



## HEALTHCARE SUPPLY CHAIN MANAGEMENT: MACRO AND MICRO PERSPECTIVES

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**ABSTRACT. Background:** The concept of supply chain management is to coordinate and collaborate among supply chain players in order to achieve system efficiency. Supply chain coordination and collaborations deal with the connection of operations throughout the chain with material and information flowing smoothly across these supply chain operations in achieving efficiency. Healthcare supply chain is one of such complex systems involving many stakeholders in the supply chain. Coordinating a single platform for these stakeholders is a challenge by achieving smooth flow of operations on this platform. Therefore, the purpose of this paper is to explore the operations in this healthcare supply chain materials and information flows across the players at two levels, macro and micro perspective.

**Methods:** The supply chain infrastructure enabling efficiency is investigated in the hospital environment. Multiple case studies have been conducted at 13 hospitals which include secondary hospitals and primary hospitals. Triangulation techniques, including interviews, site visiting and document analysis, are employed for data collection so as to enhance reliability and validity of the study.

**Results and conclusions:** The study found that the healthcare supply chain efficiency could be achieved at 2 levels, namely supply chain level and firm level. The main concerns of the organizations of both levels are process efficiency and patient safety.

**Key words:** healthcare service, supply chain management, information management, operations management, Thailand.

### INTRODUCTION

Supply chain and logistics management has become increasingly important in recent years as its perspective has led the industry to see through the process integration from upstream to downstream.

The supply chain and logistics management involves three-key flows across the boundaries of players in the supply chain – product/material, information, and finance/cash [Stock, Lambert 2001]. Successful integration or coordination of these three-key flows has improved efficiency and effectiveness for the players. The supply chain and logistics management has been defined as a system of

suppliers, manufacturers, distributors, retailers, and customers where the material typically flows downstream from the suppliers to the customers, and the information flows in both directions. Additionally, it involves managing the connected series of activities, which concern planning, coordinating, and controlling movement of material from the suppliers to the customers [Chandra, Kachhal 2004]. The key factors enabling successful supply chain and logistics management include inventory cost, information, customer service, and collaboration relationships [Coyle et al. 2002].

Generally, healthcare supply chain has a similar core structure to other industries' as it composes of input, process and output. There

are also material flow and information flow along the chain [Kritchanchai, Suwandeochai 2010]. Under the concept of supply chain and logistics management, medicine is produced and delivered in the right quantities to the right location and at the right time [Krichanchai 2015]. However, Turhan and Vayvay [2012] state that it is a must in healthcare industry as a cost of error might be someone's life. They also mention that healthcare supply chain management differs from other industries' in term of key elements as it tends to be misalignment, high costs for healthcare providers and heavy dependence on the third party.

Healthcare supply chain therefore is unique and different from other industries. It is a complex network consisting of many different parties at various stages of the value chain [Rossetti et al. 2012; Turhan, Vayvay 2012; Noorfa Haszlinna, Andrew 2009; Burns et al. 2002].

The stakeholders from the supply side and the demand side have different interest in operating healthcare supplies. The suppliers were driven for profit maximization while the healthcare providers focus more on cost and patient safety [Vikram et al. 2012; Krichanchai 2015]. Consequently, it is very challenging to implement the concept of supply chain and logistics management within healthcare context. Furthermore, experts state that supply chain and logistics management practices of the healthcare industry are ten years behind retail and manufacturing industry [Uthayakumar, Priyan 2013].

In addition, Gattorna [1998] describes a healthcare business as the operations provided by a variety of products and services enterprises including medical consumables, pharmaceuticals, catering, laundry cleaning, waste management, home-care products, information technology, vehicle fleet management and general supply. de Vries [2011] highlights that inventory management is influenced by these stakeholders who have different perception and interests in setting inventory policy. Moreover, it is found that healthcare staff in the hospital has limited knowledge of inventory management and supply chain practices, but they need to

manage the inventory without any proper guideline. This leads to inefficient operation management [Chen et al. 2013; Uthayakumar, Priyan 2013].

Muangchoo and Kritchanchai [2015] claim that healthcare supply chain is generally dominated by manual activities and regulatory pressures with product data maintained by fragmented IT systems in the entire supply chain. Consequently, healthcare organizations related to patient safety face a number of challenges in supply chain such as traceability, logistics efficiency and quality of patient care.

Likewise at the operational level, a research project entitled Business Architecture Design and Integrated Performance Measurement for Hospital Supply Chain in Thailand, Kritchanchai [2012] describes that drug manufacturers deliver drugs to healthcare providers (hospital or clinic); then the pharmacists in the healthcare providers dispense the drugs to patients without sharing medical information among the stakeholders. Comparing to other industries, product information is visible to target stakeholders from upstream to downstream.

