Original Article

Comparative study of the roles and effects of objects transporting system for effectiveness medical support services in hospital

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Abstract

Introduction: 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 was to study problems, issues, benefit and usefulness of objects transporting system usage compare with using messenger.

Method: The data for this research was collected by conducting surveys, questionnaire and interview with system users and non-system users out of 460 samples from main 7 departments of 2 medical school hospitals (131 system users and 329 non-system users). The first hospital has an area of 259,630 sq.m. and was a case study for Pneumatic Tube System and Dumbwaiter, and another medical school hospital with an area of 99,553 sq.m. was a case study for Telelift/Telecar. The data of surveys and interview were used for advantages and disadvantages of the systems usage analyzing. Another part of data were collected from monthly report of system usage and used for system errors and effectiveness analyzing. Also, technical information received from system providers were used for comparison of each system.

Result: The result of survey showed that transporting object by system really helped speed up medical support service more than messenger and also provided high accuracy with less error, lost and damage to the object and maintain high confidentiality of the object. Moreover, user friendliness was another benefit of the system. Both groups of respondents agreed that speed per transaction of the system was faster than messenger.

Discussion and Conclusion: The 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. Tables provided in this research can be used as a quick reference for proper system choosing and reduce time to collect new information of each system. Users can simply look up for comparative technical data, cost per transaction, startup cost for system installation and advantages/disadvantages of 3 systems used in hospitals in Thailand as a sample before investing for system installation.

Key words: Time management, Speed up the service, Object transporting system, Supportive data, The most proper system

Received: 21 August 2017 **Accepted: 24 October 2017**

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Introduction

In the past, 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. 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 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.

The purposes of this research were to comparatively study of the evolution of various types of objects transporting systems used in hospital and explore the variable effects of the systems for improving medical support services in hospital. Also, problems and issues of the system usage, supportive reasons and provisions, factors for considerations, benefit and usefulness for choosing the most proper systems to be installed in a hospital are studied.

Method

This study considered as a feasibility study used both qualitative and quantitative data. The basic assumption of this study was to collect technical information from systems providers, interview and conduct survey by questionnaire asking about hospital staff experience and opinion comparing between transporting documents and specimens by man and by object transporting system.

SWOT analysis model was used for comparison of strengths, weaknesses, opportunities and threats of 3 object transporting systems, Pneumatic Tube System, Dumbwaiter Lift and Telecar/Telelift, which could be implemented in hospitals.

The results received from interview about using messengers led to the usage of Fishbone Diagram to identify causes and effects of main problems of transporting objects by messenger.

Causes were 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 was performed

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

Distributing surveys and questionnaires was one of methods to collect information and opinions from users and non-users of object transporting system in the hospitals. The total number of hospital staff was 1,622 people. By calculating for sample size with Yamane’s formula, the result of this formula comes out at 460 samples from main 7 departments (131 system users and 329 non-system users). 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 became 460.The collected information was used for solutions finding for main problems and comparison.

Result

From documentary information of 3 object transporting systems provided by system providers combined with a comparative study, the advantages and disadvantages of each system were summarized in Table 1.

Table 1 Comparison Table of advantages and disadvantages of each system

Type of Logistic	Advantages	Disadvantages
• **Pneumatic Tube Systems**	1. Save time, energy and labor 2. Personalized 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. Complicated 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 personalized design 5. Stable movement 6. Quiet and flexible operation 7. Easy in maintenance 8. Recordable transfer statistic 9. Easy to track back 10. Reduce human errors	1. Small weight capacity 2. Inconvenient of station location 3. Used inside buildings only 4. High budget
• **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 occurred frequently in medical support service was the delay of service. After conducting surveys and feature interview, it was found that transporting object by messenger caused more delay than by object transporting system. Then Fishbone Diagram was used to analyze data received for root causes of object transporting by messengers for a comparative study with other systems. By using fishbone diagram, the study showed that previously used method to transfer objects by messengers caused the delay of medical service and can be explained as follow and as in diagram 1.

