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Exploring Constraints in Logistics Operations of Public Hospitals in Mountainous Areas of Northern Thailand

Narat Hasachoo, D.Eng.[1], Pornwasin Sirisawat, D.Eng.[1], Tipavinee Suwanwong Rodbundith, Ph.D.[1], Nattaphon Rangsaritvorakarn, M.B.A.[1]

[1]Healthcare Logistics Management Research Center (HLog), School of Management, Mae Fah Luang University, Chiang Rai 57100, Thailand

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Abstract:

Background: Thai public hospitals in highland rural areas are experiencing difficulties in logistics operations due to the mountainous geography and scarcity of resources compared to hospitals in the city center.

Objective: This paper aims to explore the constraints in logistics operations that Thai public hospitals located in rural mountainous areas are experiencing.

Materials and Method: A qualitative study using 3 case study hospitals from three highland border cities in northern Thailand was conducted in this study. The onsite observation and interviews were conducted at the hospital to explore operational constraints in seven logistics activities based on the framework of the World Health Organization.

Results: All sample hospitals have no centralized logistics coordination system, while I.T. systems cannot integrate the data between front and back-office systems. The inventory system of all hospitals cannot access the actual use rate of medicines and medical supplies. The systematic forecasting procedure of future consumption and the warehouse storage system does not exist. Lastly, transportation operations are faced with long driving times on dangerous roads, and there is a risk of landslides when servicing patients' referral systems to the urban hospital.

Conclusion: The result of this paper is an initial step in an attempt to reduce the gap between populations in the rural-urban quality of life through better hospital operations by exploring and understanding constraints experienced by mountainous public hospitals.

Keywords: Hospital logistics, Hospital management, Mountainous, Rural

Corresponding author: Narat Hasachoo, D.Eng.
Healthcare Logistics Management Research Center (HLog), School of Management,
Mae Fah Luang University, Chiang Rai 57100, Thailand
E-mail: narat.has@mfu.ac.th

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Introduction

The geography of the northern region is different from that of other areas of Thailand. It's mostly a mountainous highland area and is bordered by two neighboring countries: Myanmar and Laos PDR. Although the Universal Cover Scheme (UCS) was introduced in Thailand in 2002 as a social health insurance program, making most services at public hospitals free of charge, aiming at an equal chance of having the same healthcare standard across the country[1], the rural-urban inequality still found existing in various aspect.[2-3]

A number of papers focus their study on an inequality between rural and urban hospitals.[4-6] However, finding what difficulties public hospitals in mountainous rural areas, which is the shared geography of Thailand border cities in the north, are experiencing due to their location context receive less attention from researchers, especially in the area of hospital logistics operations.

Hospital logistics operations are defined as activities that enable purchasing, inventory management, and replenishment of goods and services surrounding medical services to patients[7], ensuring resource availability at any treatment place.[8] In short, the hospital logistics system helps ensure that its clinical services are always available for patients by efficiently managing all related hospital operations.

Hospital logistics systems are embedded in entire hospital operations, making it even more challenging to scope which operations should be included in this paper. A previous study has highlighted the inefficiency of Thai public hospitals' logistics operations.[9] Later, the study was extended and found that public hospitals in Thailand still rely on manual information exchange processes, causing slow and inaccurate data exchange in the supply chain.[10]

A study of the hospital logistics framework[11] states that the hospital has two primary operations. Firstly, clinical care services are a core treatment process by medical professionals, including physicians and nurses. Secondly, non-clinical services include support services, such as management of medicines and medical supplies, and administration services, such as purchasing management, information technology, transportation services, etc. Being a hospital in mountainous rural areas makes it even more challenging for the logistics system to ensure all non-clinical services will always be available for clinical services with the highest patient safety requirements.

Therefore, this paper is the first step in an attempt to reduce the gap between populations in the rural-urban quality of life through better hospital operations. The objective is to explore and understand what constraints in hospital logistics operations of Thai public hospitals in mountainous areas are experiencing. Although this paper did not develop a novel methodology, it is only a qualitative exploration with in-depth interviews and onsite observation. Still, the result is a body of knowledge that will help point out the actual constraints of public hospitals in mountainous areas for future studies.

Methodology

This paper has reviewed an international standard and found a standard developed by the World Health Organization called Hospital Readiness Checklist for COVID-19.[12] This standard has been used in many papers.[13-15] Although it's not a dedicated guidebook only for hospital logistics operations, we found it's capable of being our framework for assessment since *hospital logistics* is one of the modules in that guidebook. It comprises seven sub-operations, which will be used as a scope of study in this paper.

The operation guidelines in each scope are as follows;

1) Logistics coordination: the hospital is recommended to designate a coordination system that can ensure a mechanism for prompt internal and external transportation services, prompt maintenance and repair services of medical equipment, and prompt services for purchasing and refilling supplies.

2) I.T.: Hospitals should be able to maintain an updated inventory of all equipment, supplies, and pharmaceuticals. Establish a shortage alert and reordering mechanism.