Lack of medical information sharing not only negatively affects the efficiency in the healthcare supply chain, or makes the organizations unable to track and trace medical products but also leads to the patient safety issue. Day by day, a large amount of data has been generated in healthcare industry. The data includes record keeping, compliance & regulatory requirements, and patient care. If the data can be interpreted and translated into information and shared among the supply chain members, healthcare cost can be reduced, and the quality and effectiveness of the healthcare system can be improved. [Tiwari et al. 2017]. In addition, Stecca et al. [2016] also confirm the importance of the information sharing at the operational level. To have a better planning of inventory replenishment policies inside the hospital, there is a need of the share of information.

Moreover, it is also noticed that drug dispensing does not depend on customers or patients' demands, but it is driven by clinical treatment. Drug selection is heavily based on

the clinical preference of physician. Without medical training, the patients or end customers do not fully understand medical practices, and they cannot select the appropriate products for themselves [Pedroso, Nakano 2007]. Also, there is an interrelationship between patient condition and drug utilization. The patient condition impacts on drug demand, but how patients respond to the drugs is also uncertain. This has a great impact on the inventory management since the demand is unpredictable [Vila-Parrish et al. 2008].

A study by Kritchanchai and Meesamut [2015] show that only one inventory policy cannot apply entire drug items in the hospital. The drug demand characters are various. Therefore, applying only one single policy causes stock shortage or over stock problems. Thus, the inventory policy should be developed according to drug demand characters.

In addition, Supeekit [2014] studies internal transportation within the hospital under limited number of staff and transport equipment such as elevators. Demand of the elevator usage is high and uncertain. Patients and medical physicians struggle to get rid of the heavy traffic in vertical transportation within the hospital building especially in the rush hours. It is found that the business process in the hospital should be re-designed and developed with the assistance of related information technology.

When patients enter the hospital, they obtain services, and seize multiple resources at the same time. Therefore, it is necessary for the hospital to manage the operations and the flow of patient efficiently. Zonderland and Boucherie [2012] study a queuing network in healthcare system. They suggest that queuing theory is the value making a trade-off between patient waiting time and healthcare provider idle time. They introduce a basic queuing network like a Poisson process and also present exponential queues for the situations that either have a single or multiple servers. Kritchanchai and Hoeur [2018] study the patient flow in outpatient department (OPD) building. By applying the value chain concept, the congestion can be reduced in the floor area

of the OPD's clinics when the primary facilities are separated from support facilities.

Apart from managing patient flow and material flow within the hospital, nurse scheduling should be well-managed in order to ensure that nurses are available at the right place and the right time. Lim et al. [2012] study nurse scheduling problems in a general clinic and operational suite. The study demonstrates an optimization model and solution approach for the problems.

Another major concern in healthcare is to provide services to the patients at low cost, efficiently and timely. Niakan and Rahimi [2015] use multi-objective mathematical model to minimize the cost which consists of inventory and transportation cost. They investigate three main issues of healthcare supply chain namely inventory management, drug distribution from suppliers to healthcare facilities, and demand management.

In summary, most of the past literatures show that healthcare supply chain and logistics management is complex with variety of areas. Regarding the supply chain context, there are various stakeholders who have different interests in managing healthcare supplies. The healthcare staff has more concern about providing patient safety while the suppliers are interested more in gaining profits. This divergent goal leads to more complicated to enhance collaboration among the stakeholders. The demand is not desired based on the actual customer preference but it is made by the healthcare's staff decision based on clinical treatment. The hospital is the one that can obviously see the actual demand that generated daily. However, that demand is not really visible to other members in the chain. This affects the drug manufacturer and distributors on managing the drug procurement, production, and delivery.

From the literatures, it can be seen that supply side and demand side have different interest. Moreover, product data is on the fragmented IT system through the entire supply chain. Hence, it is very difficult to visualize product information from upstream to downstream. On the other hand, the demand in hospital is very uncertain; one inventory policy

cannot apply to entire drug items in the hospital. Transportation is another area. The challenge at operational level is to manage limited staff and transportation resources. Likewise, patient queuing and nurse scheduling are also critical.

Therefore, healthcare supply chain and logistics management can be analyzed into two levels: supply chain level and operational level. The supply chain level is about material and information management between stakeholders in the system such as drug procurement from healthcare providers to suppliers, and drug delivery from the suppliers to the healthcare supply chain providers. The operational level is logistics operations within the healthcare providers such as drug inventory management, transportation, queuing and scheduling.

