

**REENGINEERING THE INFORMATION SYSTEM IN HOSPITAL
SUPPLY CHAIN**

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Thesis
entitled
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HOSPITAL SUPPLY CHAIN**

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REENGINEERING THE INFORMATION SYSTEM IN HOSPITAL SUPPLY CHAIN

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ABSTRACT

Logistics and supply chain management play an important role in the industry of Thailand. Many industrial firms apply logistics and supply chain concepts to improve their productivity and service level. Likewise, service level and quick response to customers are significant in Thailand's service sector. It is believed that logistics and supply chain management could also be a means to improve competitive performance in this sector. This has resulted in a re-engineering of the supply chain and logistics activities and led to a re-design of the information system in firms. In this research, we diagnose a hospital's internal supply chain and logistics system by using business process analysis. The results showed inconsistent data in the internal supply chain in the medicine inventory system between the medicine storeroom in each ward, the medicine central warehouse and the hospital medicine purchasing department. Then we re-engineered the internal supply chain between these 3 areas and proposed a new information system to change the information flow between these 3 departments. This paper illustrates the business process analysis by using Integration Definition (IDEF0), proposes a re-engineered business process, and finally presents a software solution for improving this internal supply chain.

KEY WORDS: SUPPLY CHAIN MANAGEMENT / INFORMATION
SYSTEM / HEALTH SECTOR

92 pages

การรีเ็นจิเนียริงระบบสารสนเทศในโซ่อุปทานโรงพยาบาล

REENGINEERING THE INFORMATION SYSTEM IN HOSPITAL SUPPLY CHAIN

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บทคัดย่อ

โรงพยาบาลเป็นอุตสาหกรรมบริการที่มีความสำคัญและมีความจำเป็นมาก ซึ่งเปรียบเหมือนปัจจัยพื้นฐานที่ชุมชนขนาดใหญ่จะต้องมี ดังนั้นการบริหารงานในโรงพยาบาลจึงจำเป็นที่จะต้องรวดเร็วมีประสิทธิภาพและประสิทธิผลในการเคลื่อนย้าย การจัดเก็บสินค้าและบริการ และมีการจัดการสารสนเทศจากจุดเริ่มต้นไปยังจุดที่มีการใช้งานที่สอดคล้องกับความต้องการของผู้ป่วย ซึ่งเห็นได้ชัดว่าโลจิสติกส์ มีความเหมาะสมที่จะนำมาใช้กับอุตสาหกรรมบริการอย่างโรงพยาบาลเป็นอย่างมาก แต่โรงพยาบาลในประเทศไทยนั้น ยังไม่เคยมีการนำโลจิสติกส์เข้ามาใช้ในการบริหารจัดการเลยทำให้การบริการค่อนข้างช้าและเกิดปัญหา มาก งานวิจัยนี้เป็นการนำเสนอ การศึกษาการนำโลจิสติกส์เข้ามาใช้ในโรงพยาบาล โดยมุ่งเน้นไปที่การเคลื่อนไหวของยาจากจุดเริ่มต้นที่มีการรับยาเข้าคลังยาไปจนถึงจุดที่มีการจ่ายยาเพื่อใช้จริงและตัดยอดเพื่อส่งชื้อยาเข้าคลัง ซึ่งศึกษาจากยาในกลุ่มตัวอย่าง 6 ชนิดซึ่งพบว่ามีปัญหาที่เกิดจากระบบเดิม คือมีการค้างจ่ายยามากและจุดส่งชื้อยาไม่ได้สะท้อนมาจากการใช้จริง และในการจัดชื้อยาจะส่งชื้อได้เฉพาะยาที่มีการเคลื่อนไหวในแต่ละวันเท่านั้น ทำให้ยาบางตัวที่ต้องการชื้อแต่ไม่มีการเคลื่อนไหวในวันนั้นขาดหายไป โดยผลที่ได้จากการศึกษานี้คือ กระบวนการไหลของกิจกรรมและสารสนเทศใหม่ของยา ตั้งแต่การจ่ายยาจริงจนกระทั่งถึงการส่งชื้อยาและการประยุกต์ให้เข้ากับการใช้ระบบเทคโนโลยีสารสนเทศ

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CHAPTER I

INTRODUCTION

1.1 Background and Problem Statement

Logistics management has become a competitive tool for enhancing system efficiency and customer satisfactions in many businesses and industries in Thailand. However it is mostly interpreted and applied in the environment of transportation and exports. We have adapted logistics concepts together with supply chain management in industries such as textile, rubber and SMEs. It is found that implementing logistics in the order fulfillment process results in lead time reduction and higher customer satisfactions.

Thailand, one of the speedy growing manufacturing countries, also has good reputation in service industry. Having a number of high standard hospitals, the country is aimed to become a medical hub in the region. In this study, an attempt was made to apply logistics concept to this sector. First of all, we recognize some similarities between industrial sector and service sector. In the industry supply chain, we see the core system as input, process and output. Then material flow and information flow are analyzed. Likewise, we attempt to identify the input, process and output in the hospital supply chain. However, unlike the production process in industry, there are a number of chains crossing one another in a hospital. We then need to select one essential chain to study in depth. One of the significant input material flows in the hospital is medicine. It circulates across functions in hospital. Also, the information of this flow also needs to be distributed among functions in the chain.

The study takes place in one of the biggest state-owned hospitals. To understand the current situations in the chain, an interviewing phase is necessary. The purpose of this step is to gather information from an individual who possesses expertise considered important to both order process mapping and technological analytical effort. The primary data gained in this research come from an in-depth semi

- structured interview in the medicine storeroom in each hospital ward, medicine central warehouse and the hospital purchasing department. Then, to explicitly illustrate the flow of this supply chain, it is necessary to demonstrate the current situation of business process. This is called the AS-IS model business process mapping. This model describes information exchange and decision making in all processes in supply chain. The business process model consists of material and product flow (Physical Flows) and information for material management (Information Flows). The business process mapping tool used in this study is the Integration Definition (IDEF0) methodology. It was initially intended for the use in systems engineering. The IDEF methodology provides a disciplined way of graphically describing the detailed structure of processes and how they relate to one another. Then the problems can be found and the proposed system is recommended.

1.2Objective

To analyze medicine flow of across three major functions in the hospital and improve logistics flow of medicine in the hospital.

1.3Scope of Work

1.3.1 To study the medicine flow of across three major functions in the hospital. These are medicine storeroom in each ward, medicine central warehouse and the purchasing department in state-own hospital.

1.3.2 To study 6 medicines represented in the inventory, categorizing them into 3 groups as follows:

1.3.2.1 Type I: Demand has no trend and low variability.

1.3.2.2 Type II: Demand has no trend but high variability.

1.3.2.3 Type III: Demand has trend with high variability.

1.3.3 To develop the application prototype for support logistics flow of medicine in the hospital.

1.4 Step of Work

- 1.4.1 An in-depth semi-structured interview in the medicine storeroom in each ward, medicine central warehouse and the hospital purchasing department.
- 1.4.2 Demonstrate the current situation of business process.
- 1.4.3 Re-design business process.
- 1.4.4 Application development.
- 1.4.5 Testing and conclusion.
- 1.4.6 Documentation.

1.5 Expected Results

- 1.5.1 A new design for medicine information system in a hospital supply chain.
- 1.5.2 An application prototype for logistics flow of medicine in the hospital.

CHAPTER II

LITERATURE REVIEW

In this chapter, reviewing in details of related researches and developments is done in order to develop the application prototype for logistics flow of medicine in the hospital. The literature review covers topics as following.

2.1 Supply Chain Management in Health Sector

The supply chain represents a fundamental part of any business covering all physical processes and information flow from raw material procurement to delivery and end up on hands of customers. Material and information flow upward and downward along the supply chain. Supply Chain Management (SCM) is an integration of concerned activities aimed to improve supply chain relationship and achieve a sustainable competitive advantage. The business in health sector is provided by a variety of products and service enterprises including medical consumption, pharmaceuticals, catering, laundry cleaning, waste management, home-care products, information technology, vehicle fleet management and general supply (Gattorna, 1998). Moreover, Turhan and Vayvay (2009), they argue that it is a must in healthcare industry as a cost of error might be someone's life

According to Mustaffa and Potter (2009) and Burns (2002), the four major types of players are Manufacturers, Distributors, Healthcare providers and Payers. Manufacturers include primary and secondary manufacturers. In term of primary manufacturer, this refers to any manufacturing that involves the creation of active ingredient contained within the medications. Primary manufacturers act as a supplier for second manufacturer. After obtaining active ingredients from primary manufacturers, second manufacturers are responsible for transforming active ingredients into a useable medicine such as capsules, tablets, solution and so on. It can

be said that manufacturer section influences on the pharmaceutical prices, expected demand assessing, future competition and project marketing costs.

The finished products then are distributed to healthcare providers by distributors, wholesalers or manufacturers themselves. Instead of allowing a third-party to deliver their products, there are many manufactures that are responsible for distributing their own products allowing them to leverage margin on self-manufactured products and discount the distribution fee. This might solve the problem caused by the third party distributors who deliver the substitute products to the hospitals. As it is found that in several cases, the third-party distributors cut its inventory stock of the competing product aimed to reducing cost of stock control. The sample of finished products is medicine as it can be shown the part of health care supply chain in the diagram below.

