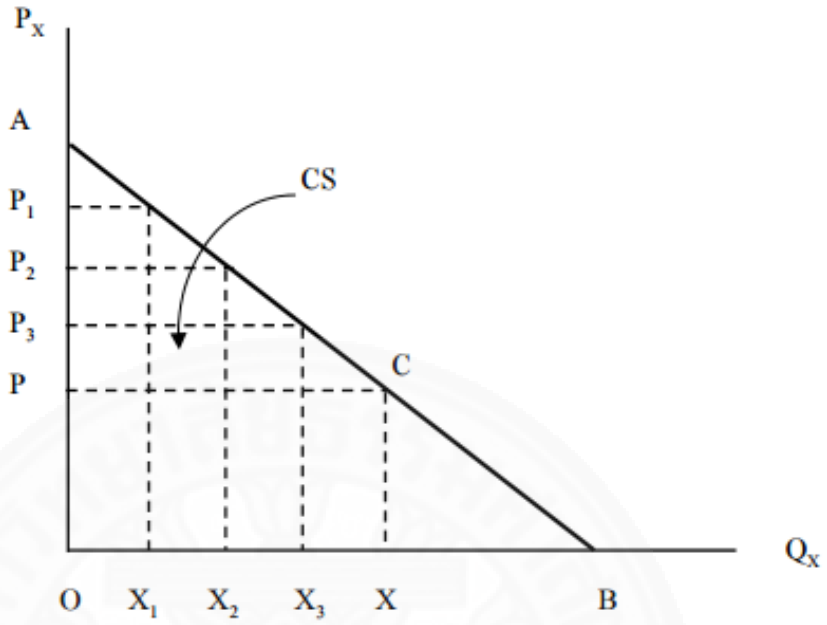


Figure 2.17 Consumer Surplus Diagram (Thanes, 2015)

2.2.4 Producer Surplus Diagram

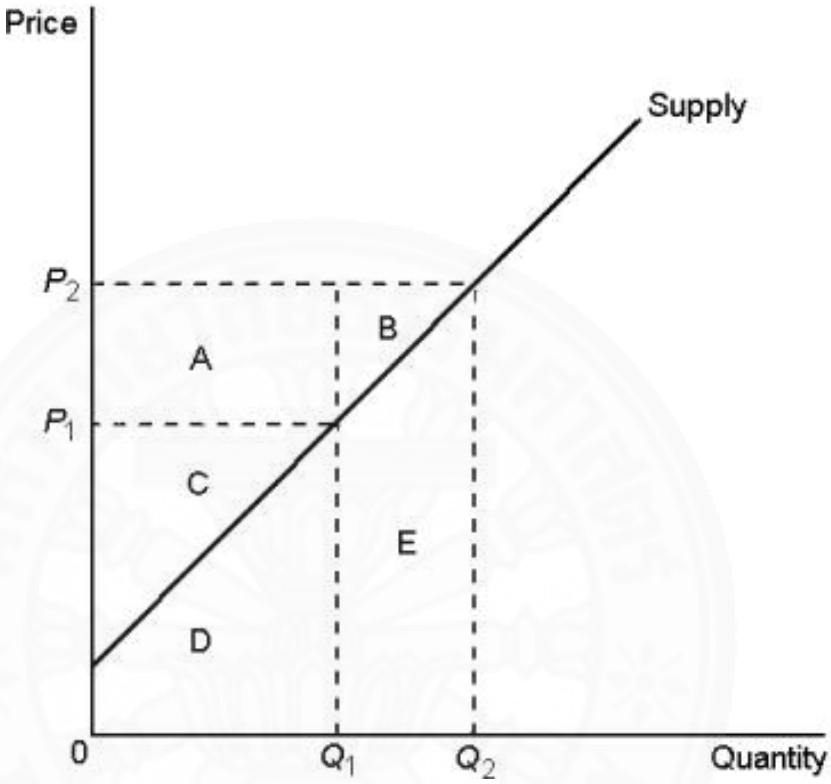


Figure 2.18 Producer Surplus Diagram (Thanes, 2015)

2.2.5 Transaction Cost Diagram

This diagram is used to calculate and analyze the relation among Consumer Surplus, Producer Surplus and Transaction Cost.

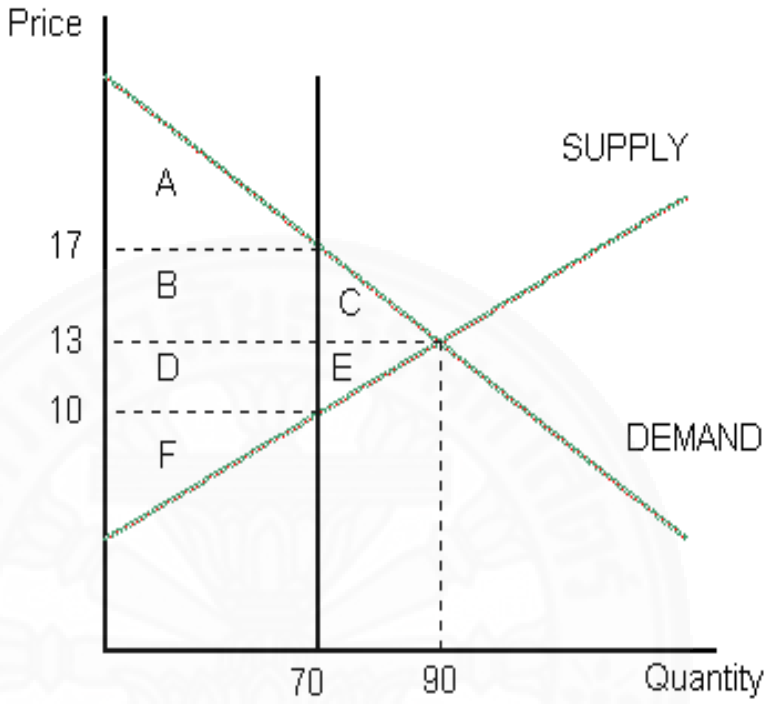


Figure 2.19 Transaction Cost Diagram (Thanes, 2015)

2.2.6 Technology Change Diagram

This diagram is used to analyze the effect of technology change to changes in hospital productivity, which is hereby hospital services.

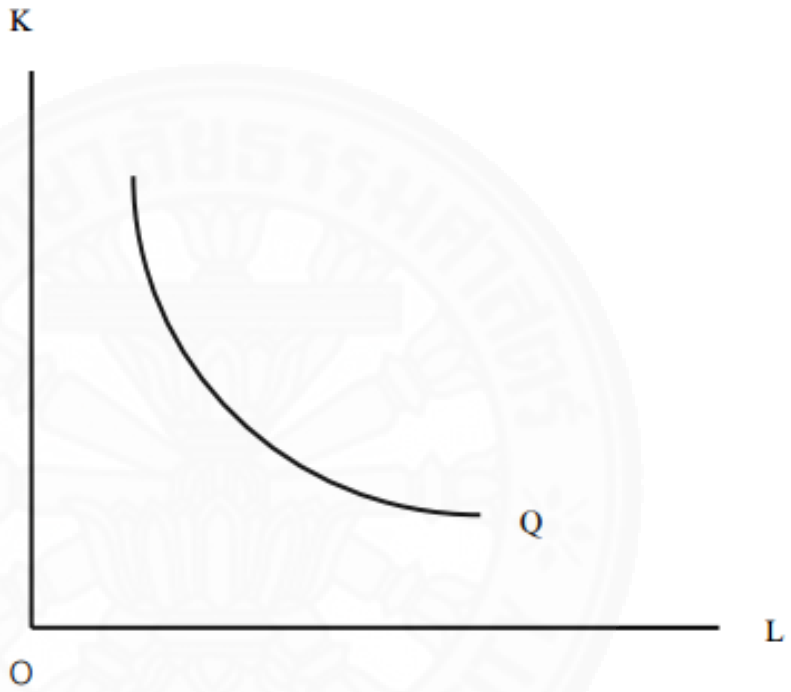


Figure 2.20 Technology Change Diagram (Thanes, 2015)

2.2.7 Survey & Questionnaire

Distributing surveys and questionnaires is one of methods to collect information and opinions from new and current users of object transfer system in the hospitals. The collected information is used for solutions finding for main problems.

2.2.8 Brain Storming

After getting enough information and data, the data is analyzed and interpreted by brain storming along with related people to wrap up the solutions.

2.3 Data Collecting Methods and Process

Researchers commonly use several methods to collect information about a population of interest. There are many different types of surveys and many methods of sampling.

2.3.1 Data Collecting Method

- Questionnaires -- a predefined series of questions used to collect information from individuals
- Sampling -- a technique in which a subgroup of the population is selected to answer the survey questions; the information collected can be generalized to the entire population of interest
- Interview

2.3.2 Types of Questionnaires

1) Closed-Ended Questions
   - The respondents are given a list of predetermined responses from which to choose their answer.
   - The list of responses should include every possible response and the meaning of the responses should not overlap.
   - Closed-ended questions are usually preferred in survey research because of the ease of counting the frequency of each response.
2) Open-Ended Questions
   - Survey respondents are asked to answer each question in their own words.