## AN EXPLORATORY STUDY

This section aims to investigate a macro-perspective in supply chain and logistics management in healthcare industry in order to see how the stakeholders in the chain have been considered as a critical issue for the suppliers and the hospitals to enhance collaborative and integrative supply chain. There are various reports of supply chain and logistics management in healthcare from global trend and best practices. We have explored and reviewed case studies from Australia, Canada, Japan United Kingdom practices in order to investigate macro-perspective of healthcare supply chain and related infrastructure in this setting.

In Canada, a system of supply chain standard has been concerned by healthcare institutions [ISMP 2013; Sheppard et al. 2009]. Since 2008, the healthcare providers and suppliers within Canada's healthcare gear toward improving patient safety, optimizing supply chain processes, enabling traceability, and maximizing the intellectual capital of healthcare professionals across the country. Members of healthcare industry implemented the standard product identification to connect the supply chain operations nationwide. Pharmaceutical products are identified not only by barcode on exterior package labels but also

at the unit-of use packaging, such as ampoules, vials, and blister packs [Sheppard et al. 2009]. There is a national collaborative effort as the Institute for Safe Medication Practices Canada (ISMP Canada) and Canadian Patient Safety Institute (CPSI) have worked with pharmaceutical manufacturer to ensure that the automated identification technology helps improve patient safety on medication dispensing and administration systems as well as the benefits from enhancing efficacies along the entire supply chain [ISMP Canada 2013; GS1 Canada 2012].

In Australian health sector, electronic commerce is one of the important concerns [Vikram and Caroline 2011; NEHTA 2016]. Researcher Clarissa et al. [2019] shows that electronic database would help in the identification of Prescription Opioids abuse or misuse. Additionally, it would also help improve individualized patient care, reduce over-prescribing, identify the concern pharmacy or doctor shopping and fraudulent prescriptions.

The core function of effective electronic commerce system is a global way to identify trade items and logistic units. In order to gain unilateral support across the Australian pharmaceutical/healthcare sector for 'one standard' identification system, the Monash Pharmacy Project team needed to illustrate the benefits, such as accurate inventory management and increased efficiency to all industry suppliers [Vikram, Caronline 2011]. In 2016, National eHealth Transition Authority (NEHTA) proved the benefits of application of the system of identification, bar coding and electronic messaging in the areas of hospital pharmaceutical ordering, picking, packing, dispatch, and receipt of goods. The benefits included 25 per cent reduction in stock receipt time at the hospital pharmacy, improving accuracy in order fulfilment, and an embracing of the new processes and technologies by staff [Vikram, Caroline 2011]. It is reported that the system composed of:

- Identification and bar coding of trade items
- Electronic messaging and improving order fulfilment accuracy
- Data synchronization via the National Product Catalogue (NPC)

- Future requirements for batch/expiry date tracking

In Japan, the healthcare stakeholders struggle to reduce medical incident and error, and increase counterfeit of drugs and medical devices. The solution to solve the problem is implementation of unique product identification and a single database of master data called MEDIS-DC, The Medical Information System Development Center, which is registered by manufacturers and shared to target healthcare providers instead of individual non-compatible Hospital Information System [Takekuma 2008]. The implementation of global standard and the datapool in Japan provides several benefits to healthcare stakeholders both suppliers and healthcare providers, the precise data of actual usage of the instruments, appropriate purchase control, and adequate stock management that lead to high motivation of the hospital staff [GS1 Japan 2009; GS1 Japan 2015].

In United Kingdom, since 2006, the Department of Health (DH) has announced a guideline called “Coding for success” which is related to an implementation of Automatic identity and Data Capture programmed (DH 2010). To addresses patient safety issues, National Health System Connecting for Health (NHS CFH) enters into the agreement with GS1 UK to issue the adoption of GS1 coding standard. In addition to coding, it also encourages the manufacturers to implement GTINs while driving the NHS to implement effective supply chain technologies. The objective of this project is to improve patient safety together with greater efficiency [GS1 2010].

Table 1 shows the common practices in each country for their healthcare supply chain.

Table 1. Practices for supply chain and logistics in each country

Country	Practices
Australia	Implement one standard identification system and data synchronization.
Canada	Implement the use of standard product identification to connect supply chain nationwide.
Japan	Implement the unique product identification and a single database.
UK	Announce a guideline called “coding for success” using GS1 standard.

According to the case studies, it reveals that healthcare system around the globe is facing challenges that affect the entire supply chain, from manufacturers through to wholesalers, distributors, group purchasing organizations and healthcare providers. Every member is concerned primarily with two main issues: increasing supply chain efficiency and, more importantly, ensuring patient safety.

Standardized healthcare infrastructures are the important means of managing healthcare supply chain and logistics to increase visibility and security. The infrastructures composed of five main areas.