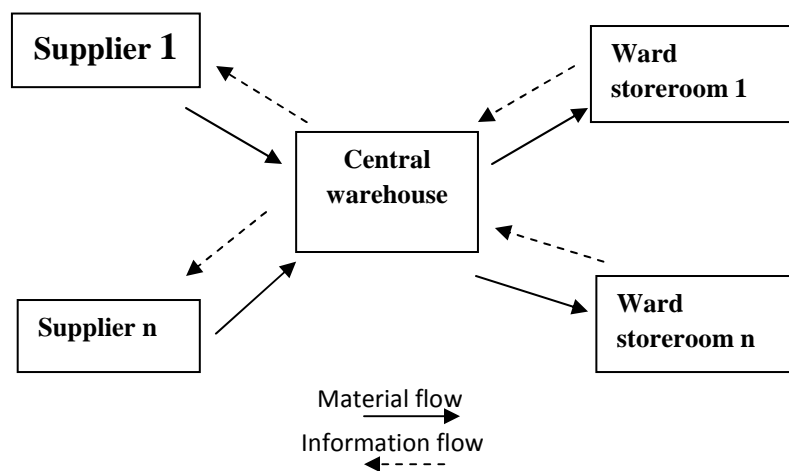


Figure 2-1. Chain of Medicine distribution system in the hospital

2.2. A case study

Ramathibodi hospital is the fourth oldest medical school in Bangkok, Thailand. It was established in September 1965 and was opened on May 3, 1969. It is one of Thailand’s leading medical schools in terms of teaching, research and clinical services. To understand logistics flow of medical commodity in the hospital, interviews are conducted. The questions are investigated how medical commodities are flowed and

managed in the current system. There are three major functions in the hospital; medicine storeroom, central warehouse and the procurement department. Four medicine storerooms locate in outpatient department and one medicine storeroom locates in inpatient department. When supplier delivers medicines products, they are sent to the central warehouse. A pharmacist takes responsibility to check these against purchasing order then stores in the storeroom. Consequently, the warehouse distributes these medicines to each ward regarding to the requests. The central warehouse acts as the supplier in the internal supply chain distributing medicine to five storerooms in the building and then each storeroom is responsible for delivering medicines to end-users or patients. Apart from this, the central warehouse itself acts as the customer in the external supply chain receiving medicines from manufacturers and distributors. Warehouse has been received requisition from medicine storeroom. The amount of requisition come from MIN – MAX value, it judged by pharmacist's experience, then warehouse will dispense to medicine storeroom and used amount of requisition from storeroom to calculate the replenishment call M-sale that mentioned in chapter 1. Later, warehouse sends the limited list to purchasing department. After that, pharmacist who has permission for purchasing will select medicine from lists because of the purchasing rule.

To improve the efficiency of supply chain and logistics in the hospital, we need to know the activity related. The main functions of a qualified logistics include inventory management, purchasing, transportation, warehousing, consultation and the organizing and planning of these activities. Logistics combines a professional knowledge of each of these functions so that there is a coordination of resources in an organization. There are two fundamentally different forms of logistics. One optimizes a steady flow of material through a network of transport links and storage nodes. The other coordinates a sequence of resources to carry out some project. So, we study medicine internal supply chain on how medicines are flowed and managed and how medicine information is flowed across three major functions in the hospital. There has been described in chapter 1.

2.3 Re-engineer Information System in Hospital

The pressures on healthcare businesses are changing. In the past, purchasing cost is one of the critical factors for efficient operations. Today, cost of materials management can exceed 35% of a hospital's operating budget, with nearly 20-25% attributable to supply costs alone (Stark E., 2010). Furthermore healthcare enterprises involve complex processes that span diverse groups and organizations. These processes involve clinical and administrative tasks, large volumes of data and large numbers of patients and personnel. The tasks in the enterprises are supported by a variety of software applications and information systems (Anyanwu, K et al., 2003). In health care, business process redesign (BPR) is used to implement organizational transformations towards more customer-focused and cost-effective care. Business process redesign was developed by industry staff and can be defined as “the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality and speed (Hammer and Champy, 1993). Although BPR was originally introduced as a major change to the total process flow, the concept has been used in many different ways (Davenport and Stoddard, 1994; McNulty and Ferlie, 2002; Locock, 2003). Despite an increasing number of redesign projects in health care, little is known about their effectiveness. Evidence-based medicine (EBM) teaches us that practice should be based on sound evidence that has been derived from clinical data captured in experimental studies of the highest quality and preferably also validated in observational studies (Walshe and Rundall, 2001). In a standard hospital supply chain, all material operations are controlled by material personnel including purchasers, material handlers, and storeroom personnel. Purchasers and material handlers are typically assigned to one or more wards within a hospital (DeScioli., 2005). These complex processes span diverse functions making a new challenge for material management in a hospital supply chain. Responding to this, there is an idea to explore and improve hospital supply chain by using business process modeling. The idea is supported by Jansen-Vullers and Reijers (2005). They offered business process redesign to radically improve the performance of business processes. Information technology also comes into play. The information technologies that focus on process management and improvement are good candidates for helping healthcare while

organizations fulfill their corporative vision. Stark E. And Mangione (2010) point out that strategic view of the hospital's supply chain is critical for success. Supply chain management must be high-level, focused, concise, non-fragmented, driven towards realizable and sustainable goals, and overall collaboration.

From above, we found that the healthcare system is complicated and various. So, the business model is created to understand the nature of organization and to analyze for finding the new process that is a high performance.

2.4 Inventory Management System in Hospital

Effective inventory management is important to achieve a profitable value chain. For companies that operate on low margins, a good approach in inventory management can make the difference whether the company will stay in business or not. The challenge lies in keeping the right amount of inventory to satisfy demand and customer needs, and on the other hand, it does not keep inventory that tie up to much capital (Krajewski & Ritzman, 2005).

Often companies are faced with the challenge of determining ordered quantities, optimal production quantities, safety stock levels and other important inventory policies that will affect supply chain costs. It is for this reason that inventory management has emerged as one of the key factors for effective supply chain management (Talluri et al., 2004)

The main of the information flow covering three major functions in the hospital is Inventory Management System which is in the part of pharmacist need to know about when and how many to replenish. This section summarizes some of published research in this area. Manuel D.Rossetti(2008) shows the paper in the part of Inventory Management Research in Health Care, such as, the solutions of MIT Center for Transportation and Logistics focused on making supply chain more demand driven, increasing collaboration between the various parties involved, increasing visibility of practices and inventories, and implementing more and better standard. In summarized, they point out to use of better demand forecasts to improve servicing while reducing inventory .Burns and Pauly suggest using more practical ways of

reducing cost, such as improving the information technology(IT) systems and the better handling of the treatment of chronic diseases, which often consume high cost. The health care sector inventory management has a limit of warehouse because of various medicines and difference of limitation and expiration. So, in the field of inventory management, the suitable and accurate forecasting for decreasing fault may occur with the patient. From literature review, it is found that the accurate forecasting should be come from demand driven since in this case is patient demand.

2.5 Technical Reviews

2.5.1 Information and Information System Concept

Data cover facts and figures that are relative meaningless to the user. Data are the raw material of information that is transformed into information by an information process.

Information is a collection of facts organized, arranged and processed (by sorting, classifying, merging, computing or summarizing) in such a way that they have additional value beyond the value of the facts themselves. They are simply useful data used in the decision making process. For instance, sales forecast data that can be processed to produce information which helps determine production strategies.

System is a set of elements or components that interact to accomplished goals. The elements themselves and the relationships among them determine how system works. System has inputs, processing mechanisms, outputs and feedback.

Information System (IS) is set of interrelated elements or components that collect (input), manipulate, store (process) and disseminate (output) data or information and provide a feedback mechanism. IS designed for operations managers is valuable if they can provide information to help in controlling operations timely.

Input is the activity of capturing and gathering raw data since it can be a manual process or it may be automated.

Processing involves converting or transforming data via manipulation and store into useful outputs. It can be done manually or with the assistance of computers.

Output involves processing useful information, usually in the form of documents, reports and transaction data. It can be produced in a variety of ways such as computer, printers and display screen are common output devices.

Feedback is output that is used to make adjustments or changes to input or processing activities. It is used by the system to monitor, control and help its operation to make sure it continues to meet its goals and objectives[8].

2.5.2 Integration Definition for Function Modeling

IDEF0 may be used to model a wide variety of automated and non-automated systems. For new systems, it may be used first to define the requirements and specify the functions, and then to design an implementation that meets the requirements and performs the functions. For existing systems, IDEF0 can be used to analyze the functions which the system performs and to record the mechanisms (means) by which these are done. The result of applying IDEF0 to a system is a model that consists of a hierarchical series of diagrams, text, and glossary cross-referenced to each other. The two primary modeling components are functions (represented on a diagram by boxes) and the data and objects that inter-relate those functions (represented by arrows).

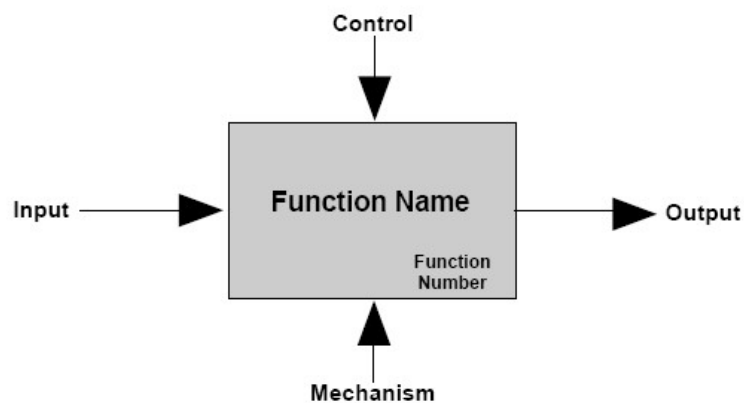


Figure 2-2. Integration Definition for Function Modeling (IDEF0)

The IDEF0 model displayed here on above is based on a simple syntax. Each activity is described by a verb based label placed in a box. Inputs are shown as arrows entering the left side of the activity box while output are shown as exiting arrows on the right side of the box. Controls are displayed as arrows entering the top

of the box and mechanisms are displayed as arrows entering from the bottom of the box. Inputs, Controls, Outputs, and Mechanisms are all referred to as concepts [9].