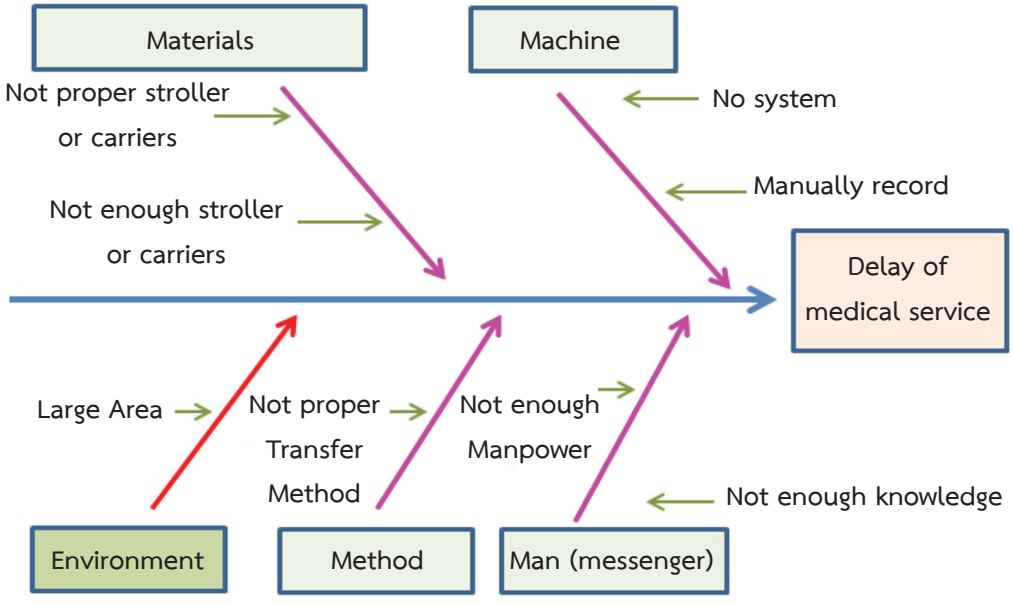

Diagram 1 Fishbone Diagram showed causes and effects of delay of medical service in hospital

Man: Messengers did not have enough knowledge. Most of the messengers had low educational qualification.

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

Materials: Messengers mostly used small strollers or small carriers. Frequency of transferring varied by amount of items. The more amount of items transferred, the longer time and more often walking round would be.

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

Environment: Large and complex area caused time consumption when transferring items by walking.

Every system was compared technically, including using messenger shown in Table 2. Also, time per transaction of each system including using messenger was comparatively studied and shown in table 3. It showed that the fastest object transporting system was Pneumatic Tubes System, which was 38.46% faster than transporting items by messenger. The most time consuming system was transporting items by Telelift/Telecar, which was 538% slower than transporting items by messenger. Not only that, cost per transaction was also calculated for comparison. Table 4 showed that Pneumatic Tubes System was the cheapest object transporting system, calculated by cost per one transaction and compared to transporting items by messenger, and was 84.33% cheaper. A sample calculation of price per transaction of Pneumatic Tubes System comes from:

① Maintenance Cost per year = 1,500,000.00 THB
② Electricity Consumption = 5.5 Unit/hour
③ Electricity Cost = 4.00 THB/Unit
④ Electricity Cost per hour = ②X③
⑤ Amount of Transaction per year = 360,000 Times
⑥ Hours per year = 24 hours X 365 days
= 8,760 hours per year
⑦ Amount of Transaction per hour $= \frac{⑤}{⑥}$
⑧ Maintenance Cost per Transaction $= \frac{①}{⑤}$
⑨ Cost per Transaction $= \frac{④+⑧}{⑦}$

For transporting object by messenger, there was a fix rate per transaction of 30 THB, excluding messenger's salary and other monthly benefit plus annual system rental cost as shown in table 2.