3) Inventory management: Hospitals should have a clear inventory policy to ensure the timely use of inventory and avoid loss from expiration.

4) Forecasting: the hospital is advised to estimate the consumption of essential equipment, supplies, and pharmaceuticals.

5) Purchasing: The hospital is advised to use an effective purchasing system to ensure prompt delivery of suppliers.

6) Storage: the hospitals must identify the physical space within the hospital for storage and ensure effective operations to guarantee the availability of essential items under storage conditions.

7) Transportation: In the recommended action of the guidebook, hospitals must ensure an effective transport system for patients and supplies in both intra-hospitals and inter-hospitals.

Study Participants and Procedure

This paper selected three mountainous rural district hospitals (also known as small community hospitals) from 3 border cities in northern Thailand to be a case study hospital. The characteristics of each hospital are as follows: **Hospital 1** has a bed capacity of 30 beds with four full-time doctors (three interns and one specialist who also works as hospital director), located in a highland agricultural district with a distance of 2.5 hours of driving time far from the city center at the altitude of 750 meters above sea level. **Hospital 2** has a bed capacity of 20 beds with three full-time doctors (two interns and one specialist who also works as hospital director), located in a highland forestry district with 3 hours of driving time far from the city center, at an altitude of 950 meters above sea level. **Hospital 3** has a bed capacity of 20 beds with three full-time doctors (two interns and one specialist who also works as hospital director), located in a mountainous travel-destination district with 2 hours of driving time far from the city center, at an altitude of 730 meters above sea level. All hospitals have an average of 250 outpatients per day.

The research team communicates with the hospitals through an official email containing research details and asks permission to conduct this research. After that, request a hospital representative experienced with hospital logistics operations from the predetermined questions included in the official letter who is willing to participate in an interview. Finally, the research team communicated and verified their positions and voluntary participation via authorized hospital contact details.

Data Collection and Analysis

The data were collected from interviews with each hospital representative (including the director of the administration department, director of pharmacy, director of nursing, and director of the I.T. department) conducted in January 2023 using an open-ended question on constraints they are experiencing in seven areas of their hospital logistics operations as scoped by WHO's guidebook. The interviews were conducted onsite, face-to-face, at the hospital, and took about 90 minutes per hospital. Hospitals were asked to explain each operation's details and the difficulties experienced when

performing them. Secondly, the onsite observation at the hospital with selected representatives was also conducted to validate and confirm the information collected from the first step, which took another 60-120 minutes per hospital. The interviews were recorded digitally and transcribed verbatim. All researchers with previous qualitative research experience brainstormed and carefully discussed the interview results by comparing them with the recommended guidelines by WHO. Lastly, the results were verified with each hospital representative as per the data validation process.

Results

Table 1 The result of constraints found in each operation

Operations	Constraints
1. Logistics Coordination	- No designated person in the organization chart - Unclear roles in hospital logistics operations
2. I.T.	- No staff with software development skill - The back-office is not integrated with the hospital's primary operations system
3. Inventory management	- Unable to access the actual use rate
4. Forecasting	- Systematic forecasting procedure has not existed
5. Purchasing	- Location constraints make vendors lose interest in bidding - Location constraints make longer purchasing lead time
6. Storage	- No systematic storage system
7. Transportation	- Location constraints make a referral system between hospitals challenges - No transporters for internal transport

Logistics Coordination

The result found no designated person for internal logistics coordination in the organization chart of all sample hospitals, and each department needs to manage its own department. This is because they don't have enough personnel to handle this type of overlapping operation since budget allocation for job positions from the government was proportionate to the population size in each area, which population size in mountainous districts is considered extremely small compared to city hospitals. This constraint creates many inefficient operations, including a shortage of stock, since each ward needs to monitor and decide when and how much stock should be replenished.

Information Technology

Although all three hospitals are located in a mountainous rural area, they all have quality internet networks in both wired and wireless versions. What was found to be the constraints related to the hospital information technology system is lacking I.T. staff with software development skills. All hospitals found have only information technology staff with skills in fixing everyday problems, such as installing printer drivers and Wi-Fi

connections. etc. However, no hospital has staff with software development skills, leading to a lack of software that can integrate between the back-office software, like the quantity of medicine purchased and remaining in the warehouse, all running with different software from the front-office software where physicians prescribe the medicines and supplies for patients.

Inventory management

A constraint differentiating case study hospitals from city hospitals is the inability to access the actual use rate of medicines and medical supplies. Their inventory software cannot access the actual use rate of medicines that physicians prescribed to each patient, but it can only see the replenishment rate from each ward's request to the central warehouse for re-stocking purposes. Relying on the ward's replenishment rate instead of the actual use rate of patients will lead to fault and inefficient inventory control.