- Standardized Product and Location Identification (GTIN-Global Trade Identification Number and GLN-Global Location Number respectively)
- Electronic product catalogues
- eProcurement enabled by Electronic Data Interchange (EDI)
- Automatic Identification and Data Capture (AIDC) systems, including barcodes and RFID
- Traceability Systems

Global supply chain standards enable products and information to flow accurately, efficiently and quickly across jurisdictions and borders. GS1 is the world’s leading supply chain standards organization. As such, global GS1 standards like barcodes and other automatic product identifiers enable traceability, efficiency, cost savings and a host of key benefits in various industries, including healthcare.

As mentioned earlier, these five main infrastructures can enhance efficient processes and contribute to patient safety. They not only help a particular stakeholder gain advantages from the collaboration but also provide benefits to all in the entire supply chain. In addition, they should not disregard the operations and service within the hospital as they directly affect healthcare service delivery to the patients. Therefore, it is important to understand the operations management in hospital setting.

## AN EMPIRICAL STUDY

The objective of this part is to explore an operational level or micro-perspective within the hospitals from the healthcare providers' point of view. In-depth case study was employed at the hospital because it is a point where supplies meet demand [Krichanchai 2015]. Improving operational performance at the hospital has a huge impact on both supply chain performance and quality of care for the patients.

Also, it is noted that the multiple case studies can provide the external validity and create more testable theory than a single case [Barratt et al. 2011]. Therefore, multiple case studies were conducted at thirteen hospitals which include tertiary, secondary, primary and private hospitals. The hospital cases were selected based on theoretical sampling in order

to present similar results or show differences and diversities among case studies [Yin 2013]. The brief description of case studies was presented in Table 2. The cases were conducted at both public and private hospitals. The first ten of the thirteen cases were the public hospitals which can be divided into three types namely primary, secondary and tertiary, based on the size of the hospital and the characteristics of healthcare service. The least of the cases were conducted at the private hospitals.

Semi-structures interview was used as a primary data collection approach. Also, triangulation techniques, including interviews, site visit and document analysis, are employed for data collection so as to enhance reliability and validity of the study. Table 2 shows the profile of each hospital.

Table 2. Hospital profile involved in this study

Case	Name	General data			
		Type of hospital	Patient per day	Beds	Drugs (SKU)
1	Hospital 10	Primary	708	30	324
2	Hospital 5	Primary	458	58	413
3	Hospital 6	Primary	435	62	354
4	Hospital 20	Primary	433	67	368
5	Hospital 12	Primary	431	30	619
6	Hospital 13	Primary	425	69	378
7	Hospital 3	Primary	400	54	433
8	Hospital 17	Primary	364	48	302
9	Hospital 11	Primary	281	60	294
10	Hospital 2	Primary	260	70	300
11	Hospital 1	Primary	206	46	471
12	Hospital 7	Primary	149	27	296
13	Hospital 4	Secondary	864	186	523
14	Hospital 16	Secondary	642	177	450
15	Hospital 8	Secondary	635	90	480
16	Hospital 15	Secondary	532	97	515
17	Hospital 9	Secondary	511	96	356
18	Hospital 18	Secondary	355	113	415
19	Hospital 19	Secondary	318	120	375
20	Hospital 14	Secondary	245	200	711

### Analysis from the hospitals

From the hospital perspective, we see a similar pattern of hospital operations. Generally, the operations inside the hospital can be analyzed into three aspects-the structure of nodes and links, Information management, and material flow management. This is illustrated in Figure 1.

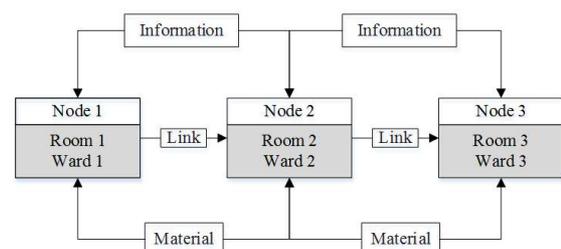


Fig. 1. Structure within hospital operations

Firstly, within the hospital, there is an interconnecting among healthcare staff within various rooms, wards, and departments in order to share information, resources and materials which are necessary to provide healthcare services. The complexity of hospital operations is different among various types of hospitals which we conduct the case studies. However, we can simplify the structure of hospital operations into two constitutes-Nodes and Links. Nodes can be either an origin station, in which information is generated or a material is delivered, or a terminated station, in which information or a material is received. An origin station or a terminated station can be a ward, a storeroom, a warehouse and a department even somewhere else in the hospital. In term of link, it is an activity enhancing the flow of information or material interconnecting between two nodes. Given an example, the hospital typically has a warehouse where medicines are kept once they are received from the suppliers and the storeroom where medicines are located before being prescribes to patients. A warehouse and a storeroom can be defined as a node. A link is an activity including ordering process from the storeroom to the warehouse, distributing process from the warehouse to the storeroom and information sharing between both nodes.