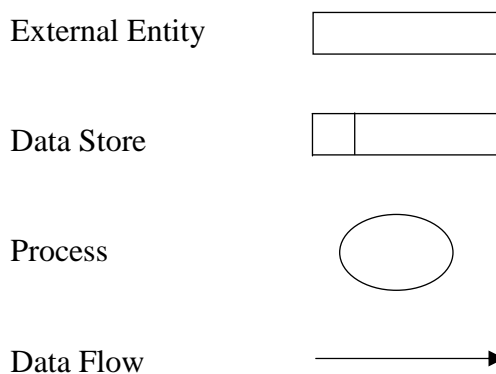
❖ Arrow : A directed line, composed of one or more arrow segments, that models an open channel or conduit conveying data or objects from source (no arrowhead) to use (with arrowhead). There are 4 arrow classes: Input Arrow, Output Arrow, Control Arrow, and Mechanism Arrow.

❖ Box : A rectangle, containing a name and number, used to represent a function

2.5.3 Data Flow Diagram (DFD)

A data flow diagram is a top – down structure analysis and design tool, which illustrates the flow of data through a system and the work performed by that system. The data is transformed at each step before moving on the step.

Data flow diagram has the advantage that it is efficient for explaining the system to the users who can therefore participate in validating the analysis. Data flow diagram symbols are four notation of data flow specification.



- External entity is an environment around the system that interacts with the system, shown as a rectangle. For example: people, places or object for which data are (เนื่องจาก data เป็นพหูพจน์ค่ะ เอกพจน์ของมันคือ datum ดังนั้นกริยาต้องเป็น are) stored, collected and maintained.

- Data store is a repository of data used and maintained by the system, is depict open – ended box. A data store can represent database, filing cabinet, computer memory or manual data storage.
- Process is modified or changed data from one form to another form and the process transforms this data to produce output data.
- Data flow shows the direction of the work flow (is shown as an arrow). The flow travels between processes, data stores and external entities. Data flows can be inputs or outputs[8].

2.5.4 A Database and Database System

A database consists of some collection of persistent data that are used by the application systems of some given enterprise. The database itself can be regarded as a kind of electronic filing cabinet; in other words, it is a repository for a collection of computerized data files. The user of the system will be given facilities to perform a variety of operations on such files such as adding, inserting, retrieving, updating, deleting and removing data. A database system is basically a computerized record keeping system and its purpose is to maintain information and to make that information available on demand. A database system has four major components, namely, data, hardware, software and users.

2.5.5 The Entity – Relationship Model

The entity – relation (E – R) model is based on perception of a real world, which consists of a collection of basic objects, called entities and relationship among these objects. An entity is an object that is distinguishable from other objects by a specific set of attributes. A relationship is associates among several entities.

There are various notations of an E – R diagram, which consists of following components.

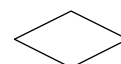
Entity Sets



Attributes



Relationship among Entity



Link between Attribute and Entity Sets

or Entity Sets and Relationship

The relational model is a way of looking at data. It is a prescription for a way of representing data (namely, by means of tables) and a prescription for a way of manipulating such a representation. The ideas of the relational model apply at the external and conceptual levels of the system not the internal level. The relational model represents a database system at a level of abstraction that is somewhat removed from the details of the underlying machine. It is concerned with three aspects of data (data structure, data integrity and data manipulation). These three aspects are object, integrity and operators.

- A relation corresponds to what is called a table.
- A tuple corresponds to a row of such a table and an attribute to a column. The number of tuples is called the cardinality and the number of attributes is called the degree.
- The primary key is a unique identifier for the table, a column or column combination with the property that, at any given time, no two rows of the table contain the same value in that column or column combination.
- Domain is a pool of values from which specific attributes of specific relations draw their actual value.

The properties of relation are as follows.

- There are no duplicate tuples.
- Tuples are unordered from top to bottom.
- Attributes are unordered from left to right.
- All attribute values are atomic.

2.5.6 Normalization

Normalization is set of rules and technique concerns with identifying relationships among attributes, combining attributes to form relations and combining relation to form database. A major of data normalization is to avoid modification anomalies.

Every normalized relation has single theme. Any relation having two or more themes should be broken up into two or more relations; each of which has a single theme. This process is the essential of normalization. When we find a relation with modification anomalies, we eliminate them by splitting the relation into two or more separate ones, each containing a single theme.

CHAPTER III

MATERIALS AND METHODS

This chapter reviews the research study area selection data sources and collection, describes materials and methods that used to analyze, design and develop the application prototype for logistics flow of medicine in the hospital.

3.1 Research Study Area Selection

As reviewed in the previous chapter, the research objective are analyze medicine flow of across three major functions in the hospital and re-design business process together with develop the application prototype for support logistics flow of medicine in the hospital.

The current system illustrates the unconnected information between end demand at each ward and the reorder point calculating at the warehouse. But, warehouse and medicine store room in each ward are connect with medicine requisition from medicine store room. The level of replenish are decided by the experience of pharmacist in each ward. Therefore, the calculation for each month for purchase medicine does not reflect from the end demand and a higher opportunity discrepancy. Thus, from current medicine ordering system can be seen that the total order has not been considered patient's real demand.

Then, we propose a linkage from the ward storeroom to the warehouse. The end patient usage is reflected to the warehouse. Instead of using the pharmacist's experience in setting minimum stock level for reordering point, the central warehouse can monitor the supply chain stock and set the reorder point more accurately to the end patient demand. The patients' medicine dispensed quantity per day is then sent directly from each ward's storeroom to reorder point calculation. Also stock is updated at the same time as medicine is dispensed from the warehouse.

3.2 Data Sources and Collection

For primary data, it is collected for this research. These are based on observations and interviews, to investigate how medicines are flown and managed. The study found that medicine and its information are flown across three major functions in the hospital. These are medicines storeroom in each ward, medicine central warehouse and the purchasing department. Then, we collected a one-year data of 5 medicines starting from October 2005 to September 2006 to compare the result of the application prototype for support logistics flow of medicine in the hospital.

3.3 Methodology

In this section, research methodology will be presented. The proposed consists of main steps as follows:

3.3.1 Preliminary Investigation

Gathering data from interviewing phase is necessary and studying the current information system flow, to investigate how medicines are flown and managed. The study found that medicine and its information are flown across three major functions in the hospital. These are medicines storeroom in each ward, medicine central warehouse and the purchasing department.

3.3.2 System Analysis and Design

To analyze of former and new system by study logical system and physical system that will be shown in form of IDEF0. And design the information system by using IDEF0 and Data Flow Diagrams.

3.3.3 Software development.

In this step that bringing the data received from analysis and design system forms came to use in Software development for implement database and application software for this system.

3.3.4 Software testing and conclusion.

The system will be installed and tested in order to ensure that the application work properly and accurately as expected result. The debugging process will be used if there is error occurred.

3.3.5 Documentation

To prepare documentation such as user and system manual and the research documents.

3.4 Research Tools

3.4.1 Hardware

Consist of the following equipments.

- CPU Pentium IV 2.4 GHz.
- RAM 512 MB
- Hard Disk 60 GB
- Mouse
- Keyboard
- Monitor

3.4.2 Software

- Visio (for create Data Flow Diagram)
- Microsoft WINDOWS XP
- Microsoft Visual Studio 2005
- Microsoft SQL Server 2005 Express

CHAPTER IV

RESULTS

This chapter shows the new business process based on the development of application prototype for supporting logistics flow of medicine in the hospital.

4.1 Current System

To understand logistics flow of medicine in the hospital, interviews are conducted. The questions are to investigate how medicine are flew and managed. The study found that medicine and its information are flown across three major functions in the hospital. These are medicine storeroom in each ward, medicine central warehouse and the purchasing department. When medicines are delivered by suppliers, it is sent to the central warehouse. The warehouse checks against purchasing order and store these medicines in its storeroom. Then the warehouse distributed medicines to each ward storeroom according to the requests. Fig. 4-1 shows medicine distribution system in the hospital.