Table 2 Comparison Table of each system for considerations

Items	Messengers (human)	Pneumatic Tube System	Dumb Waiter	Telelift/Telecar
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	240,000	240,000
Expense (year/THB)	8,040,000 (system rental + salary)	1,500,000 (velcro rings + parts)	-	1,333,506
Comments	Sick leave/not enough staff	Noisy	Vertical only	Obstruction/indoor only/distance & height limit/same floor
Properness	X	✓	Only for some area	X

* Remark: Calculated by resized the area to 100,000 m^2

Table 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%

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

Table 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%

After the calculation of sample size, the same number of surveys were distributed (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) and the result of surveys was summarized for quantitative data as in table 5.

Table 5 Mean of survey result

Questions	Result from users (N=131)		Results from non-users (N=329)	
	X	Decode	X	Decode
1. Does object transporting system help speed up medical support service?	4.8	VG	4.6	VG
2. Does messenger help speed up medical support service?	3.0	N	3.9	G
3. Is object transporting system user friendly?	4.6	VG	3.2	N
4. Is on-site service of the systems quick enough?	4.3	VG	3.8	G
5. Is level of confidentiality of object sent by systems good?	3.5	G	4.3	VG
6. Is level of confidentiality of object sent by messengers good?	4.0	G	4.4	VG
7. Is the speed per transaction of transporting objects by systems fast?	4.6	VG	4.8	VG
8. Is the speed per transaction of transporting objects by messengers fast?	2.3	P	3.6	G
9. Is the system accurate (no mis-transporting or errors)?	4.6	VG	2.5	P
10. Is 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 information received from surveys, questionnaires and interview showed variety of comments and opinions of respondents. Most of non-users did not know about object transferring systems used in hospitals and the benefit of the systems. They were also used to transport items and specimens by messengers and they thought it was quite convenient and easy.

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

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

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

Discussion and Conclusion

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 systems 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 as in table 6.

Table 6 Quick reference for proper system choosing

Provisions \ Systems	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

Table 6 Quick reference for proper system choosing

Systems / Provisions	Messenger	Pneumatic Tubes	Dumbwaiter Lift	Telelift/Telecar
Level of Confidentiality of Item transported ★ Low ★ Medium ★ High	★ High	★ Medium	★ Low	★ Low
Type of Item Sent	Document/ Specimen/ Medicine	Document/ Specimen/ Medicine	Document/ Specimen (except blood)/ Medicine (Tablet only)	Document/
Future Expansion of Service	OK	OK	OK	OK
Future Expansion of Building	Inter-Building OK	Inter-Building OK not suitable	Inter-Building not suitable	Inter-Building

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

To use or not to use object transporting systems depends on difference 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.

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.

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บทคัดย่อ

การศึกษาเชิงเปรียบเทียบบทบาทและประโยชน์ของระบบขนส่งสิ่งของต่อประสิทธิภาพการบริการสุขภาพในโรงพยาบาล

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** ฝ่ายบริหารอาคารและวิศวกรรมเครื่องมือแพทย์ โรงพยาบาลศิริราช ปิยมหาราชการุณย์

บทนำ: การบริหารจัดการเวลาเป็นสิ่งที่สำคัญมากในการให้บริการสุขภาพ โดยเฉพาะอย่างยิ่งในการให้บริการในสถานพยาบาลหรือโรงพยาบาล ในการมาใช้บริการที่โรงพยาบาลแต่ละครั้ง ผู้ป่วยจะต้องใช้เวลาค่อนข้างนาน ตั้งแต่เริ่มรับบริการในจุดแรกจนเสร็จสิ้นขั้นตอนการตรวจ เทคโนโลยีและนวัตกรรมใหม่ๆ จึงถูกนำมาใช้ในโรงพยาบาลและการให้บริการทางการแพทย์ เพื่อลดระยะเวลาของกระบวนการตรวจรักษา เช่น ระยะเวลาในการส่งต่อเอกสารทางการแพทย์และสิ่งส่งตรวจทางการแพทย์ต่างๆ ที่ในอดีตมักถูกส่งต่อโดยพนักงานส่งเอกสาร