It is noticed that all of the case studies have very similar characteristics and locations of these nodes and links. They put effort to manage resources in the nodes. Resource management such as staff utilization and inventory management is critical. On the other hand, to manage the links, they focus on facilitating working flow processes between nodes network. Information sharing and network flow management are targeted.

Secondly, information management is another aspect that is critical for the hospital operations. Hospitals deal with a volume of information which flows simultaneously all day all night. The larger size hospitals, which reflect by the number of patients being served and the number of beds, are likely to handle a load of information which is greater and more complicated than the smaller size hospitals. Generally speaking, this information can be generalized into two types, the information that is necessary for providing

healthcare services and information that is necessary for hospital operations. The first type of information includes patient information, lab results, X-ray films, clinical information. The purpose of this information is directly used for providing treatment and healthcare services to patients. Another type of information is not directly related to patient care but it helps support the operations within the hospitals. This includes a status of room, a status of patients, and the number of medicines in a warehouse. Regardless of information type, there is a need of enhancing information sharing and visibility among those who are eligible to access. For example, patient information is available for doctor, nurse and pharmacist who are responsible for providing treatment to patients. Although a pharmacist at the warehouse might refer to only an authorized pharmacist who can access pharmaceutical purchasing activity, the entire usage must also be visible.

Based on the study from hospitals, the results show that information system and system integration can be defined into two characteristics: integrated information system and separated information system. The integrated information uses a single system to operate information within the hospitals. This system is used to operate both information that is necessary for healthcare services and operations management in the hospitals. It is found that using this integrated information system helps information flow smoothly, and be accurate and consistent throughout the processes in the hospitals. Therefore, it enables the hospital to operate efficiently and ensure patient safety. Regarding a separated system, it is found that some hospitals usually implement two systems to manage information, front office and back office. The front office refers to a node or operation dealing directly with the patients, clinics, ward, pharmacy storeroom, emergency department and finance. Hence, this system supports the function related to medical services, transactions and operations management at the pharmacy storeroom. The information being operated by the front office system includes information related to patient care like patient status, scheduling, lab results and patient's payment.

In addition, the back office refers to any operations which are not related to patient care but they are typically related to hospital operations. These systems deal with human resource, resource, hospital finance, warehouse management and inventory management. Sometimes, these both systems are not integrated due to the compatibility of the systems or the complicated functions. Some hospitals like primary hospitals or small size hospitals sometimes have only a single system to operate the front office while the operations at the back office is done manually. It is found that the separated system can lead to the problem due to inconsistent information and inaccurate information. Given an example, when the hospitals operate the information related to medicine inventory level, the actual total stock level is invisible as the inventory level can be seen at the warehouse and the storeroom separately. Interestingly, the hospitals give the patient care as a priority regardless of any other operations that do not deal directly with the medical services even these operations help support the medical services provided by the healthcare staff. It has been seen that the information related to patient care is not consistent and standardized, and the information supporting hospital has not yet been standardized. Worse, it sometimes uses different set of product code in different systems as the systems are used for different purposes. Lack of consistency and inaccurate data can lead to inefficient hospital operations. Consequently, this can negatively affect the patient care.

Thirdly, material flow management is another operation that is important to healthcare services. There are various products that are delivered among departments, wards or units within the hospitals including food, clothes, sterile equipment, pharmaceutical medicine, patients and so on. Types of material management and transportation can be classified based on the responsibility into three types. Firstly, a supply unit delivers material to a service unit. To illustrate the point, a washing unit delivers clean clothes to wards and patients or central distributing unit delivers sterile products to dental units. Secondly, a terminal service unit picks up material at the distributing point; for example, pharmaceutical products and non-pharmaceutical products can

be picked up at the pharmacy storeroom. Thirdly, both service unit and supporting unit share responsibility. A service unit collaborates with a supporting unit to manage material and transportation. For instance, an in-patient ward collects used clothes and delivers to the collecting point. Then, a washing unit picks up the clothes from the collecting point and is responsible for cleaning the clothes. Also, it can be classified based on the frequency of delivering service. For example, food is delivered three times a day while clothes are delivered two times a day. Storeroom prescribes pharmaceutical products for out-patient and emergency case every day. However, medical supplies are distributed less frequent as they are prescribed every week.