- Responses are usually categorized into a smaller list of responses that can be counted by the study team for statistical analysis.

2.3.3 Type of Sampling

1) Simple Random Sampling : Simple random sampling is the most basic form of sampling. Every member of the population has an equal chance of being selected.

2) Cluster Sampling : Cluster sampling is generally used when it is geographically impossible to undertake a simple random sample. Cluster sampling requires that adjustments be made in statistical analyses.

3) Stratified Sampling : Stratified samples are used when a researcher wants to ensure that there are enough respondents with certain characteristics in the sample. The researcher first identifies the people in the population who have the desired characteristics, then randomly selects a sample of them.

4) Nonrandom Sampling : Common nonrandom sampling techniques include convenience sampling and snowball sampling. Nonrandom samples cannot be generalized to the population of interest. Consequently, it is problematic to make inferences about the population.

2.4 Chapter Summary

Chapter 2 explains the root reason of the beginning of logistic innovation invention. The technical function of 3 object transporting systems used in hospitals in Thailand are described. Also, related researches are provided for supportive data and information to show how the systems help improve medical support services in hospitals.

CHAPTER 3
MATERIALS AND METHODS

This chapter is to explain how the research design is, how to calculate sample size which fits to the total amount of real number of population. Also, surveys and questionnaires are distributed to get information, comments and opinions from respondents as qualitative data and quantitative data collecting method.

3.1 Research Design

This study considered as a feasibility study and the research questions use both qualitative and quantitative data. All questionnaires were answered by hospital staffs which are categorized into 2 groups : system users and non-system users. The data shown their satisfaction and preference of the implementation of object transporting systems and their opinions of how object transporting system helps with the speed of services, how useful and beneficial the system is, and is it worth having the system at a hospital. All data and information given in survey/questionnaires were kept confidential and all respondents were informed about the confidentiality. Also, hospital staffs who have to work with object transporting systems directly and who prefer sending items by messengers, will be interviewed for more supportive comparison.

3.2 Population

1) System providers: for technical data

2) Hospital staffs: for opinions and comments as systems users

3.3 Sample Calculation

Sample size: Theoretical aspects, formulas

Simplified formula for proportions* (Taro Yamane)

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

Figure 3.1 Taro Yamane sampling size formula

n -the sample size
N -the population size
e -the acceptable sampling error
* 95% confidence level and p = 0.05 are assumed

The total number of SiPH staff is 1,622 people. By calculating for sample size with Yamane's formula, the result of this formula comes out as follow :

N = 1,622 (the number of total hospital staff)
e = 0.05 (allowable errors)

$$n = \frac{1,622}{1 + 1,622\ (0.05)^2}$$

n = 399.75 (sample size for research) or 400

For each research, researchers should add up 15% of the number of sample size for data loss. So the total sample size for this research will become 460.

3.4 Data Collecting Process

Step 1: Interview

The interview is made to collect data and opinions of hospital staff of how object transporting system helps improve hospital services and speed up their work flow. The interviewees are hospital staffs in each department or section which can be divided into 2 groups, the staff who use the system as a tool for their jobs and the staff who prefer using messengers for object transporting. There are 7 main departments which can be categorized into 37 clinics/sections in Siriraj Piyamaharajkarun Hospital where the installed system, Pneumatic Tubes System and Dumb Waiter, are used.

Step 2: Survey/Questionnaire

Two kinds of questions are used in questionnaires: closed-ended questions and opened-ended questions. Respondents to questionnaires are Hospital staffs, both ones who use the system and ones whose preference is using messengers.

Table 3.1 Number of total staff, system users and non-users (as a case study of Pneumatic Tube System usage)

Department/Section	Number of Total Staff	Number of System Users	Number of System Non-Users
1. Back Office	365	10	355
2. In Patient Department (IPD or Wards)	592	30	562
3. Out Patient Department including all Clinics, X-ray and Radiology	506	50	456
4. Lab	32	7	25
5. Pharmacy	50	20	30
6. Central Sterile Supply Department (CSSD) and Medical Supply	52	10	42
7. Medical Record	25	4	21
Total	1622	131	1491

Step 3: On Site Observation

The observation provides real time observation of usage issues/problems/errors occurred. Customer's satisfaction of system usage is included.

3.5 Data analysis and interpretation

Surveys for this research is written to collect opinions and comments of Siriraj Piyamaharajkarun Hospital staff as a case study of object transporting system called Pneumatic Tube System. All hospital staff is divided into 2 groups as mentioned in chapter 2 : system users and non-users. Before distributing surveys, the accuracy and properness of survey questions are rechecked. Samples of surveys are given to some of users and non-users to let them read and feedback if the questions are understandable or not. Questions that are too complicated are cut and replaced by more clear and understandable questions.

- **Quantitative data analysis**

The descriptive statistics are used to describe the percentage of demographic satisfaction of hospital staff both users of object transporting systems used in hospitals and non-users who transporting items by messengers. The opinions of how the implemented object transporting system helps speed up the medical support service will be used as fundamental reason to consider the proper system for other hospitals.

- **Qualitative data analysis**

Hospital staffs opinions and experiences of using object transporting systems in hospitals are used and analyzed in order to understand the needs and trend of users to improve the systems for a satisfaction sustainability. Also, their comments and opinions are analyzed and summarized if the implementation of the system is worth to invest and helps improve hospital services. Moreover, the opinions of non-users who prefer to use messengers will be used for comparisons. Their reasons of messengers usage preference are important as well.

3.6 Chapter summary

The methodology and method used for data collecting provide important information that need to be understood and studied. The more information and opinions respondents provide, the more supportive provisions of the systems benefit and usefulness researchers will get. Also, the provisions for consideration of system installation will be more useful, logic and trustable.

CHAPTER 4
FINDINGS AND RESULTS

4.1 Comparative study of 3 object transporting systems used in hospital in Thailand

From documentary information of 3 systems provided by system providers combined with the use of SWOT Analysis, strength, weakness, opportunity and threat of each system are summarized as in the table below.

4.1.1 Technical comparison: Advantages and disadvantages of each system

Table 4.1 Comparison Table of each system

Type of Logistic	Advantages	Disadvantages
▪ **Pneumatic Tube Systems**	1. Save time, energy and labor 2. Personalize design 3. Easy to control and operate 4. Recordable transfer statistic 5. Easy to track back 6. Reduce human errors	1. Noisy 2. Wide open space for transport tube and station installation required 3. Complicate maintenance 4. Small size carrier 5. Limitation of item weight 6. Used both inside and between buildings 7. High budget
▪ **Dumbwaiter Lift**	1. Small space required 2. Save time, energy and labor 3. Fit to old and new construction 4. Economic and personalize design 5. Stable movement	1. Small weight capacity 2. Inconvenient of station location 3. Used inside buildings only 4. High budget

Type of Logistic	Advantages	Disadvantages
	6. Quiet and flexible operation 7. Easy in maintenance 8. Recordable transfer statistic 9. Easy to track back 10. Reduce human errors	
▪ Automated Guide Vehicle System (Telecar/ Telelift)	1. Quiet 2. Minimal maintenance required 3. Compact and flexible construction 4. Enhance the operational efficiency 5. Reliable 6. Long life 7. Save time, energy and labor 8. Recordable transfer statistic 9. Easy to track back 10. Reduce human errors	1. Space limitation of containers 2. Not proper for liquid, specimens or fragile items 3. Used inside buildings only 4. High budget

The most important problem which occurs frequently in Medical service is the delay of service. In the past, hospitals transported items by messengers. The productivity came out quite low due to many reasons, which mainly leads to delay of services. Fishbone Diagram is used to analyze root causes of object transporting by messengers for a comparative study with other systems.

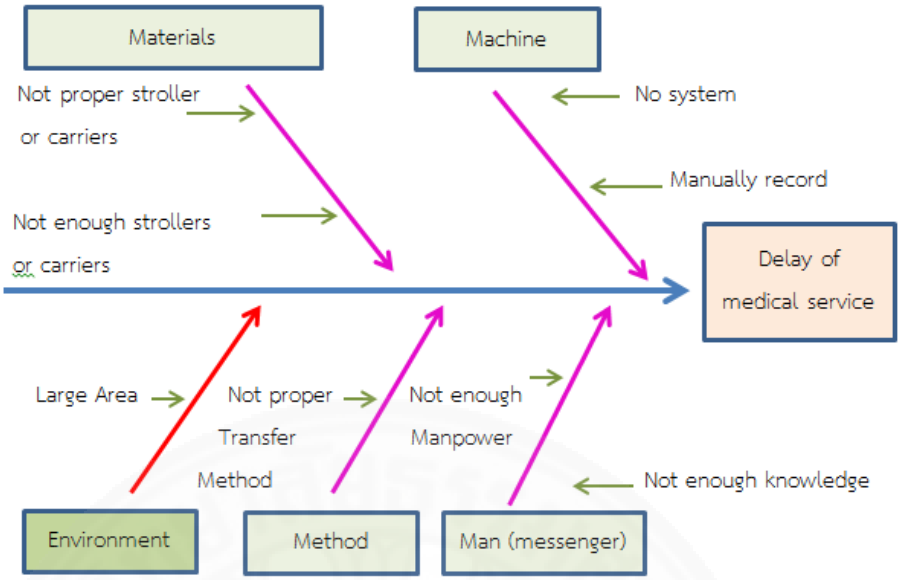


Figure 4.1 Fishbone Diagram shows causes and effects of delay of medical service in hospital

By using fishbone diagram, the study shows that previously used method to transfer objects by messengers causes the delay of medical service and can be explained as follow.