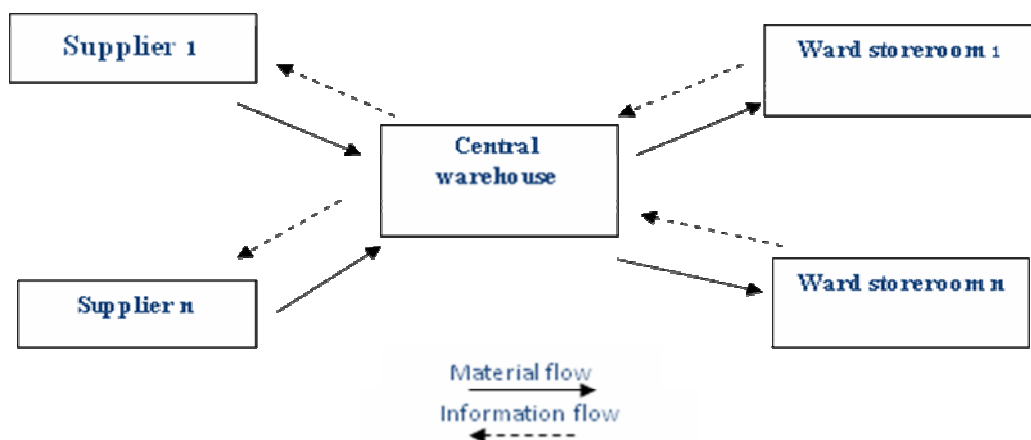


Figure: 4-1: Medicine distribution system in the hospital

As the research about operating system of present medicine inventory and medicine-stored room, its management is as followed:

Medicine-stored room

There are totally 7 medicine-stored rooms divided into 5 rooms such as main medicine-stored room, drug ER, drug room for Obstetrics & Gynecology and drug room for children also two drug Inpatients rooms such as drug room5 and drug room7. In each room, there are different drug items depended on the specific check-up units

Drug Dispensary

There are 5 medicine-stored rooms for out-patients as:

1. The main role of large drug room is to dispense drug to:

- Out-patients in different departments
- Inpatients rooms
- Dispensing small rooms (request or borrow)

2. ER room takes responsibility on dispensing drugs for 24 hours. Since other medicine-stored rooms are closed in night time so ER room has to stand by for serving drugs for all needs at night

3. The Ophthalmic pharmacy offers dispensing special drug.

4. The Obstetrics pharmacy gives service of dispensing special drug.

5. The drug room for children offers dispensing drug to inpatients in children ward.

There are 2 medicine stores for inpatients as medicine-stored room no.5 and medicine-stored room no.7 which their principal roles are to dispense drug to the inpatients of hospital.

Drug Request

The pharmacist asks for the drug request based on MIN (at least quantity of drug inventory), MAX (highest quantity of drug inventory). The pharmacist who takes responsibility in each drug room specifies types and number of drugs needed while the program has MIN-MAX system provided for drug ordering. Everyday, each

drug room will send a form for ordering drug to the store on 9.00 am. to 9.30 am. but the drug dispensing is not daily operated. Mostly, the process is run on Monday, Wednesday, Friday (the main drug room) and drug will be dispensed on Thursday in case of emergency.

For normal drug dispensing, the medicine-stored room concludes daily drug request but not drug order for the store. Also, there is no record of drug in and out. In case of emergency, the form will be printed and is asked pharmacist to sign for drug ordering. This process is not different from drug dispensing in advance since both of them have to be recorded in the emergency book of drug request. The emergency drug request has no specific rule for controlling, but it is depended on responsibility of officers who request the drugs. In case urgent need, any drug room can borrow needed drugs from other room and return them back later.

To Purchase

To Purchase new drugs, the purchasing department employs concerned drug information from the drug inventory's database and some from Msale. The purchasing department will print lists of needed drugs and select the proper some from the lists for ordering.

To Purchase drug, there are 3 main drug supply routes as:

1. To order directly from pharmaceutical companies. The time consumed from ordering till receiving drug is at least 10 days in normal ordering and 2 days for urgent case. The urgent case can be possible on two conditions as:

- a. The high worth drug which is directly ordered through direct selling or direct contract

- b. The low cost drugs can be ordered by a limited contract (not more than 100,000 baht/round). Since low cost drugs must be provided for patients frequently, a new contract for ordering more than 100,000 baht/round must be set if it is needed. At the end of the year, annual payment of drug ordering is summed up, then divide them into not more than 100,000 baht a month. In case of being more than 100,000 baht, it is necessary to make the contract in order to eliminate an incident of the higher price.

2. To order from governmental-pharmaceutical organization, this route can be proceeded by reserving drug in-needed before ordering. When the process of reserving has been accepted, the hospital then provides a form for ordering. Lead time since ordering till keeping drug in the inventory is 30 days.

3. To order from The Office of Consumer Protection, lists of drug which can be ordered from the office cover psychotropic drug and drug related to nerve system including type-II of drug abuse and drug dependence. Generally, the Office of Consumer Protection offers the quota of specific drugs for each hospital and hospitals have to pick up ordered drugs they ordered by themselves.

There is the same pattern on purchasing drug from various companies. Anyway, there are some types of drugs which are less in rate of dispensing but more in volume of dispensing in each time. In addition, drugs purchased from source no.2 and 3. are different in price from other sources. Moreover, hospitals have to pick up donated drugs from their donators and some from the Red Cross Society.

Drug Store

There are over 2,000 items in drug inventory in which there are 11 staffs taking responsible for controlling them. One staff is in chart for only one zone. Staffs have to bring the nearly expired drug up front and when new drugs are sent, the drug stock will be filled from the bottom upward. Drugs will be reserved in the cold-storage place categorized owing to types of drugs. Especially, the dangerous one is kept separately and carefully.

Drug Dispensary

Drug dispensary for all types will be recorded and drug stock is regularly check everyday. Information of drug dispensary is linked to purchasing department and each time for dispensary is not more than 3 hours. When the process of dispensary is finished, related data will be updated based on remained drug available in the inventory. At 07.00 in the morning, concerned officers have to check the available number of drugs in stock.

To Purchase (Transfer to purchasing department)

Drug toll in the inventory can be estimated through Msale (drug toll in stock divided by month) . There are 3 methods applied for the inventory checking:

1. For the regularly used drugs, if Msale (the number of drugs per day in stock) is lower than 70%, the total volume of order will probably reach 100 – 150%.
2. Some dangerous drugs will be purchased/ordered early since they are in complicated process and take time for asking permission to order.
3. Life-saved drug must be stocked even it has never been dispensed.

The operation for ordering drugs is done daily through 50-60 order forms with 20 companies. The lists of drug are prepared then the pharmacists will consider which types of drugs needed to be purchased and what companies. The in-and-out flow of drug is presented by IDEF and the Function Flow Diagram below:

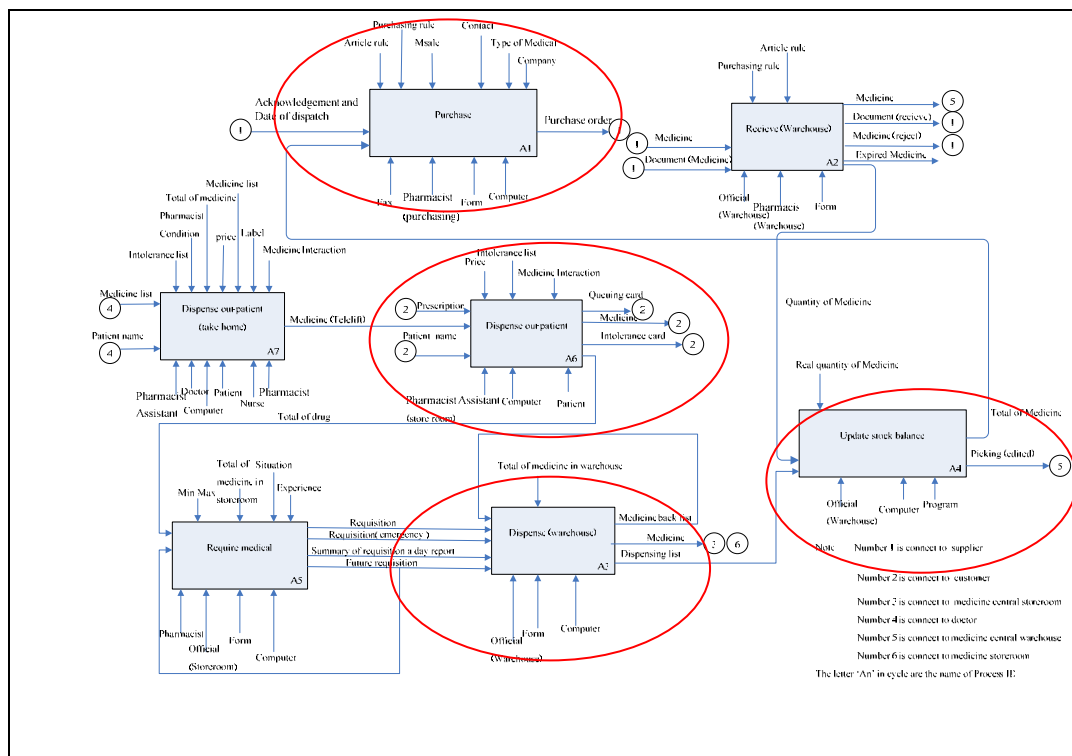


Figure4-2: The internal management flow of hospital.