Common problems related to material flow management within the hospitals are high service frequency and limited space in the unit. Firstly, it has been identified that various products are delivered, and there is high delivering frequency per day. This is inefficient process especially when a lift is used as a transporting medium in a high building since the lift is used for delivering pharmaceutical, non-pharmaceutical products and patients. The number of lifts is limited, and it is not capable to support the delivering process during a rush hour. This delays processes and consequently leads to inefficient healthcare services. Moreover, some particular wards or units may require large space for holding inventories. For example, operation unit and in-patient ward typically hold various materials including medicines, sterile products, medical supplies, clothes in order to stock enough materials for one order cycle. However, it is typically found that space in the ward and unit are not enough to store the materials properly. It can be seen that limited resources within the hospitals affect the delivering process.

Therefore, it is important to classify the material management in the hospital into three types namely patient logistics, pharmaceutical logistics, and non-pharmaceutical logistics. It is suggested that the hospitals should be centralized to control the logistics activities. It requires a central transport unit to carry out these three logistics activities. The purpose of this unit is 1) to manage people and the

medium of transportation efficiently and suitably for each task in order to deliver the materials as requested. 2) to manage delivery lead time efficiently regarding the limited resources in the hospitals. The mission of this unit is to deliver the materials to the right place, at the right time and quantity, in a good

quality of material, and under the right condition or cost.

Issues at operation level regarding these three aspects – nodes and links, information management and material management can be illustrated in Figure 2.