Man: Messengers do not have enough knowledge. Most of the messengers has low educational qualification.

Machine: Transfer object by man with manually report or record which is easy to get lost and difficult to track back.

Materials: Messengers mostly using small strollers or small carriers. Frequency of transferring vary by amount of items. The more amount of items transfer, the longer time and more often walking round will be.

Method: Messengers do not know the proper method to transfer specific items. No precaution.

Environment: Large and complex area causes time consumption when transfer items by walking.

4.1.2 Other related researches

Mr.Patchara Khanammitr conducted research on"Automated Guided Vehicle System in Hospitals" and admitted that nowadays hospitals continue to apply technology to increase their ability to deliver expanding hospital services without increased staffing and using Pneumatic Tube System provides an immediate and measurable result and can deliver items 10 times faster than any other types of logistic systems used in hospitals.[22]

Source: Mr.Patchara Khanammitr, 2012

Swisslog, a logistic system provider, claims that improving the delivery of care is one of the best ways to promote better clinical outcomes, especially for patient-centered care service. There are normally a number of primary transport applications in hospitals which consume time differently and could cause delay of services. The implementation of automated logistic systems help reduce such problem. The implementation of the system has many direct and indirect benefits which all improve the care hospitals deliver as written below.[18]

1. Process improvement
2. Faster sour-service turnaround times for the lab, pharmacy and etc.
3. More stringent traceability of payloads : prevents lost/stolen/diverted of payloads, delivers the right items to the right place.
4. Faster payload delivery times
5. Increase the safety of patients and employees : reduces human touches of lab samples or specimens, reduces incidence of employee injuries related to lifting and hauling activities.

Table 4.2 Hospital Material Payloads by Weight

Payload	Primary Transport Applications
Light (up to 25 lbs.)	- Pharmaceuticals - Lab specimens - Small supply items - Patient and administrative paperwork
Medium (26-60 lbs.)	- Medical records - Central supply items - X-ray film - Intra-lab transport of specimens - Bulk Pharmaceuticals
Heavy (61-800 lbs.)	- Hot meals and empty trays - Clean and soiled laundry - Bulk central supplies - Surgical supplies - Bio-hazardous waste

Source: U.S. Agency for Healthcare Research and Quality. 2013

4.1.3 Consumer Surplus

Table 4.3 Comparative difference of time per transaction

Method/System	Time per Transaction	Diff. Messenger : System	Percentage of Diff.
Messenger	26 Sec.	-	-
Pneumatic Tubes	16 Sec.	10 Sec. (faster)	38.46%
Dumbwaiter Lift	23 Sec.	3 Sec. (faster)	11.54%
Telelift/Telecar	166 Sec.	-140 Sec. (slower)	-538.46%

Note: Time Consuming of the study calculates by 1 transaction per 100 meters.

The table shows that the fastest object transporting system is Pneumatic Tubes System, which is 38.46% faster than transporting items by messenger. The most time consuming system is transporting items by Telelift/Telecar, which is 538% slower than transporting items by messenger.

4.1.4 Producer Surplus

Table 4.4 Comparative difference of Cost per Transaction

Method/System	Cost per Transaction	Diff. Messenger : System	Percentage of Diff.
Messenger	30 THB	-	-
Pneumatic Tubes	4.70 THB	25.30 THB	84.33%
Dumbwaiter Lift	5.28 THB	24.72 THB	82.40%
Telelift/Telecar	10.00 THB	20.00 THB	66.67%

The table shows that Pneumatic Tubes System is the cheapest object transporting system, calculate by cost per one transaction and compare to transporting items by messenger, and is 84.33% cheaper.

4.1.5 Transaction Cost

Table 4.4 shows the comparative difference of price per transaction. For example, the calculation of price per transaction of Pneumatic Tubes System comes from:

①Maintenance Cost per year = 1,500,000.00 THB

②Electricity Consumption = 5.5 Unit/hour

③Electricity Cost = 4.00 THB/Unit

④Electricity Cost per hour = ②X③

⑤Amount of Transaction per year = 360,000 Times

⑥Hours per year = 24 hours X 365 days

= 8,760 hours per year

$$⑦\text{Amount of Transaction per hour} = \frac{⑤}{⑥}$$

$$⑧\text{Maintenance Cost per Transaction} = \frac{①}{⑤}$$

$$⑨\text{Cost per Transaction} = \frac{④}{⑦} + ⑧$$

4.2 Result of Survey and Questionnaires

Table 4.5 Number of Surveys distributed

Department/Section	Number of Non-System Users	Number of System Users	% of staff number (out of total staff no.)	Number of Surveys
1. Back Office	355 (21.88%)	10 (0.62%)	22.50%	104 (22.50%)
2. In Patient Department (IPD or Wards)	562 (34.65%)	30 (1.85%)	36.50%	168 (36.50%)
3. Out Patient Department including all Clinics, X-ray and Radiology	456 (28.11%)	50 (3.09%)	31.20%	143 (31.20%)
4. Lab	25 (1.54%)	7 (0.46%)	2.00%	9 (2.00%)
5. Pharmacy	30 (1.85%)	20 (1.25%)	3.10%	14 (3.10%)
6. Central Sterile Supply Department (CSSD) and Medical Supply	42 (2.58%)	10 (0.62%)	3.20%	15 (3.20%)
7. Medical Record	21 (1.29%)	4 (0.21%)	1.50%	7 (1.50%)
Total	1491	131	100%	460 (100%)

Table 4.5 shows the amount of surveys distributed to 7 main departments where both object transporting system and messenger are used. Since there are only few people who use object transporting system directly with their job, so all of the system users in each department will get surveys. For non-system users are randomly chosen as sample of respondents.

4.2.1 Quantitative Data Analysis

After the calculation of sample size in chapter 3, the sample size comes out at 460 samples which are 131 system users (all system users out of total number of hospital staff) and 329 non system users (randomized from total number of hospital staff). The same number of surveys are distributed and the result of surveys can be summarized for quantitative data as in the table shown below.

Table 4.6 Mean of survey result

Questions	Result from users (N=131)		Results from non-users (N=329)	
	$\bar{X}$	Decode	$\bar{X}$	Decode
1Does object transporting system help speed up medical support service?	4.8	VG	4.6	VG
2Does messenger help speed up medical support service?	3.0	N	3.9	G
3Is object transporting system user friendly?	4.6	VG	3.2	N
4Is on-site service of the systems quick enough?	4.3	VG	3.8	G
5Is level of confidentiality of object sent by systems good?	3.5	G	4.3	VG
6Is level of confidentiality of object sent by messengers good?	4.0	G	4.4	VG
7Is the speed per transaction of transporting objects by systems fast?	4.6	VG	4.8	VG
8Is the speed per transaction of transporting objects by messengers fast?	2.3	**P**	3.6	G
9Is the system accurate (no mis-transporting or errors)?	4.6	VG	2.5	**P**
10Is messenger's performance accurate (no mis-transporting or errors)?	3.6	G	3.7	G

Result Interpretation (Decode)

1.0-1.8 = Very Poor (VP)

1.8-2.6 = Poor (P)

2.6-3.4 = Neutral (N)

3.4-4.2 = Good (G)

4.2-5.0 = Very Good (VG)

The distributed surveys to users and non-users Contain 10 questions which respondents give the answers by scoring 0-5 in each question. Scores are rated as follow:

1 = Very poor
2 = Poor
3 = Neutral
4 = Good
5 = Very good

The score received are used for comparison of transporting object by systems and by messenger. The score mean of 10 questions are put in different 5 levels: very poor, poor, neutral, good and very good as shown in result interpretation below table 4.6. The result show that transporting object by system really helps speed up medical support service more than by messenger. The system provides high accuracy with less error, lost and damage to the object and maintain high confidentiality of the object as well. Moreover, the system operation is not as complicated or difficult as respondent thought. Also, both groups of respondents agreed that speed per transaction of the system is faster than messenger. In case of system error, there is also on-site service for system fixing.

The lowest mean are the result of question 8 and 9. For question 8 system users said that the speed per transaction of transporting objects by messengers is very slow. Sometimes messenger does not go directly to receiver, but he stop by at other points on the way. In contrary, non-system users said that messenger's time consuming is controllable. That is why non-system users prefer to use messengers instead of using systems. For question 9 system users trust in accuracy of the systems and only few lost, damage or errors occur when using systems. On the other hand, non-system users think that errors might occur due to the complication of system operation.