Forecasting

Forecasting is a critical logistics operation that uses mathematical models to ensure adequate procurement for future consumption. However, a systematic forecasting procedure does not exist in any sample hospitals. This hospital system that only relies on self-estimation of purchasing staff will create a risk of inventory shortage, especially in mountainous areas where purchasing lead time is much longer than in city hospitals. This is because all hospitals never attempt to recruit staff with forecasting skills since they all never acknowledge the importance of forecasting.

Purchasing

All sample hospitals have a smaller demand for medicines and medical suppliers than the urban hospital, derived from a smaller population size. This constraint creates a loss of interest in suppliers' bidding system, a one-size-fits-all purchasing procedure from the Ministry of Health since demand is too small to achieve their break-even point within their acceptable time. This results in all three sample hospitals inevitably driving their own vehicle to the city center and purchasing themselves instead of having suppliers deliver to their hospitals.

Storage

All sample hospitals still operate their warehouse without using information technology; a storage location and quantity of stock on hand cannot be checked in the software but only known by warehouse staff through their self-recorded stock card. This system causes difficulty in finding inventory stored in the storage room, such as the outdated inventory status. The persons responsible for all three hospitals say the number of storage items is still manageable using a manual system and see no point in implementing a new technology like a warehouse management system.

Transportation

The results found that all three hospitals had the same distance constraint for inter-hospital transportation since it took them more than 6 hours for each patient referral to the network hospital in their city center. Two hospitals are often faced with landslides during the rainy season that will block the road, and they need to wait for at least two hours before authorities re-open the road. The limited number of ambulances in each hospital will be even less on the day ambulances are on duty to transfer patients to network hospitals since they would not be available for at least one day until it's returned.

At the same time, internal transport operations still rely on traditional manual systems. Nurse in each ward needs to walk and refill their sub-stock themself. For

wheelchairs, a nurse will call the wheelchair counter via the internal phone number. Their request for wheelchair transport e.g., moving a patient from the ward to the parking lot, will be written in the paper, and whenever wheelchair staff, or might be any other male staff who willing to help see requesting notes are awaiting at the wheelchair counter, they will go the location of the user as per requested.

Discussion and Conclusion

This paper observed and interviewed three public hospitals in a mountainous area of three border cities in northern Thailand regarding their hospital logistics operations constraints. The finding revealed constraints in seven logistics operations, including the finding of no designated person for logistics coordination due to budget allocation for full-time staff proportionate to population size. This system differs from city hospitals, where they have a logistics department designated to link each hospital unit, e.g., internal transport, stock monitoring, forecasting, purchasing, and automatic stock replenishment services to ensure all non-clinical services will always be available for clinical services. Suppose such services are available in mountainous hospitals. In that case, a limited number of medical staff will have more time servicing patients instead of managing back-office operations, which the logistics coordinator personnel can centrally manage.

The major constraint of information technology is an inability to integrate data between back-office and front-office software due to the lack of I.T. staff with software engineering skills. This inability also leads to inventory management's constraint from a failure to access the actual use rate of medicines and medical supplies. If the front and back office systems can be integrated, physicians will see how many medicines and supplies are available in the storage area. The purchasing team will have better information for planning its replenishment strategy to ensure no stockout problem. The forecasting function will also benefit from the obtained data. However, all hospitals say attracting specialists willing to work full-time in remote areas is challenging, especially with lower salaries than city hospitals and their current staff is unable to integrate both systems.

The constraint of purchasing operations from suppliers lacking interest in joining the bidding process due to the small quantity demanded of a small mountainous hospital makes their investment infeasible compared to bidding for a city hospital. This is because all Thai public hospitals in mountainous and urban areas have the same one-size-fits-all purchasing procedure via a centralized e-bidding system. The total of six hours of driving time for delivering one box of medical supplies might last six months in mountainous hospitals compared to 10 boxes every week, with only 10 minutes of driving time in the city hospitals, making suppliers lose interest in joining the bid. This paper would suggest developing a purchasing procedure that matches the location contexts of small rural mountainous hospitals.

The storage system of all sample hospitals heavily relies on single warehouse staff, with no real-time digital data available for monitoring, while city hospitals mostly run under the bin-location system. It's a storage system capable of identifying each item's storage location and expiration details, enabling real-time data for inventory control via computer software. Implementing the bin-location system in mountainous hospitals will enable them to lower the risk of shortage and product expiration problems through a notification system.

The transportation system is found to be a direct manual request from the ward to the responsible staff, while the city hospital pulled all requests for both internal and

inter-hospital transport operations into a single centralized software, including requesting wheelchairs or portable beds for stretched patients and requesting sub-stock refilling by picking up inventory from the central warehouse and delivering it to the ward. This pull system will improve the utilization of limited vehicles and staff in mountainous hospitals through better scheduling.

Apart from logistics problems, an inadequate number of doctors, language barriers of local hill tribes population when communicating with hospital staff, and insufficient resources, including lacking laboratory tools and ambulance, are also found to exist in three sample hospitals which is in the same direction with a number of papers that explored rural-urban inequality in Thai hospital operations.[16-18]

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