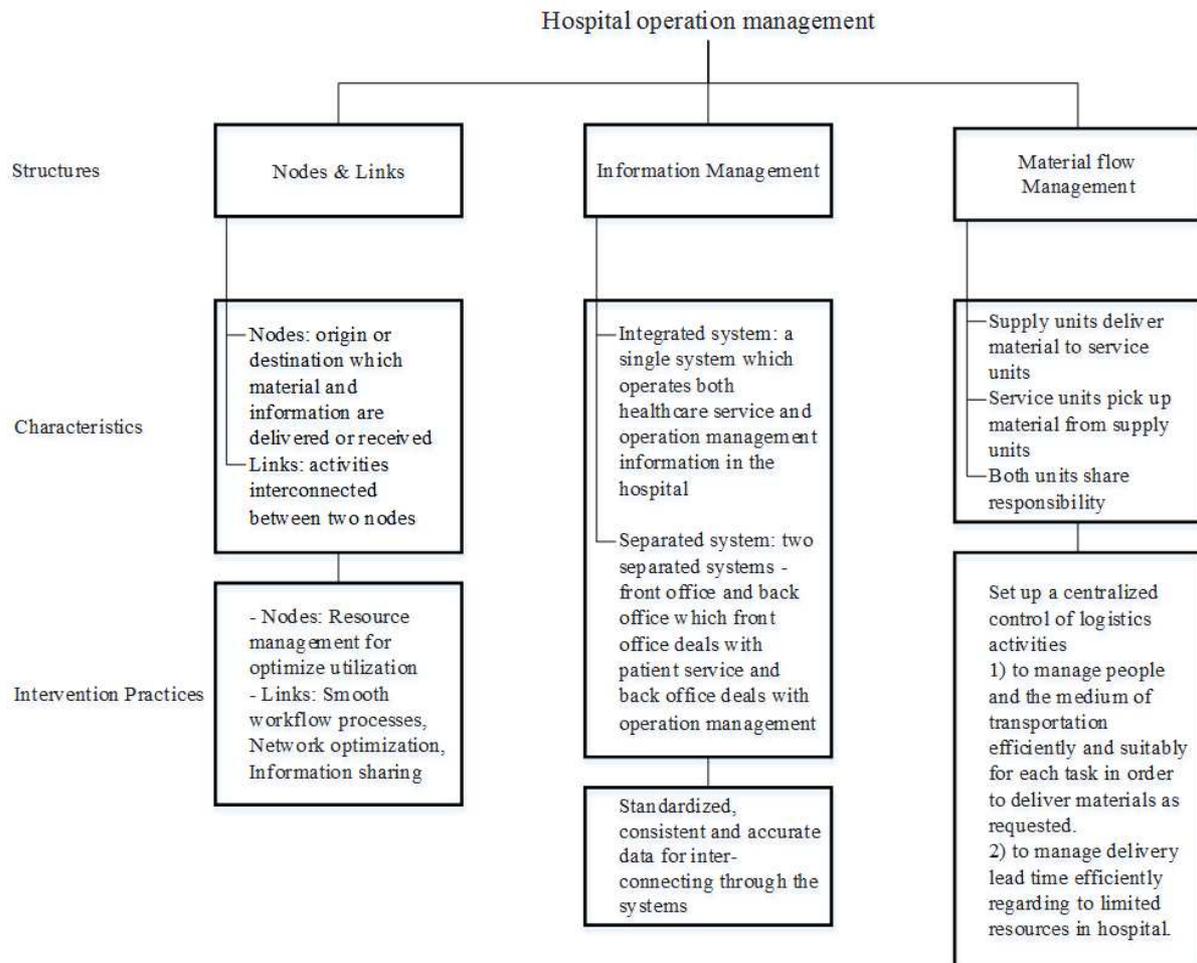


Fig. 2. Hospital operation management

## ANALYSIS AND DISCUSSION

When conducting an investigation of the statement of knowledge in a field, two approaches have been used. The first approach is an exploratory review which literatures related to supply chain and logistics management in healthcare are studied in order to explore the global trends and best practices. The second approach is to conduct the exploratory case study within one focal player – hospital, which is analyzed in depth. This

emphasizes on the operations and services within the hospital context. According to the explorative reviews and case studies, to enhance the collaboration among supply chain partners and better healthcare service level, two aspects namely macro-perspective and micro-perspective level are taken into consideration.

In macro-perspective, the explorative reviews present a global best practice and a major concerning issue which contain five infrastructures. These include standardized Product and Location Identification (GTIN-

Global Trade Identification Number and GLN-Global Location Number respectively), Electronic product catalogues, eProcurement enabled by Electronic Data Interchange (EDI), Automatic Identification and Data Capture (AIDC) systems such as barcodes and RFID, and Traceability Systems.

At the macro-level, it shows the need for all stakeholders to get accurate and consistent information [Vikram, Caronline 2011]. That is the reason why it is opted for the standardized product code and electronic product catalogue. This information helps stakeholders from supply side to demand side to communicate with each other efficiently. Therefore, this kind of information is required to support both clinical activities and logistics activities. Also, national standard code may not be sufficient to help the stakeholders in the industry communicate with each other. Generally speaking, the stakeholders involving in the industry are not only domestic organizations and local pharmaceutical companies but also multinational pharmaceutical companies and international distributors. The global standard code is evidenced to be implemented as a medium to communicate among the stakeholders in the industry [NETAH 2016; ISMP Canada 2013].

Moreover, e-procurement is suggested to facilitate the order and demand information among the stakeholders in the chain. To enhance e-procurement, it is suggested that the suppliers and the customers need to have an integrated system, by using EDI system, which as a consequence it will be more collaborative than using traditional approach for the procurement process. Employing e-procurement process means that the customers or the hospitals have to simplify the previous procurement process and shorten administration lead time. Therefore, the procurement process can be operated efficiently and enhanced collaboratively among trading partners.

Additionally, when dealing with a volume of information and simultaneous flow of demand in the healthcare, it will be difficult to operate manually like operating under a conventional system [Tiwari et al. 2017]. Automatic Identification and Data Capture like

barcoding are now suggested in order to help capture and collect information. Typically, this automatic identification is used at the exterior package to support the logistics activities of the pharmaceutical manufacturers, the distributors and the hospitals. However, it has been less concerned and regarded to implement the barcode at the interior level. Once the medicines are unpacked from the box or from the pallet, they are difficult to be tracked or traced. Hence, it is now concerned that the automated identification system should be employed to operate product at the unit for the sake of better medication administration.

At the micro-perspective, the focus should be on the operations in the hospital. This is because the hospital is a linkage between the suppliers and the actual customers. The healthcare services or operations occur within the hospital context. Therefore, if there is anything affecting the operations within the hospital, it will negatively affect the healthcare services and patient safety [Vikram et al. 2012; Kritchanchai 2015].

The hospitals are where the operations occur and the healthcare services are generated to serve the patients. In the hospital setting, it typically consists of the structure of nodes and links, information management and material management. Among various types and sizes of hospitals, there is a difference in term of the number of nodes and links within the hospitals and the complicated process either information management or material management. The larger size of hospitals contribute to the number of nodes or operations, the number of materials and the high volumes of information. It is necessary that the hospitals should enhance information visibility and implement an integrated information system. Information visibility not only enables the clinical staff to make a right decision and provide right treatments to the patients, but also enables the healthcare staff who operate the supporting activities including queuing and scheduling system, to perform the operations efficiently. Regarding the material flow management, there should be the integrated and centralized department providing the authorized logistics activities. Due to limited resource and the number of materials in the hospitals, the flow of the materials should be planned and

managed properly. This presents that even at the operations level in the hospital, the concept of supply chain and logistics management

should not be ignored. The conceptual framework of macro and micro perspective can be summarized in Figure 3.