4.2.2 Qualitative Data Analysis

Qualitative data are from personal interview with non-users and current users (frequent users) of each clinic, wards and department which documentations and specimen transport are required.

Frequent users of the systems can be categorized into main

groups as below :

1. Back Office
2. In Patient Department (IPD or Ward)
3. Out Patient Department (OPD) including all Clinics, X-ray and Radiology
4. Lab
5. Pharmacy
6. Central Sterile Supply Department (CSSD) and Medical Supply
7. Medical Record

Table 4.7 Number of Total Staff and Number of System Users

Department/Section	Number of Total Staff	Number of System Users
1. Back Office	365	10
2. In Patient Department (IPD or Wards)	592	30
3. Out Patient Department including all Clinics, X-ray and Radiology	506	50
4. Lab	32	7
5. Pharmacy	50	20
6. Central Sterile Supply Department (CSSD) and Medical Supply	52	10
7. Medical Record	25	4
Total	1622	131

The information received shows most of users prefer to have the system improved due to operation errors. Also, annual system training by system provider is preferable for current users as well as providing user manual in native language for easy usage since mostly system manual is in English and other foreign language except in Thai.

A short and easy system training will be preferable for both non- and currents users. Effective on call service or on-site service are also required.

Quantitative data of this research received by conducting surveys with users and non-users of object transporting systems. The questions in survey for non-users focus on their experience of system usage compare with messenger usage and their opinions of system usefulness and system type preferences. For current users, the questions focus on their comments and opinions of system usage difficulties/problems, their experiences of various types of system, the usefulness and effectiveness of the systems, their suggestions for system improvement and system references.

The information received from surveys, questionnaires and interview show variety of comments and opinions of respondents. Most of non-users do not know about object transferring systems used in hospitals and the benefit of the systems. They are also used to transport items and specimens by messengers and they think it is quite convenient and easy.

Most of the respondents have no willingness to learn to use the new system due to fear of difficulty and complexity usage of the system. They concern of time consuming for system usage training. The user manual provided might be too difficult for self-learning.

Few of non-users concern of high budget for installation and maintenance, especially for governmental hospitals.

For current users, system breakdown and time consumption for maintenance are the most concern. Also, on- site service might not be effective enough in term of adequate of service staff in case many problems occur at the same time.

The issues and occurrences received from both groups of respondents can be summarized in groups as follow:

Points to be concerned of system usage

- Users

- Speed: 1) Concerning of on-site quick service

2) Concerning of maintenance time consumed and parts replacement

- Budget: 1) Might cost a lot of budget for maintenance

2) Concerning of budget worthiness

- Confidentiality: 1) Anyone in the department could get to the transported item easily

- Other: 1) Concerning of system errors

- Non-users

-Speed: 1) Might have to wait if many transactions are in Queue

-Budget:1) High budget for installation and maintenance

-Confidentiality: 1) Concerning of confidentiality of object to be sent

- Other: 1) No time for training

2) Concerning of difficulties of system usage and training

Points to be concerned of messenger usage

Both groups of respondents have same opinions and points to be concerned of transporting object by messenger.

-Speed: Concerning of sending time consumed

-Confidentiality: Concerning of object being sent to wrong receiver

-Other: 1) Sick leave of messengers might cost shortage of manpower

2) Concerning of damage or lost to the objects

3) Not proper of handling method for the object being transported

The errors statistics collected by Engineering Service Department of Siriraj Piyamaharajkarun Hospital shows reduction of errors compare to previous years. This statistics is the results of more efficiency in system usage skill of hospital staffs and better maintenance plan.

Table 4.8 Pneumatic Tubes System Errors Statistics at SiPH in 2014-2015

Month	2014 (No. of Transactions)	2014 (Times of Errors)	2014 (% of errors)	2015 (No. of Transactions)	2015 (Times of Errors)	2015 (% of Errors)
January	36,501	12	0.03%	46,101	21	0.05 %
February	37,102	7	0.02%	47,123	18	0.04 %
March	37,225	18	0.05%	48,003	22	0.05 %
April	36,514	20	0.05%	47,904	29	0.06 %
May	37,021	16	0.04%	47,857	27	0.06 %
June	37,117	15	0.04%	46,861	20	0.04 %
July	38,010	13	0.03%	43,881	26	0.06 %
August	37,996	9	0.02%	48,171	22	0.05 %
September	36,987	14	0.04%	**48,916**	35	**0.07 %**
October	37,024	15	0.04%	44,451	27	0.06 %
November	38,496	12	0.03%	43,110	10	0.02 %
December	38,794	10	0.03%	45,215	17	0.04 %

Pneumatic Tubes System Errors Statistics at SiPH in 2014-2015 shows that the percentage of transaction error occurred between year2014-2015 is less than 1%, which considered very low error statistic. The highest percentage of system errors is 0.07% occurred in September 2015 due to high number of transaction in month and high number of OPD visit and high number of admitted patients as in table 4.9 and 4.10.

Table 4.9 Number of Admitted Patients at SiPH in 2013-2015

From:	2014
To:	2015

Results

2013

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No of AN	427.00	415.00	488.00	450.00	497.00	462.00	531.00	593.00	583.00	569.00	535.00	467.00

2014

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No of AN	599.00	583.00	654.00	623.00	669.00	781.00	781.00	786.00	821.00	809.00	835.00	867.00

2015

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No of AN	960.00	907.00	1,003.00	889.00	1,004.00	1,033.00	1,155.00	1,169.00	1,088.00	1,207.00	1,143.00	1,133.00

Table 4.10 Number of OPD Visits at SiPH in 2013-2015

Parameter(s)

From:	2013
To:	2015

Results

2013

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HN(VN)	10,471.00	9,482.00	11,738.00	11,435.00	13,850.00	14,302.00	16,608.00	17,484.00	18,014.00	18,848.00	17,241.00	15,204.00

2014

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HN(VN)	17,541.00	17,728.00	19,407.00	17,457.00	19,732.00	21,336.00	22,391.00	23,170.00	24,244.00	23,647.00	23,860.00	23,592.00

2015

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HN(VN)	25,252.00	23,880.00	26,989.00	24,391.00	28,299.00	29,302.00	30,426.00	31,285.00	32,333.00	33,497.00	34,443.00	33,497.00

4.3 Comparative System Analysis

Table 4.11 Comparison Table of each system for considerations

Item	Messengers (human)	Pneumatic Tube System	Dumb Waiter	Telelift
Speed (sec./meter)	0.26	0.16	0.23	1.66
Distance (meter)	Depends on job order	Depends on installation	Depends on installation	Depends on installation
Warrantee (year)	0	3	3	2
Maintenance (year/THB)	0	1,348,200 (velcro rings + parts)	240,000	240,000
Expense for system start up	8,040,000 THB (system rental + salary)	1,500,000 THB	-	1,333,506 THB
Comments	Sick leave/not enough staff	Noisy	Vertical only	Obstruction/indoor only/distance & height limit/same floor
Properness	×	✓	Only for some area	×

Note: Calculate by resized the area to 100,000 m^2

4.4 Provisions for considerations

Before deciding to implement the most proper system for each hospital, several provisions should be considered. Provisions for considerations are:

- Annual budget
- Usage area
- Operation speed
- Operation properness
- Population

4.5 Summary for decisions of system implementation for SiPH as a case study of Pneumatic Tubes System and Dumbwaiter Lift user

After the consideration, the comparison table shows that Pneumatic Tubes System is the most proper logistic system for SiPH. The supportive reasons for system installation are:

- Due to a wide spread usage area of SiPH, the system must be installed in every service area which located in every floor except in parking (B1-B3).
- The operation stations must be compact (no obstruction) and installed in or closed to nurse counter or service counter for convenience.
- The operation speed must be fast.
- Minimum risk of broken transferred items.
- Containers or carriers fit for several types of items transferred, including specimen tubes.
- The system can be used for floor-to-floor (indoor) transfer
- The system can be used for building-to-building (outdoor) transfer in case of building expansion in the future.
- Users friendly with training from system provider, user manual, warrantee, after sales service and suitable price.

4.6 Chapter Summary

Implementation of object transporting system is beneficial for medical support services in order to raise customer satisfactions, both internal and external customers and to become more competitive in business field. Several concerns and provisions should be considered carefully. There are several object transporting system which can be used in hospitals. Each hospital should conduct survey to understand trends and needs of customers before choosing the most proper system for hospital. Budget, the ability of the systems, advantages and disadvantages of the systems should be comparatively study as well.