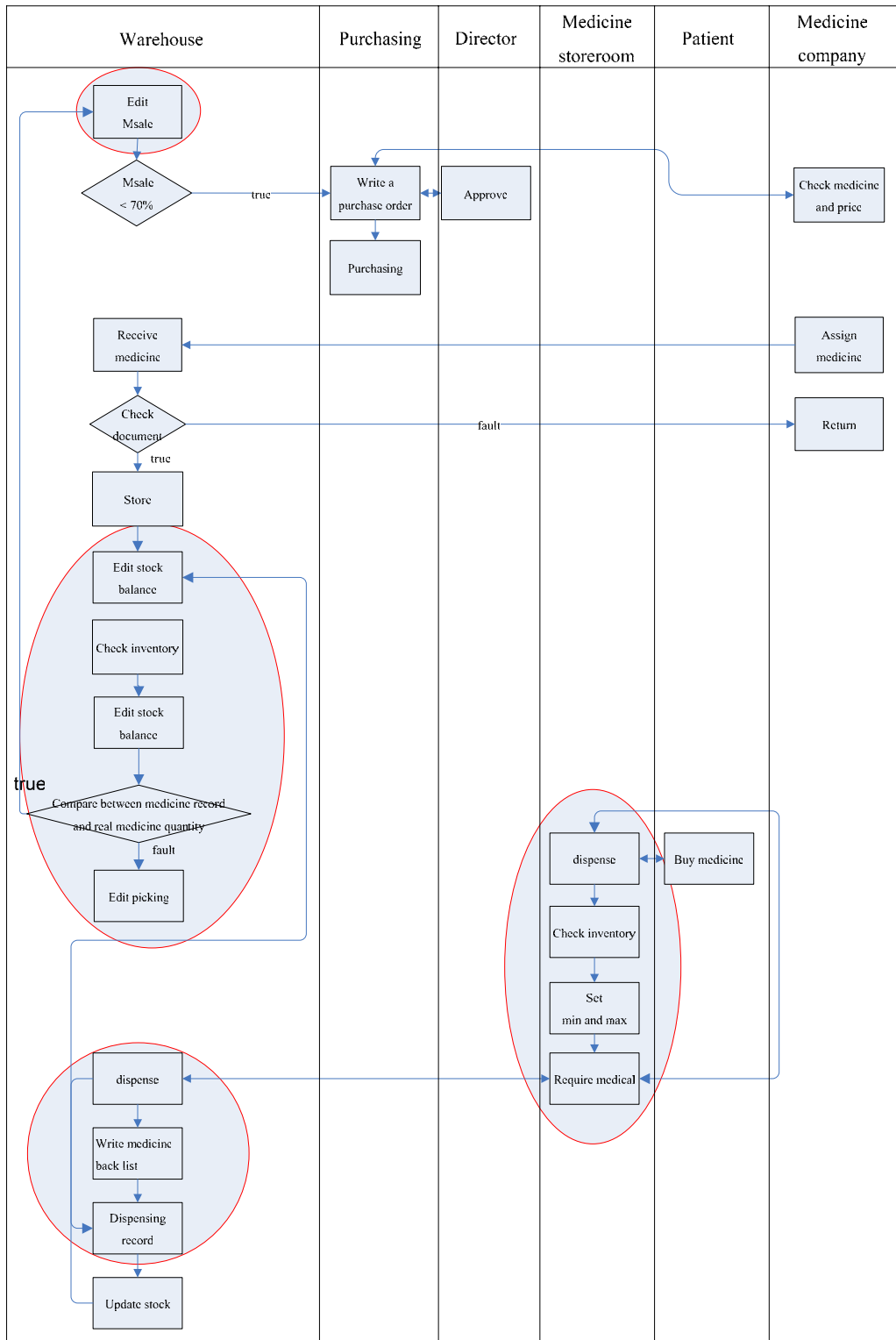


Figure4-4: Function Flow Diagram shows the process of drug purchasing and dispensing.

The problems of IDEF0 and Function Flow Diagram are often found as:

- The staff of drug room does not keep the statistical record on drug dispensary regularly.
- There is no information exchange between the inventory and drug rooms so it causes a new nonsense job of reporting the suspended drugs.
- To count to Msale, it does not concern for the time of drug receiving or dispensing as well as statistic information of drug dispensing daily. Then, it causes over-ordering which finally ends up with huge volume of expired drugs.
- Remained drugs in the inventory are formally checked double times. This repeated process occurs from the problem of having no information linkage between the inventory room and drug rooms.

4.2 The Interviewed Information

Drug Inventory

The problems which are often founded.

The number of drugs needed to purchase or Msale (Amount of dispensing drug / month) is not precise which causes delayed ordering, over-ordering as well as error number of drugs from the number forecasted.

Medical Information

The interviewees for this study cover: IT officer and concerned officers who are responsible in program of drug room and drug inventory.

The problems which are often founded

The system of drug room and drug inventory is separated. They will be linked by the order forms which are prepared by small drug store. Every drug room must use the same order form. The drug-ordered program is normally operated in the morning as the officer of drug room starts to key in the details into program according to the orders gained from pharmacist.

Drug Room

Interview with the pharmacists' supervisor revealed some problems that

The problems which are often founded

- Lack of systematic drug operation since it strongly depends on the decision of physicians and various-scattered policies of organizations and hospitals.
- Some drugs are too much available in the inventory since the process of delivery is shorter in time than it should be.
- Undisciplined time asked for drugs since there are some orders occurring out of the office hours (The drug rooms were closed)
- Drug order arbitrarily depends on the decision of physicians. For example, if physician "A" is dealing with patients, drug room must be ready for him no matter whether it is in the office hour or not.
- There are many new kinds of drugs launched in each year. These new kinds of drugs affect to recent drugs available in stock, especially those which the new one can be substituted.
- If the patients want to buy medicines but there are not available in the inventory or stock. This kind of case is not recorded in which it means the hospital loses important information for making decision for drug purchasing in the next time.

The factors of problems

- The national policies about dispensing: when we ask for the drugs from main accounting dept. directly, it causes the more using of some other drugs because in-patients never pay the expense in advance. To change the drug items in national drug accounts influence to use drugs extremely.
- The organizational policies: it is to specify the using drug that hospitals have ever dispended and later they change some policies that it influences to using drug. Moreover, there are some underline policies (means to confirm using the original drugs or as ordered by physicians and never placed by generic local drugs). But however, the national policies in this case are created not often but they are many effects to people that if it is out of stock, it must be purchased.

- To decide in personal level: for example, one physician used to prescribe a type of drug but later he went aboard so that kind of drug is lowered in terms of volume used accordingly.

- Some situations such as pestilences etc. probably cause the appointment of medical students, nursing students to inject patients. Normally it is peak of amount of people during before and after holidays. The medicines to used in this situation reduce Msale because there are enough ones to dispense (Msale is accounted by the dispensing ones)

To Purchase

As the interview, we found that the complete purchasing can be done for drugs which are used regularly shown in terms of their dynamic stock but for those of static, the purchasing might be impossible.

The problems which are often founded.

If the drugs have own values over 100,000 baht as purchasing agreement , it must to keep some part of drugs in order to purchase in the next day but in the program, the kept drug never show the movement in the next day so the drugs are out of stock.

After finding problems, we ask IT department about the problems of Ramathibodhi hospital. We found that IT section has never known the occurred problems because the old program has used for very long time.

4.3 The working system of medicine inventory and information system

The information system of medicine inventory program is the resshelf system aimed to dispense drug and adapt the inventory. The program operates according to the objectives as followed:

1. To increase or reduce the responsibility of each group
2. To adapt the value of MIN MAX
3. To dispense and record in-out drug items for drug inventory

4. To adapt the value of inventory on hand to increase or reduce the things.

5. To ask for drug

6. To make daily report

The information system which is used in the drug inventory shows the details of each items and show the quantity of drug in inventory.

4.3.1 Main medicine-stored room

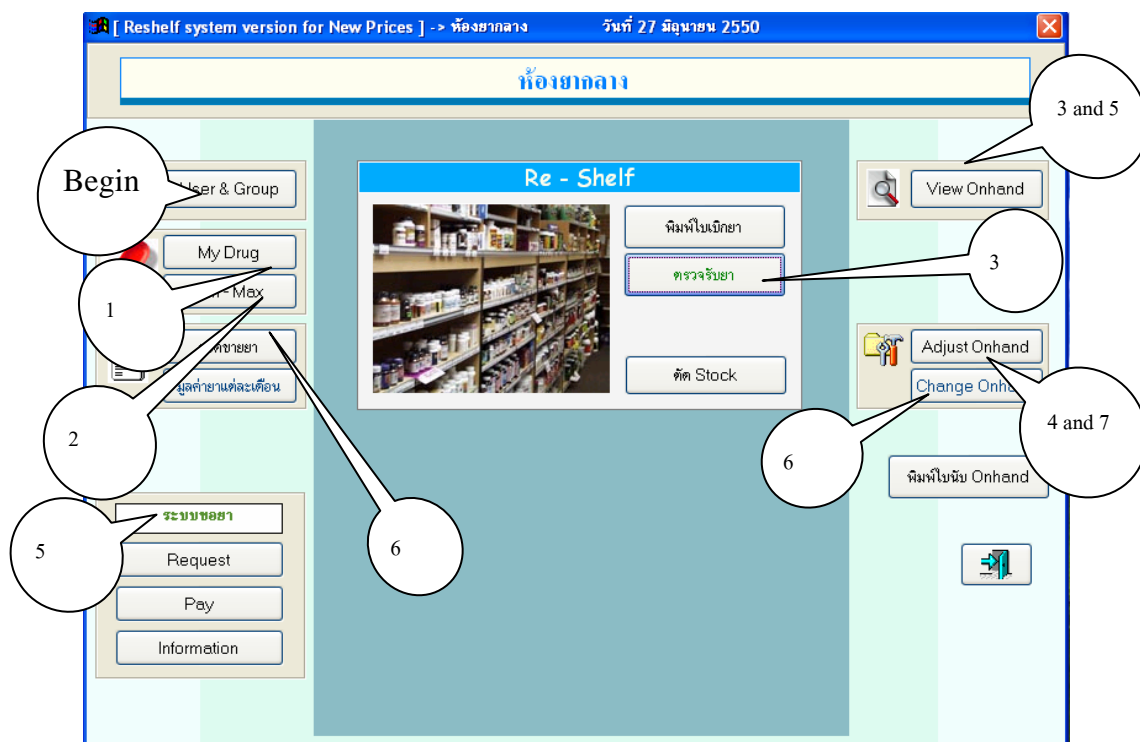



Figure4-5: The program of drug room

The program of drug room starts from “click the button of User & Group” in order to fill the different groups that each group separate the responsibility about drug and each one must care of own responsibility. It needs to fill Username and password every time when they want to select the items.