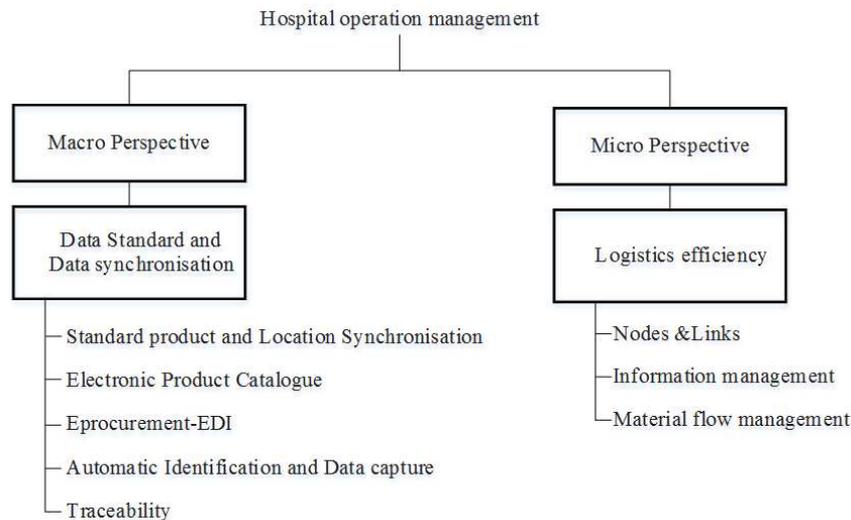


Fig. 3. Macro and micro perspective in Healthcare Supply Chain

## CONCLUSION

Supply chain and logistics management has become increasingly important in recent years. It has been taken in consideration that collaboration among stakeholders and an integrated supply chain not only provide benefits in term of supply chain performance, but also help the healthcare improve services for the patients. As the result, it leads to an efficient process and greater patient safety. An explorative review of supply chain and logistics management in healthcare provides a clear picture of the best practices from five countries. It suggests five main standardized infrastructures namely Standardized Product and Location Identification, Electronic product catalogues, eProcurement enabled by Electronic Data Interchange (EDI), Automatic Identification and Data Capture (AIDC) systems such as barcodes and RFID, and Traceability Systems. Furthermore, the explorative studies present an in-depth analysis within a focal point at the hospitals. Based on the study with the hospitals in Thailand, there are the structure of nodes and links, information management, and material management. In the micro-perspective, the

current operations in the hospitals are still fragmented and disintegrated. It is suggested that the concept of supply chain and logistics management should be taken into account. Therefore, it will lead to a collaborative among the nodes and the operations within the hospitals. Moreover, it can enhance an integrated information system and centralized material management (Tiwari et al. 2017). Consequently, it contributes to an efficient process and patient safety (Vikram et al. 2012; Krichanchai 2015).

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## ZARZĄDZANIE ŁAŃCUCHEM DOSTAW W SŁUŻBIE ZDROWIA: PERSPEKTYWA MICRO I MAKRO

**STRESZCZENIE.** **Wstęp:** Zarządzanie łańcuchem dostaw to koordynacja i kooperacja pomiędzy różnymi podmiotami, będącymi członkami tego łańcucha w celu osiągnięcia jak najwyższej efektywności działania. Koordynacja i kooperacja łączy się nieodwrotnie z tworzeniem połączeń pomiędzy operacjami w obrębie łańcucha dostaw, przepływów materiałowych i informacyjnych. Łańcuch dostaw służby zdrowia jest skomplikowanym systemem włączających wielu udziałowców do łańcucha dostaw. Koordynacja pojedynczej platformy dla tych współudziałowców w celu osiągnięcia płynnego przepływu operacji jest dużym wyzwaniem. Celem tej pracy jest rozpracowanie operacji w obrębie łańcucha dostaw służby zdrowia, obejmującego przepływy materiałowe jak i informacyjne na dwóch poziomach: makro oraz mikro.

**Metody:** Analizie została poddana infrastruktura łańcucha dostaw szpitali umożliwiająca osiągnięcie efektywności operacji. Badania te zostały wykonane w 13 szpitalach dwóch szczebli organizacyjnych. Techniki trójkątne, obejmujące wywiady, wizyty w poszczególnych obiektach oraz analizę dokumentacji zostały użyte w celu zebrania danych o wymaganym stopniu rzetelności.

**Wyniki i wnioski:** Efektywność łańcucha dostaw służby zdrowia można uzyskać na dwóch poziomach, a mianowicie na poziomie całego łańcucha dostaw jak i na poziomie poszczególnych firm. Najistotniejszym czynnikiem determinującym sposób organizacji na obu poziomach jest efektywność oraz bezpieczeństwo pacjentów.

**Słowa kluczowe:** służba zdrowia, zarządzanie łańcuchem dostaw, zarządzanie informacją, zarządzanie operacjami, Tajlandia

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