Provisions and points to be concerned which written above can be summarized into quick reference table below :

Table 4.12 Quick reference for proper system choosing

System / Provision	Messenger	Pneumatic Tubes	Dumbwaiter Lift	Telelift/ Telecar
Usage Area	259,630 sq.m.	259,630 sq.m.	259,630 sq.m.	99,553 sq.m.
System Characteristic	Horizontal & Vertical	Horizontal & Vertical	Vertical only	Horizontal only
Budget for System Start Up	8,040,000 THB (system rental + salary)	1,500,000 THB	0 THB (Included in Building Elevator System Start Up)	1,333,506 THB
Maintenance Expense per Year	0 THB (Included in system rental contract)	1,348,200 THB (velcro rings + parts)	240,000 THB	240,000 THB
Warrantee (year)	0	3	3	2
Cost per Transaction	30 THB	4.70 THB	5.28 THB	10.00 THB
Time per Transaction	26 Sec.	16 Sec.	23 Sec.	166 Sec.
Number of Bed	345 beds	345 beds	345 beds	389 beds
Number of Section/Department	7	7	7	7
Level of Confidentiality of Item transported ★ Low ★ Medium ★ High	★	★	★	★
Type of Item Sent	Document/ Specimen/ Medicine	Document/Specimen/	Document/	Document/Specimen

System Provision	Messenger	Pneumatic Tubes	Dumbwaiter Lift	Telelift/ Telecar
		Medicine	Specimen/ Medicine	(except blood)/ Medicine (Tablet only)
Future Expansion of Service	OK	OK	OK	OK
Future Expansion of Building	Inter-Building OK	Inter-Building OK	Inter-Building not suitable	Inter-Building not suitable

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

The research study and its results are described in this chapter. Also, findings and implications, and recommendations are discussed for future research and reference.

5.1 Summary of the Research Study

The purposes of this research were to comparatively study of roles and effects of objects transporting system for improving medical support services in hospital. Also, supportive reasons and provisions for choosing the most proper systems to be installed in a hospital are studied. Many hospitals try to be more competitive and increase customer satisfaction by speed up services providing a one-stop-service or other proper strategy. Introducing any logistic system for transporting items, documents and specimen is one of the innovative ways to improve speed of service.

There are several systems which can be used for transporting items, documents and specimen in hospitals such as Pneumatic Tubes System, Track Vehicle System and Dumbwaiter Lift.

5.2 Discussion

After brain storming with related people, several strength and weakness of each system were pointed out. The most concerning points are:

- Size of the building
- Scope of service of hospitals
- The area for system installation: inside the building, outside the building
- Budget
- Future expansion of hospital building and service
- Layout of service area, clinics, nurse counters and department (distance between each service station or counter)
- Capability for system expansion
- System maintenance
- Users friendliness

- Capability to fulfill customer's need and trend: internal customers, external customers

- Daily amount of confidential objects or documents needed to be transported (amount of transactions)

- Level of confidentiality and policy of transporting them set by hospital

5.3 Conclusions

This research provides fundamental data and information for the 3 systems used in hospital in Thailand to become a supportive research for hospitals where the improvement of medical support service is needed. Object transporting system implementation is one of many innovative ways to help speed up medical support service.

To use or not to use object transporting systems depends on different reasons and decisions. For objects or documents which confidentiality and speed are highly required, nurses or hospital staffs prefer using messenger instead of using the systems. For ordinary objects or medical document and specimen which can be transporting regularly, the systems can fulfill such needs.

5.4 Recommendations

Before making decision for a proper system implementation, some questions should be answered.

- Does it really help with the service? How?
- Is it worth the high budget investment for a hospital?
- Why a hospital should implement such logistic system as Pneumatic Tube System, Track Vehicle System or etc.?
- Any requirements or provisions to choose a proper system?

Also, information of each system should be compared for considerations. Researchers should conduct case study of hospitals where the system is installed in order to study errors, problems and obstructions of system usage. Different type of system matches different size of hospital with different scope of service and lead to different level of customer satisfaction. More than one system can be implemented in a hospital to

reach the highest quality of service and highest level of customer satisfaction.

REFERENCES

Books

Langabeer, J.R. (2008). Health care operations management a quantitative approach to business and logistics. Sudbury, Massachusetts: Jones and Bartlett Publishers.

Articles

Apiwan, T. Thanwadee, C. Natharika, R. Aussadavut, D. (2011). Investigation of Patient and Medicine Flows in Thai Hospitals. *EPPM Singapore,* 157-164

Jennifer, Ouellette. (2011). A Brief history of the pneumatic tube transport system that never were. *Cocktail Party Physics*.

John Victor, Peter. Shalom, Patole. Fleming, Jude Joseph. Ratnasamy, Selvakumar. Patra L., Graham. (2011). Agreement between paired blood gas values in samples transported either by a pneumatic system or by human courier. *Clinical Chemistry and Laboratory Medicine*. 49(8), 1303-1309

Ministry of Health, Bureau of Policy and strategy. (2012). The split-level hospitals.

Worakamol, H. (2010). Logistics and Supply Chain Management in Hospital Industry. *Engineering Today 85.*

Electronic Media

A brief history of Pneumatic Tube Transport. Retrieved October 7, 2015, from http://io9.gizmodo.com/5822028/a-brief-history-of-pneumatic-tube-transport

Aerocom. Retrieved from http://www.aerocom.co.uk/air-tube-applications/ #hospitals

Dumbwaiter. Retrieved December 10, 2015, from https://en.wikipedia.org/

Dumbwaiter. Retrieved from http://www.otis.com/site/eg/OT_DL_ Documents/OT_DL_DownloadCenter/Dumbwaiters/Dumbwaiter %20SKG.pdf
from http://www.olympiathai.com/ products/mhsa/product/

http://library.ra.mahidol.ac.th/archive/catalog.php?idp=469

http://www.siamhitachi.com/directory.asp?pageid=NQ&directory=NjA& parent=MTI&lv=MQ

http://www.swisslog.com/translogic

LEONICS CO.,LTD. (2012). *Hospital Pneumatic Tube System*. Retrieved November 10, 2015, from http://www.leonics.co.th/ hml/th/d_ecp/

Olympia Thai. *Pneumatic Tubes System*. Retrieved November 12, 2015,

Otis. Telelift. *Innovation for Logistic Solutions*. Retrieved November 12, 2015, from http://en.telelift-logistic.com/ pneumatic/ hospital_pneumatic.php

Siriraj Piyamaharajkarun. (2014). *History*. Retrieved September 5, 2015, from http://www.siphhospital.com/en/

Swisslog. *Hospital of the Future White Paper*. Retrieved from www.swisslog.com/-/ media/swisslog/documents

Technical Support and services Co.,Ltd..*Pneumatic Tube Carrier Systems*. Retrieved September 12, 2015, from http://www. technicalsupport.co.th/

Technical Support and services Co.,Ltd..*Telecar*. Retrieved September 12, 2015, from http://www. technicalsupport.co.th/ wiki/Dumbwaiter

Woodford, Chris. (2015). *Pneumatic Tube Transport*. Retrieved December 7, 2015, from http://www.explainthatstuff.com/pneumatic-tube-transport.html

Project Report

Krittapob, S., Weerayuth, B. (2011). *Improving transport documents and blood collection tube logistic system*. Faculty of Engineering KhonKaen University. Project Report No. IE 2011_06.

Thesis

Patchara, K. *Automated guided vehicle system in hospital*. Faculty of Medicine Ramathibodi Hospital, Bangkok.

บุญลือ เทียนทองผาติกุล. (2548), *การวิเคราะห์ต้นทุนธุรกรรมในการใช้บริการอินเตอร์เน็ตแบงก์กิ้ง*. (วิทยานิพนธ์ปริญญามหาบัณฑิต). มหาวิทยาลัยธรรมศาสตร์, กรุงเทพ.