1. To increase – reduce the responsibility of each group

To increase the drug into stock, we must to select the drug items as required then click **➡** in order to increase them??? into the group. If we want to

reduce the selected drugs, we can press  in order to send the request of drug items to group without notification. Then click “save” button. In this sample, it shows the drugs which are in responsible of YOSO group that they divide their responsibilities that it depends on each duties of each drug room and it divided the different responsibilities of officers in each drug room.

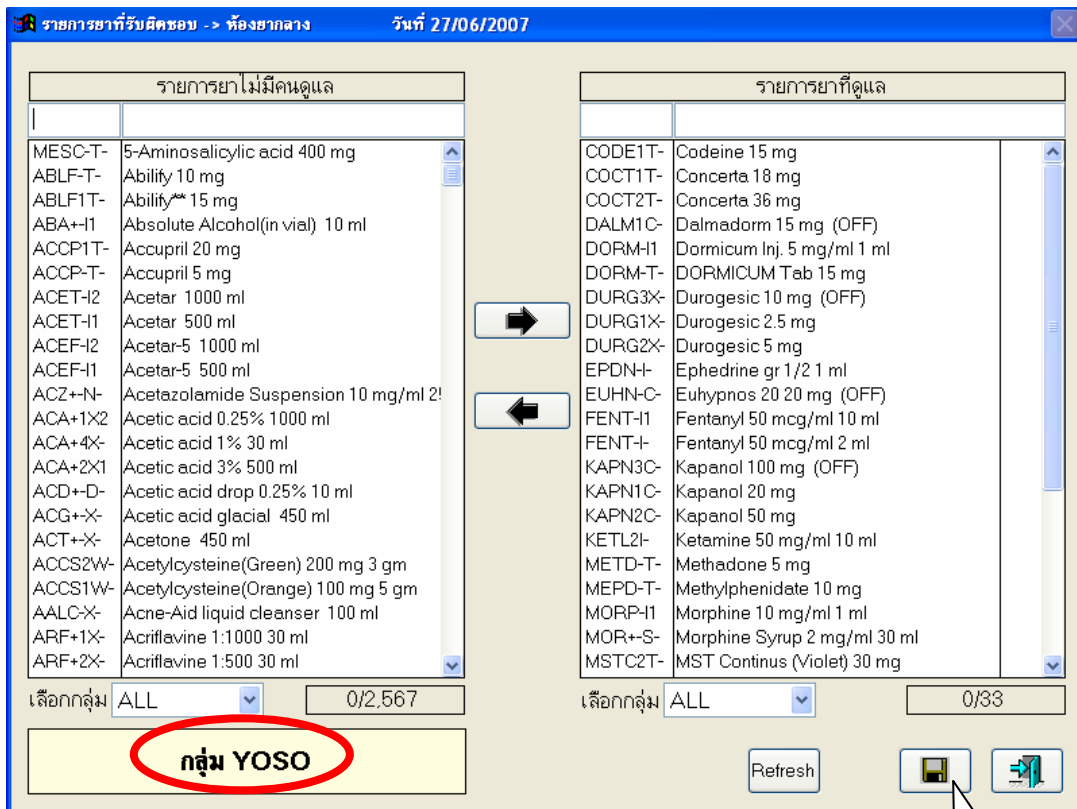


Figure4-6: The program of drug room 1

2. To adapt the value of MIN MAX (As IDEF Processed A5)

The pharmacists fill the value of MIN-MAX which are specified by the experiences that they fill the value in the scale of MIN – MAX of each drug items.

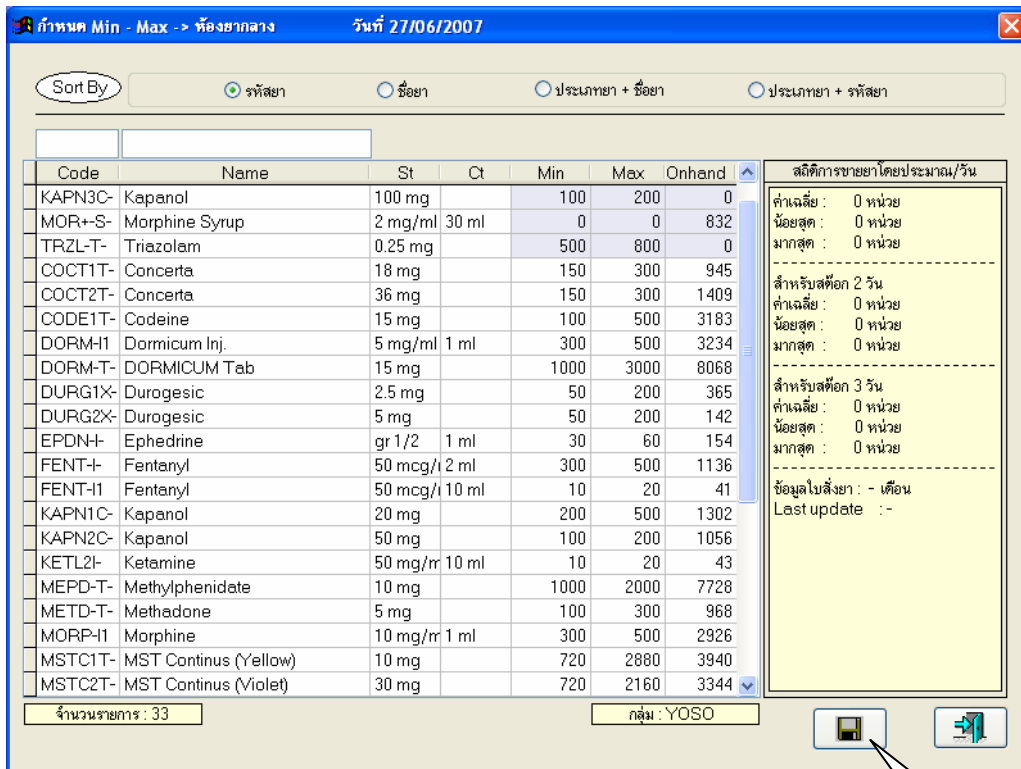


Figure4-7: The program of drug room 2

save

3. To dispense and record the drugs items of drug room (From IDEF Processed A5)

Each drug room must send the order form which is printed from the program then sends dispensing file via the information system, also to the drug inventory. Within the order form, it shows detailed files that there are 2 features of dispensing as followed:

- To dispense full amount of drug automatically
- To dispense with the number of drugs as pharmacist required.

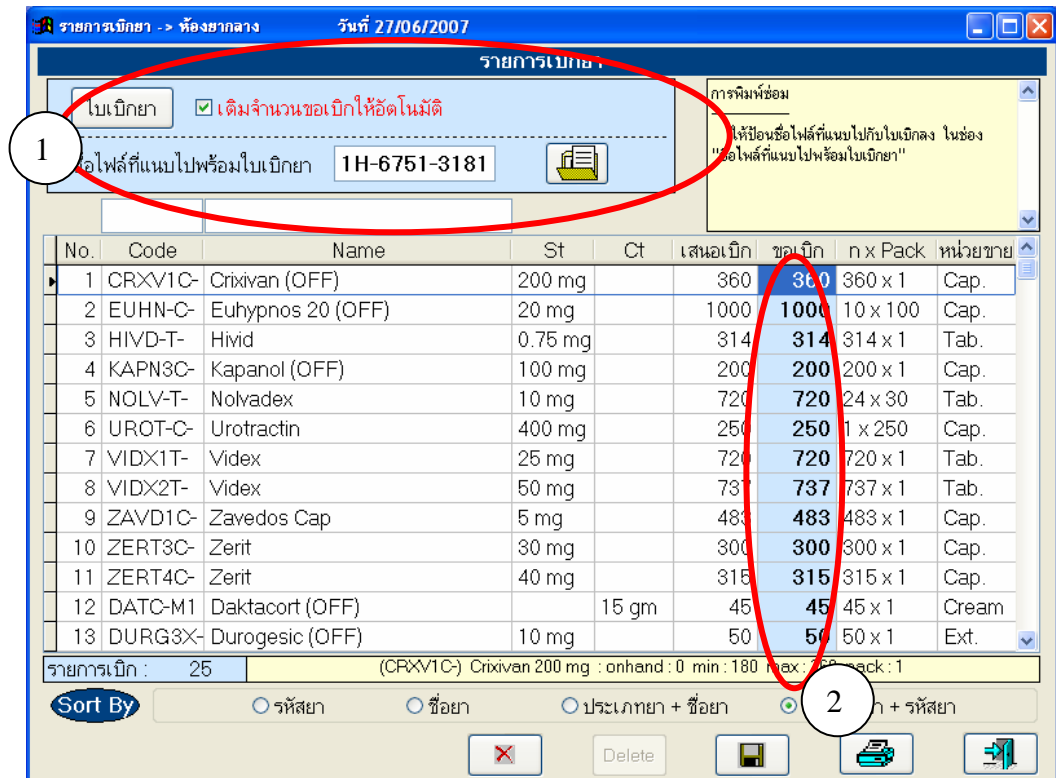


Figure4-8: The program of drug room 3

When they've been filled already, press "print" button

When we print the dispensing drug items, it shows the dispensing drug report. When they've finished the dispensing process already, the officer of drug room will check all drugs and it needs to be recorded how many receiving drugs that it is shown as blue tab then click save button.