วิธีการศึกษา: ศึกษาและเปรียบเทียบปัญหา ประเด็นต่างๆ ประโยชน์ และความคุ้มค่าในการใช้งาน ระหว่างการส่งต่อเอกสารทางการแพทย์และสิ่งส่งตรวจทางการแพทย์โดยพนักงานส่งเอกสารกับการส่งโดยระบบ ทำการเก็บข้อมูลโดยการสัมภาษณ์และแจกแบบสอบถามให้กับกลุ่มตัวอย่างจำนวน ๔๖๐ ตัวอย่าง จากเจ้าหน้าที่โรงพยาบาลของโรงเรียนแพทย์ ๒ แห่ง ที่มีการติดตั้งและใช้งานระบบขนส่งสิ่งของภายในโรงพยาบาล ซึ่งกลุ่มตัวอย่างแบ่งเป็นผู้ที่ใช้งานระบบส่งสิ่งของจำนวน ๑๓๑ ตัวอย่าง และผู้ใช้การส่งสิ่งของโดยพนักงานส่งของ จำนวน ๓๒๙ ตัวอย่าง นอกจากนี้ ยังมีการนำข้อมูลจากรายงานการใช้งานประจำเดือนและข้อมูลด้านเทคนิคของแต่ละระบบมาใช้ในการวิเคราะห์ข้อดีข้อเสียและประสิทธิภาพของระบบแต่ละระบบด้วย

ผลการศึกษา: การขนส่งเอกสารทางการแพทย์และสิ่งส่งตรวจทางการแพทย์ด้วยระบบขนส่ง ทำให้ลดระยะเวลาการให้บริการทางการแพทย์ได้มากกว่าการส่งด้วยพนักงานส่งของ อีกทั้งยังเกิดข้อผิดพลาดและความเสียหายระหว่างการขนส่งน้อยกว่า และยังเก็บรักษาข้อมูลความลับของผู้ป่วยได้เป็นอย่างดี และระบบยังใช้งานง่าย จากการสัมภาษณ์และเก็บข้อมูลพบว่ากลุ่มตัวอย่างทั้งสองกลุ่มเห็นพ้องกันว่าการส่งเอกสารทางการแพทย์และสิ่งส่งตรวจต่างๆ ผ่านระบบ มีความรวดเร็วกว่าการส่งด้วยพนักงาน ทว่า มีผู้ใช้งานบางท่านเห็นว่าแม้การส่งเอกสารและสิ่งส่งตรวจโดยพนักงานจะช้ากว่าการส่งโดยระบบ แต่หน่วยงานสามารถควบคุมการปฏิบัติของพนักงานส่งของได้

วิจารณ์ และสรุปผลการศึกษา: การติดตั้งระบบส่งเอกสารและสิ่งส่งตรวจเป็นประโยชน์อย่างมากต่อการให้บริการทางการแพทย์ หากแต่ยังมีปัจจัยหลายอย่างที่ควรพิจารณาก่อนการติดตั้งระบบ เพื่อเลือกใช้ระบบที่มีประสิทธิภาพสูงสุดและเหมาะสมต่อการใช้งานมากที่สุด ข้อมูลและผลที่ได้รับจากการศึกษานี้ สามารถนำมาเป็นข้อมูลสนับสนุน สำหรับโรงพยาบาลเปิดใหม่และโรงพยาบาลอื่นๆ เพื่อประกอบการพิจารณาคัดเลือกระบบที่เหมาะสมและคุ้มทุน

คำสำคัญ: การบริหารจัดการเวลา, ความรวดเร็วในการให้บริการ, ระบบส่งเอกสารและสิ่งส่งตรวจทางการแพทย์, ข้อมูลสนับสนุน, ระบบที่เหมาะสมที่สุด