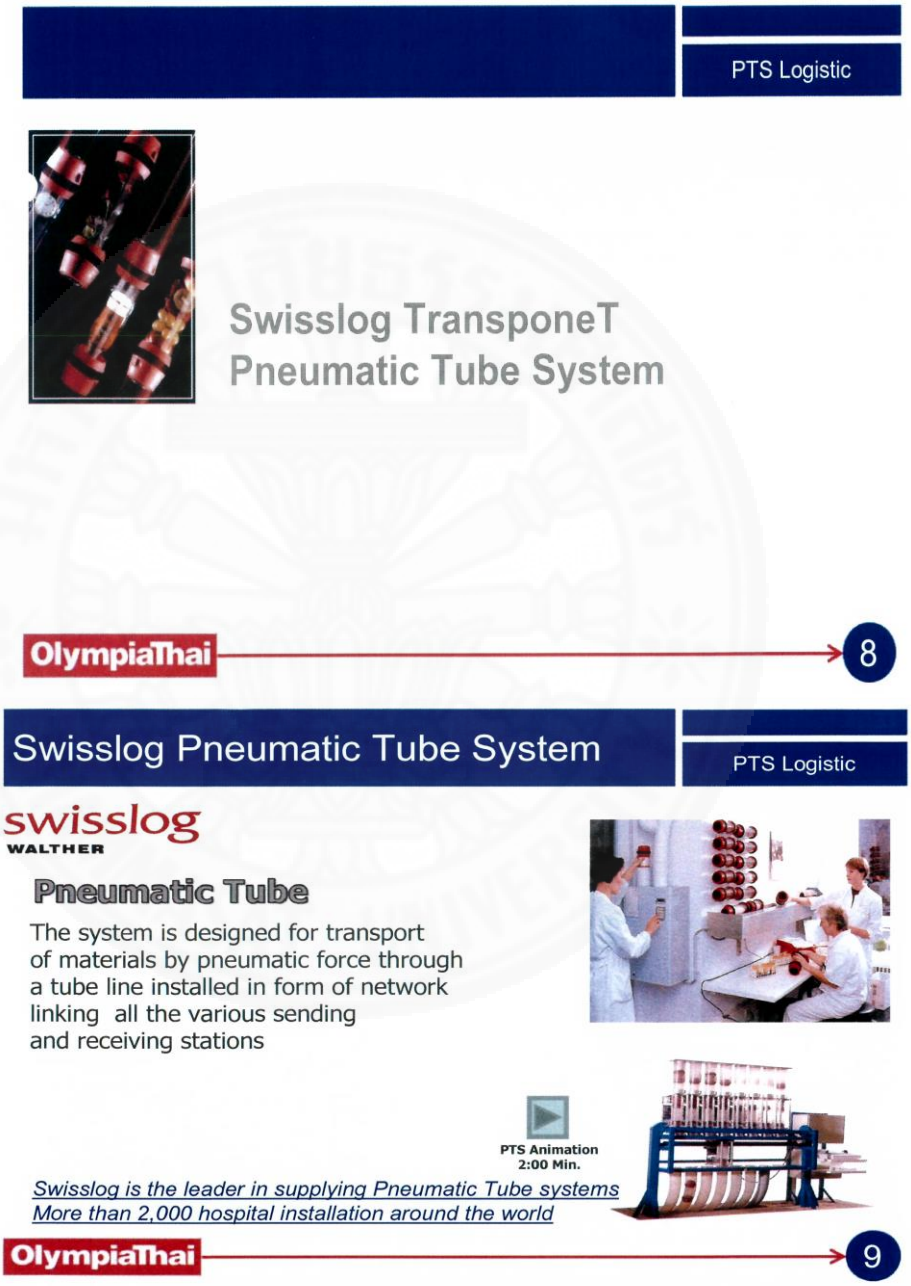
ปวีณ์นุช ขวัญยืน. (2553), *การประยุกต์ใช้แนวคิดการจัดการโลจิสติกส์ในเรื่องเวลาเพื่อวิเคราะห์ความพึงพอใจต่อแผนกผู้ป่วยนอก โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ จังหวัดปทุมธานี*. (วิทยานิพนธ์ปริญญามหาบัณฑิต ไม่ได้ตีพิมพ์). มหาวิทยาลัยแม่ฟ้าหลวง, เชียงราย.

APPENDICES

APPENDIX A

Introduction of object transporting system in hospital

Pneumatic Tube System



Everyday hospital life

PTS Logistic

Transport Items

- Blood samples
- Blood plasma
- Tissue samples
- Prescriptions
- Patient records
- X-Rays
- Documents
- Drugs
- Analysis results
- Other samples

SL-hospital
3:00 Min.

OlympiaThai 1

Proven Reliable Components

PTS Logistic

Carrier

Station

Station

Diverter

PVC Tubing

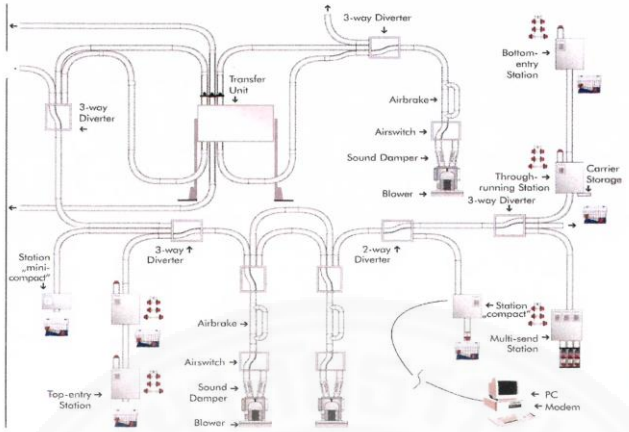
Blower

OlympiaThai 1

Fully PC-Controlled System

PTS Logistic

TRANSPO.NET



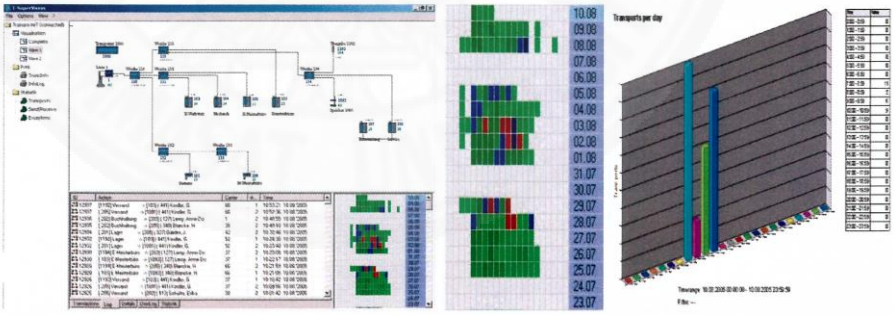
OlympiaThai

1

Advanced Features and Functionality

PTS Logistic

- Monitor, Control and Diagnostic
- Remote Access via LAN, Internet etc. for all the same functions.
- Report Printing for Audit Trail and Tracking.



Graphical Visualisation of Entire System

OlympiaThai

1

MESSENGER

PTS Logistic

- **Sending messages**
  through different communication means [for e.g. : phone]
- **Arrival notification**
  via E-mail [only with MailClient, for e.g. Outlook]
- **Arrival notification**
  via spoken message [only with ISDN]
- **Sending SMS texts**
  to the technician by failure

Personal Arrival Notification !

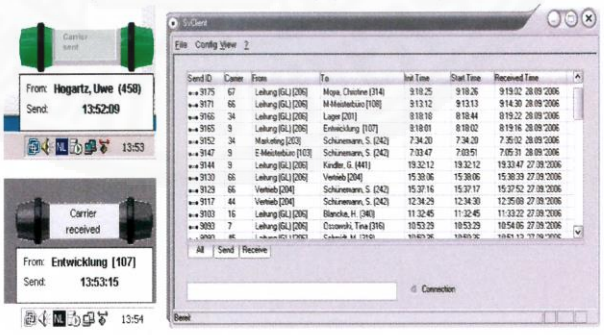
OlympiaThai

1

NetClient – transactions viewing

PTS Logistic

- Lab or Pharmacy can view and trace all transactions.
- Successful carrier dispatching indicated in PC.
- Extra PC for Lab required.
- Connected to hospital's LAN network (by hospital).



OlympiaThai

1

Zero-Error Operation
- No Lost Carriers to Lab

PTS Logistic

- Special TransponeT technology ensures that "Lab-Direct" carriers dispatched from wards, ICUs, OTs, SOCs will go direct to Lab only
- System automatically knows the destination and source of each "Lab-Direct" carriers.
- "Lab-Direct" carrier placed at station is automatically send to the Lab…no key-in of destination required...hence reduced possible human error

Guaranteed delivery of blood and specimens to Lab

OlympiaThai → 1

Telecar/Telelift

ETV Unicar

Swisslog Telelift Unicar[10] Track Transport System

OlympiaThai → 2

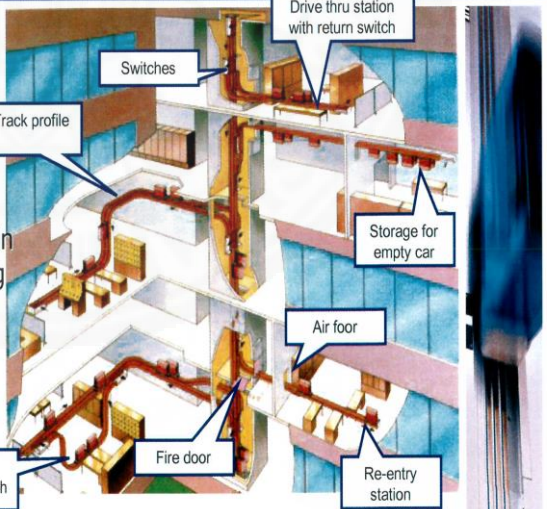
Telelift Unicar
– world's leader in track transport system

ETV Unicar

swisslog
TELELIFT

Unicar 10

The system provides a wide range of transport flexibility in a car running on track linking together the sending and receiving stations at different locations



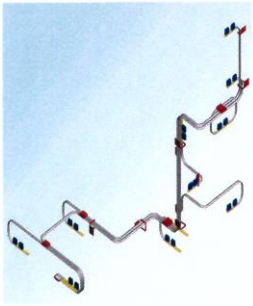
Since 1964, with more than 1,500 systems installed around the world