บันทึก/แก้ไข จำนวนรับ -> ห้องยากลาง วันที่ 27/06/2007

บันทึกการรับเข้า

RefNo 1H-6751-6636

ตำแหน่ง

ให้ป้อนหมายเลข ไฟล์ที่แนบมาบันทึกสารจากยา ลงในช่อง RefNo หรือ แฉีกจากรายการยาจาก ปุ่ม "รายการยา" เมื่อเสร็จสิ้นรับเข้า ให้คลิกปุ่ม Save เพื่อเปลี่ยน Onhand

No.	Code	Name	St	Ct	ขอเบิก	ได้รับ	n x Pack	หน่วยขาย
1	BETV-M3	Betnovate	0.1%	15 gm	60	60	60 x 1	Cream
2	CASK-J-	Capsika Gel		35 gm	10	10	10 x 1	Gel.
3	CETP-X-	Cetaphil Cleanser		125 ml	36	36	36 x 1	Ext.
4	CLBT-M-	Clobetasol	0.05%	15 gm	60	60	60 x 1	Cream
5	CLOT-M1	Clotrimazole	1%	10 gm	40	40	40 x 1	Cream
6	CLRM1M-	Clariderm	2%	10 gm	40	40	40 x 1	Cream
7	DATC-M-	Daktacort		5 gm	36	36	36 x 1	Cream
8	DEMC-M-	Dermacombin		15 gm	30	30	30 x 1	Cream
9	DEMT-M-	Dermatop	2.5 mg	5 gm	100	100	1 x 100	Cream
10	DIFE-J-	Diclofenac	1%	30 gm	180	180	180 x 1	Gel.
11	ELOM-M1	Elomet Cream	0.1%	5 gm	100	100	2 x 50	Cream
12	ELOM-M2	Elomet Cream	0.1%	15 gm	20	20	20 x 1	Cream
13	EPER-O1	Esperson	0.25%	5 gm	100	100	1 x 100	Oint.
14	FASC-M-	Fascicare		50 gm	24	24	24 x 1	Cream

รายการเบิก : 37 (BETV-M3) Betnovate 0.1% 15 gm : onhand : 2,296 min : 60 max : 100 pack : 1

Sort By รหัสยา ชื่อยา ประเภทยา + ชื่อยา ประเภทยา + รหัสยา

Figure4-9: The program of drug room 3(2)

4. To adapt the value of on hand in drug room to increase and to reduce everything (From IDEF Processed A5) such as to return drug/medicine, to borrow drug/medicine.

To adapt the value of on hand is divided into 2 reasons that the symbol + (Blue) will be increased highly weather we select the reason of increased drug quantity and the symbol – (light orange) appears weather we select the reason of reducing the drug amount as filled. After finished process, click the save button.

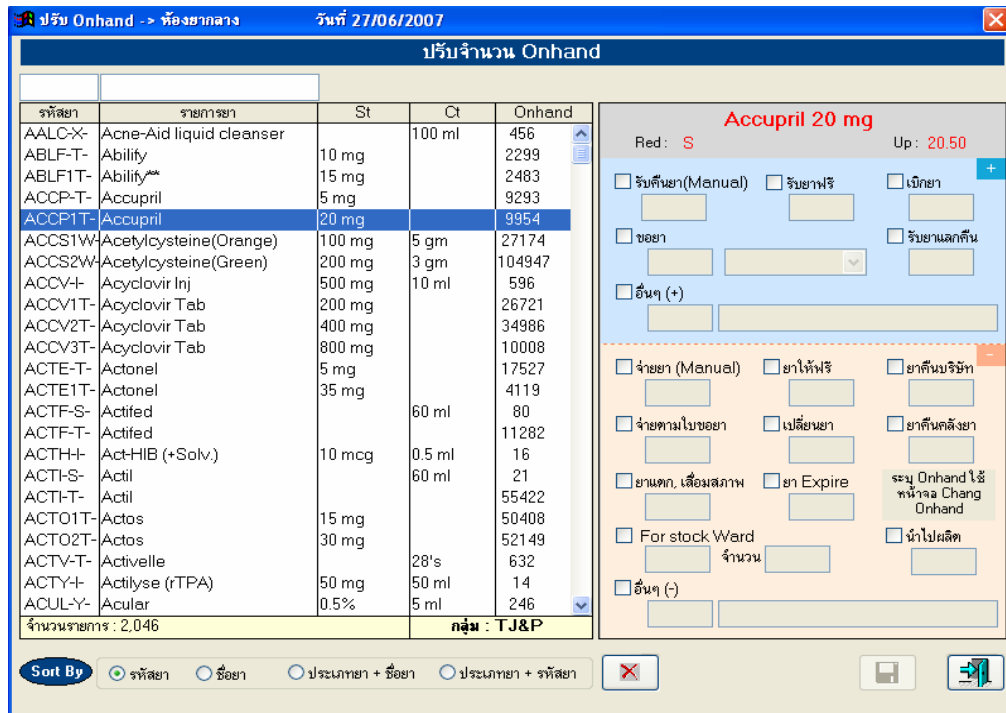


Figure4-10: The program of drug room 4

5. To ask for drugs (From IDEF Processed A5)

The process of asking drugs, firstly, users have to identify whether drugs are ordered from drug room or patient. Later, users select drug room and type of drug then print the filled form for drug ordering.

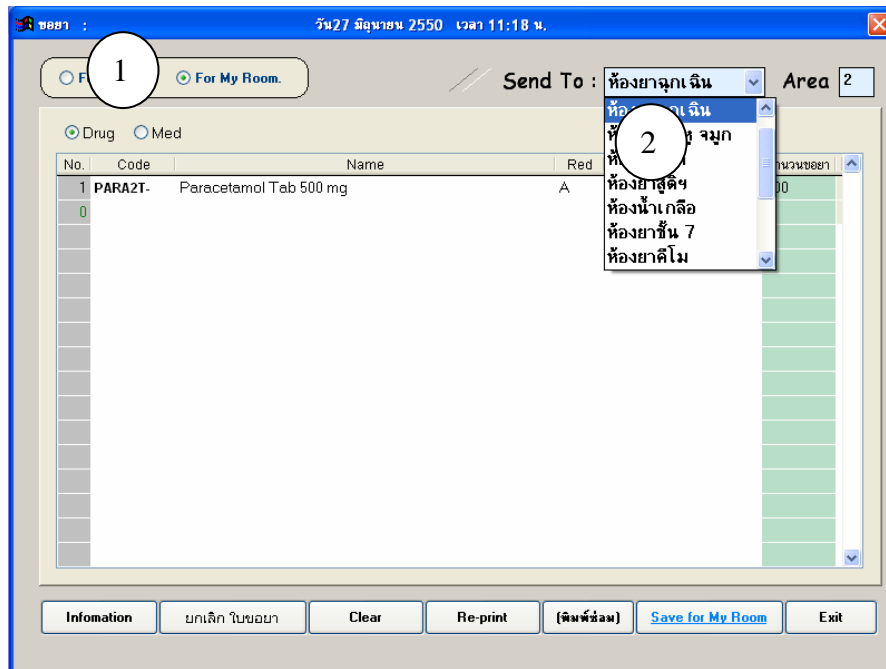


Figure4-11: The program of drug room 5

In the case of in-patients, it must fill the patients name and collect the details in database of drug rooms.

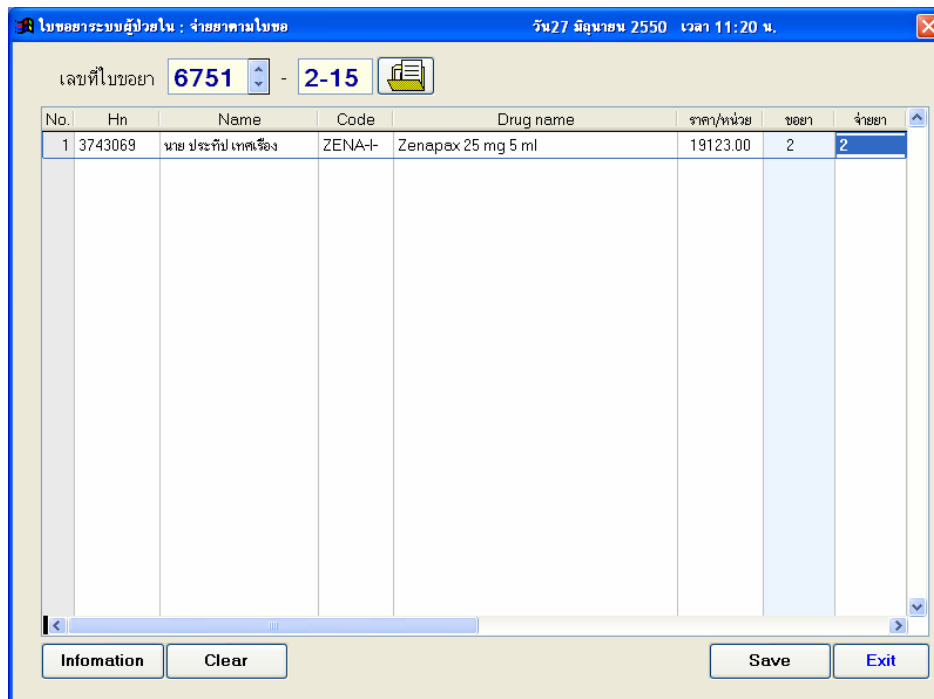


Figure4-12: The program of drug room 5(2)

6. To create the monthly report (From IDEF Processed A5)

To choose year, month then print the report.