OlympiaThai → 3

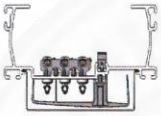
Unicar 10 – Components

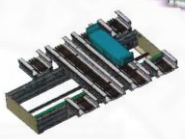
ETV Unicar

- Straight track profile
- curves
- bends
- switches
- self propelled containers
- fire shutters
- dezentralised storages for empty containers
- drive through stations
- reentry stations
- dezentralised control system



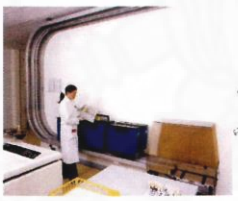
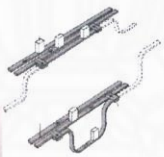
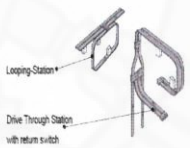




OlympiaThai

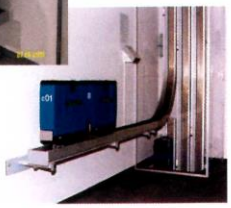
Variety of Stations

ETV Unicar


Through Station



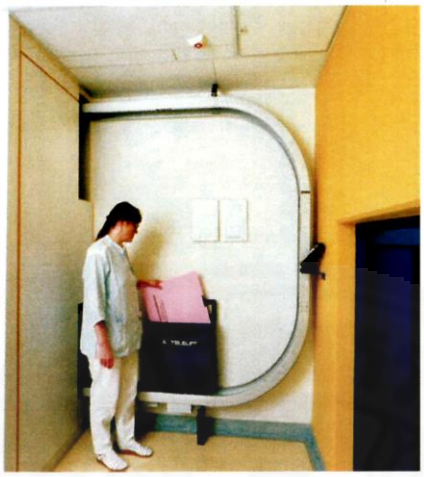



Auto Drop stations

OlympiaThai

Re-Entry Station & Storage

ETV Unicar



OlympiaThai 3

Through Stations – for high throughput

ETV Unicar

OlympiaThai 3

Variety of Choices in Layout

ETV Unicar

OlympiaThai 3

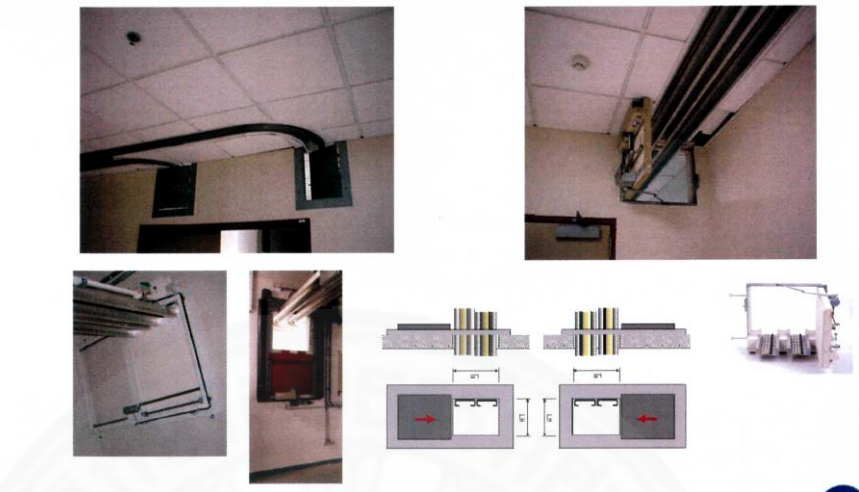
Main Track & Switch

ETV Unicar

OlympiaThai 3

Air Flap, Air Door, Fire Door

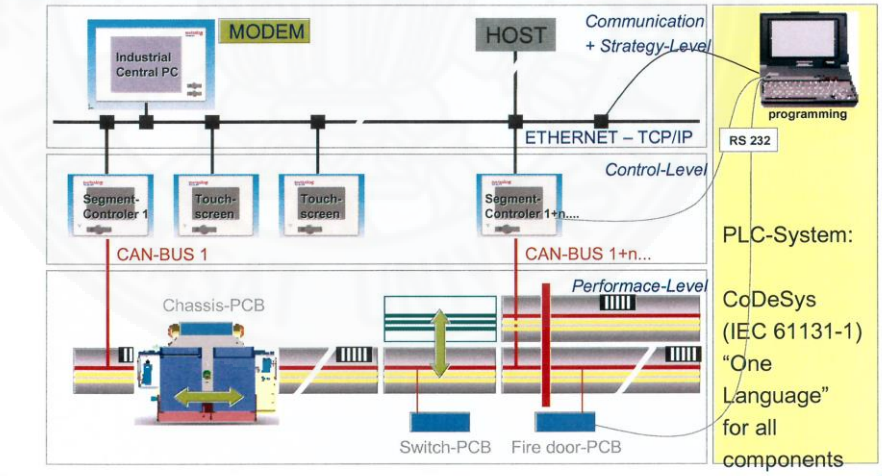
ETV Unicar



OlympiaThai 3

TELEcontrol - advanced control technology

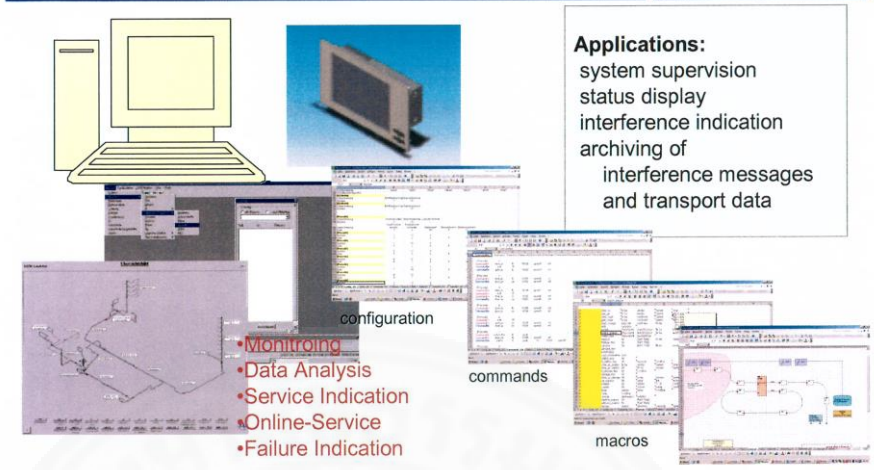
ETV Unicar



OlympiaThai 3

TELE*control* - Central Supervision

ETV Unicar



Applications:
system supervision
status display
interference indication
archiving of
interference messages
and transport data

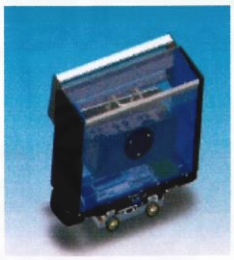
- Monitoring
- Data Analysis
- Service Indication
- Online-Service
- Failure Indication

OlympiaThai

3

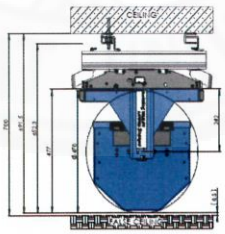
Designed Containers for Hospital use

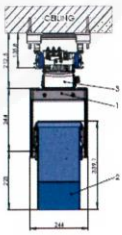
ETV Unicar

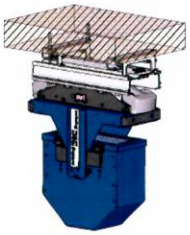


Pendulum-
Inside-Container

Type H175.



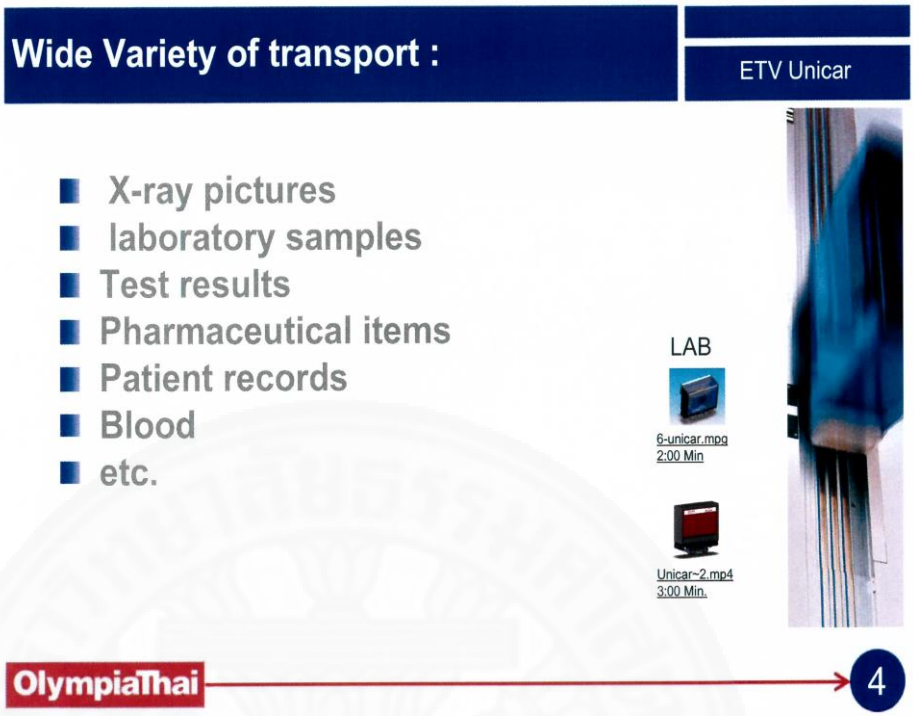




Type H175 :Payload 10 kg L480xW175xH400mm.

OlympiaThai

4



Dumbwaiter

DUMBWAITER *

Restaurants, hotels, offices, banks, archives, information centers, hospitals, clinics, retirement homes, industrial premises, laboratories, supermarkets, shops, private houses, cellars.

Otis' Dumbwaiter range covers a host of applications and is capable of transporting items as diverse as packages, plates and crates.

Compact in design, the service-elevator is also extremely robust and as such is noted for its reliability. Two door types are available – swing and bi-parting – and there are shelf loading and floor loading options. All models within the range are supplied with a self-supporting, steel modular pylone on which equipment is pre-mounted.

* Complies with the machine directive n°89/392/EU

Specifications

Capacity

- 50 kg, 100 kg, 200 kg, 300 kg.

Motor

- Electric.
- Machine above.

Car and doors

- Galvanised steel sheet finish.
- Flameproof doors.
- Door opening (height and width) exactly corresponding to interior car dimensions.

Self-supporting hoistway

- Galvanized steel finish.
- Modular design with pre-mounted equipment.
- Pylone cladding in masonry or steel sheet.

Main Options

- Stainless steel finish.
- Movable shelving.
- Car lighting.
- Overload device.
- Car safety device.
- Car door.
- Machine below or on side.
- Corner post arrangement.
- Entrances on 3 sides.
- Heating of intermediate shelves.
- Automatic doors.
- Automatic loading and unloading for 50 kg loads

Standard models

Load	Landing doors		Speed	Car dimensions by 25 mm increments		Car modular	Hoistway dimensions (mm)	
kg	Type	Height H (mm)	(m/s)	CW	CD	increments CW, CD, HW	HW	HD
50	Bi-parting shelf loading	600 to 800	0,4	400 to 600	400 to 1000	25 mm	CW + 300	CD + 150
100	Bi-parting shelf loading or floor loading	600 to 800	0,4	400 to 1000	400 to 1000	25 mm	CW + 300	CD + 150
	Swing floor loading	800 to 1200	0,27	500 to 1000	600 to 1000	25 mm	CW + 350	CD + 150
200 and 300	Bi-parting shelf loading or floor loading	600 to 800	0,25	400 to 1000	400 to 1000	25 mm	CW + 300	CD + 150
	Swing floor loading	800 to 1200	0,25	500 to 1000	600 to 1000	25 mm	CW + 350	CD + 150

APPENDIX B
Research Questionnaires

Hospital Staff Opinions and Satisfaction of medical logistic

(Users)

Objective : This questionnaire is to collect information, opinions and comments of respondents about object transporting system in hospital in order to analyze and compare preferences between transporting by system and by messengers.

Directions : Please provide the following information either filling in the data or by putting ✓ in ☐ that corresponds to your respond

---

Part I Personal Profile

1. Gender ☐ Male ☐ Female
2. Age ……..Years …….. Months
3. Education ☐ High school
   ☐ Vocational certificate
   ☐ Bachelor degree
   ☐ Master degree
   ☐ Others (please specify)
   ……
   …..
4. Name of hospital
   ……
   ……..
5. Department of work :
   ……..
   ☐ Front of the House
   ☐ Back of the House

6. Your job position (please specify)

   ……

   ☐ Medical Staff

   ☐ General Staff

7. Years of work ……Years……Months

Part II Instructions : Please place a checkmark (✓) to rate how much the statement represents your perceptions.
0 = Unable to rate, 1 = Very poor, 2 = Poor, 3 = Neutral, 4 = Good, 5 = Very good

Statements	0	1	2	3	4	5
1. Does object transporting system help speed up medical support service?						
▪ Registration process						
▪ Triage process						
▪ Examination/consultation process						
▪ Lab process						
▪ Medical documentation process						
▪ Cashier/payment process						
▪ Pharmacy process						
2. Does messenger help speed up medical support service?						
▪ Registration process						
▪ Triage process						
▪ Examination/consultation process						
▪ Lab process						
▪ Medical documentation process						
▪ Cashier/payment process						
▪ Pharmacy process						
3. Is object transporting system user friendly?						
4. Is on-site service of the systems quick enough?						
5. Is level of confidentiality of object sent by systems good?						
6. Is level of confidentiality of object sent by messengers good?						

Statements	0	1	2	3	4	5
7. Is the speed per transaction of transporting objects by systems fast?						
8. Is the speed per transaction of transporting objects by messengers fast?						
9. Is the system accurate (no mis-transporting or errors)?						
10. Is messenger's performance accurate (no mis-transporting or errors)?						

Part III Instructions : Please provide your answers related to questions given below.

1. Have you ever seen or experienced any object transferring systems?
   ☐ Yes ☐ No
2. If seen of experienced, what type?
   ☐ By men (Messenger) ☐ By machine
3. What do you think the system used for? (For what type of service?)
   ☐ All types of Medical support service
   ☐ For office use
   ☐ Sending only documents
   ☐ Do not know
4. How useful is the system in your opinion?
   ☐ Speed up services ☐ Easy to use
   ☐ Track back easily ☐ Reduce mishandling, damage and lost of items
5. What type of the systems would you prefer?
   ☐ Messengers ☐ Track Vehicle System
   ☐ Pneumatic Tubes System ☐ Dumbwaiter

Hospital Staff Opinions and Satisfaction of medical logistic
(Non-Users)

Objective : This questionnaire is to collect information, opinions and comments of respondents about object transporting system in hospital in order to analyze and compare preferences between transporting by system and by messengers.

Directions : Please provide the following information either filling in the data or by putting ✓ in ☐ that corresponds to your respond

---

Part I Personal Profile

1. Gender ☐ Male ☐ Female
2. Age ……..Years …….. Months
3. Education ☐ High school
   ☐ Vocational certificate
   ☐ Bachelor degree
   ☐ Master degree
   ☐ Others (please specify)
   ……
   …..
4. Name of hospital
   ……
   ……..
5. Department of work :
   ……..
   ☐ Front of the House
   ☐ Back of the House
6. Your job position (please specify)
   ……
   ……..
   ☐ Medical Staff
   ☐ General Staff
7. Years of work
   ……Years……Months

Part II Instructions : Please place a checkmark (✓) to rate how much the statement represents your perceptions.
0 = Unable to rate, 1 = Very poor, 2 = Poor, 3 = Neutral, 4 = Good, 5 = Very good

Statements	0	1	2	3	4	5
1. Does object transporting system help speed up medical support service?						
▪ Registration process						
▪ Triage process						
▪ Examination/consultation process						
▪ Lab process						
▪ Medical documentation process						
▪ Cashier/payment process						
▪ Pharmacy process						
2. Does messenger help speed up medical support service?						
▪ Registration process						
▪ Triage process						
▪ Examination/consultation process						
▪ Lab process						
▪ Medical documentation process						
▪ Cashier/payment process						
▪ Pharmacy process						
3. Is object transporting system user friendly?						
4. Is on-site service of the systems quick enough?						
5. Is level of confidentiality of object sent by systems good?						
6. Is level of confidentiality of object sent by messengers good?						
7. Is the speed per transaction of transporting objects by systems fast?						

Statements	0	1	2	3	4	5
8. Is the speed per transaction of transporting objects by messengers fast?						
9. Is the system accurate (no mis-transporting or errors)?						
10. Is messenger's performance accurate (no mis-transporting or errors)?						

Part III Instructions : Please provide your comments and opinions related to questions given below.

Question 1 : At hospital you work for, how is the logistic system? What type of the logistic system is being used?

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Question 2 : How does the system help with services? Please specify.

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Question 3 : Is the system useful in your opinion? If no, please clarify.

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Question 4 : What is your preferable for logistic system in the hospital?

☐ By men

☐ By machine

Question 5 : Why is that? Please explain.

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Question 6 : Have you experienced any problems or difficulties transfer items or documents by men?

☐ Yes

(please explain)……

☐ No

Question 7: Have you experienced any problems or difficulties transfer items or documents by machine?

☐ Yes

(please explain)……

☐ No

Any comments or suggestions for improvement of recently used system? (Convenient, satisfied or need improvement?)

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BIOGRAPHY

Name	Boontarika Kietburanakul
Date of Birth	June 8, 1976
Educational Attainment	1993 : Bachelor of Arts
Work Position	Executive Secretary Siriraj Piyamaharajkarun Hospital
Work Experiences	2011 until present Executive Secretary at Siriraj Piyamaharajkarun Hospital 2010 – 2011 Freelance English Teacher 2000 – 2010 Cabin Attendant (Supervisor) at Japan Airlines