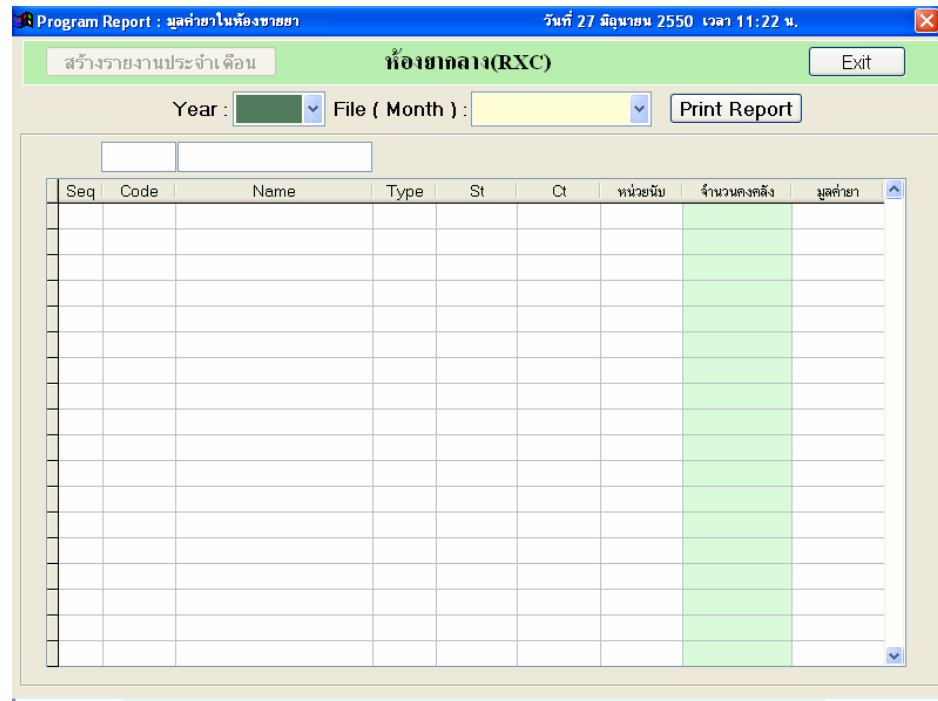


Figure4-13: The program of drug room 6

4.3.2 Inventory

1. To check the details of each medicine

This page designed is for checking the details of medicines such as name, supplier and amount in stock, price and value of Msale

Query Onhand : Version for SAN

Find Drug

คำที่ต้องการค้นหา

Do Clear

Code	Name	St	Ct
ACCP1T-	Accupril	20 mg	
ACET-I1	Acetar		500
ACET-I2	Acetar		100
ACEF-I1	Acetar-5		500
ACEF-I2	Acetar-5		100
▶ACCS1W-	Acetylcysteine	100 mg	5 g
ACCS2W-	Acetylcysteine	200 mg	3 g
AALC-X-	Acne-Aid liquid cleanser		100

ชื่อยา Acetylcysteine 100 mg 5 gm

บริษัท Greater Pharma Limited (Greater Pharma Limited)

Unit price 1.50 Onhand 4,740 Msale 9498

Ord_no	Proc_st	Proc_end	Ign_dt	Ord_qt	Pack	Pp	In_qt	Free	Sup
0009344/50	19/06/2007	22/06/2007	28/06/2007	300	60	36.92	0		GRGRT

Exit

Figure4-14: The program of warehouse 1

2. To check the number of medicines in inventory (From IDEF Processed A4)

This program is shown the details in drug inventory. Users will print the lists then use them with the stock guard form (by hand writing) (attached doc.) in order to check the remained medicines in the inventory.

Date	Bno	Qty	To	Balance	Agent	Qt	Pck	Act	Code
10/09/06				1120	OLAST	11	28	2	CASD-T-
10/09/06				1176	OLAST	2	28	P	CASD-T-
10/09/06				1204	OLAST	1	28	P	CASD-T-
10/19/06	18285	280	A	924					CASD-T-
10/26/06	18425	280	A	644					CASD-T-
10/30/06				1764	OLAST	40	28	2	CASD-T-
10/30/06				2044	OLAST	10	28	P	CASD-T-
11/07/06	18723	644	A	1400					CASD-T-
11/23/06	19105	280	A	1120					CASD-T-
11/30/06	19285	280	A	840					CASD-T-
12/07/06	19425	280	A	560					CASD-T-
12/19/06	19680	280	A	280					CASD-T-
12/19/06				1400	OLAST	40	28	2	CASD-T-
12/19/06				1680	OLAST	10	28	P	CASD-T-
12/21/06	19736	280	A	1400					CASD-T-
12/26/06	19873	280	A	1120					CASD-T-
01/11/07	10176	280	A	840					CASD-T-
01/16/07	10294	560	A	280					CASD-T-
01/22/07				1400	OLAST	40	28	2	CASD-T-
01/22/07				1680	OLAST	10	28	P	CASD-T-
02/13/07	11027	560	A	1120					CASD-T-
02/27/07	11376	1120	A	0					CASD-T-
03/15/07				1680	OLAST	60	28	2	CASD-T-
03/15/07				2100	OLAST	15	28	P	CASD-T-
03/16/07	11803	1120	A	980					CASD-T-
03/30/07				2100	OLAST	40	28	2	CASD-T-
03/30/07				2380	OLAST	10	28	P	CASD-T-
05/03/07	12997	280	A	2100					CASD-T-
05/15/07	13215	560	A	1540					CASD-T-
05/23/07	13407	560	A	980					CASD-T-
06/19/07	14079	560	A	420					CASD-T-

Figure4-15: The program of drug room 2

4.4 Study 6 medicines represent inventory

According to the interview, we analyzed a one-year of patients’ demand starting from October 2005 to September 2006. Pharmacist selected 6 medicines which often occurred problem to represent all demand types as follows:

1. Tuberculin proved on dermal testing in animals and human, is applied for identifying tuberculosis infection. Tuberculin has a short lifetime and stock variance.

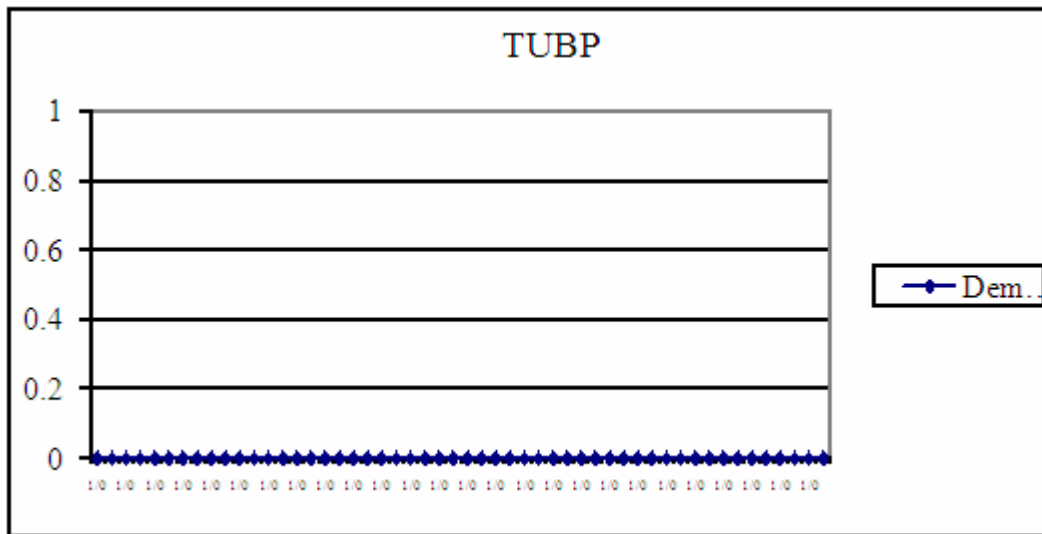


Figure 4-16: Patient's demand of Tuberculin from October 2005 to September 2006

From the figure above, an average usage rate is approximately 1 vial per week. However, sometimes the usage rate reaches to 10 vials per week. According to the interview, it is found that the high usage rate caused by giving an injection to medical student and resident before ward round. Therefore, the actual usage rate is about 1.40 vials per week or 6 vials per month. The cost of one pack, containing 5 vials, is approximately 250 baht. It is about 50 baht per vial.

Tuberculin has short shelf life, it must be used within 5 months after received from manufacturers. Therefore, the real demand of medicine usage should be 30 vials for 5 months. The average of M-sale is 41 vials per month but the average of usage is 6.08 vials per month. Thus, M-sale has not considered the patient's real demand. With the current situation the hospital need to waste 387 vials with the usage of 83 vials during a study period. It is shown that, the hospital needs to waste about 4.66 times of usage.

2. Dormicum is used to produce sleepiness or drowsiness and to relieve anxiety before surgery or certain procedures. Dormicum has been purchased frequently because of highly usages.

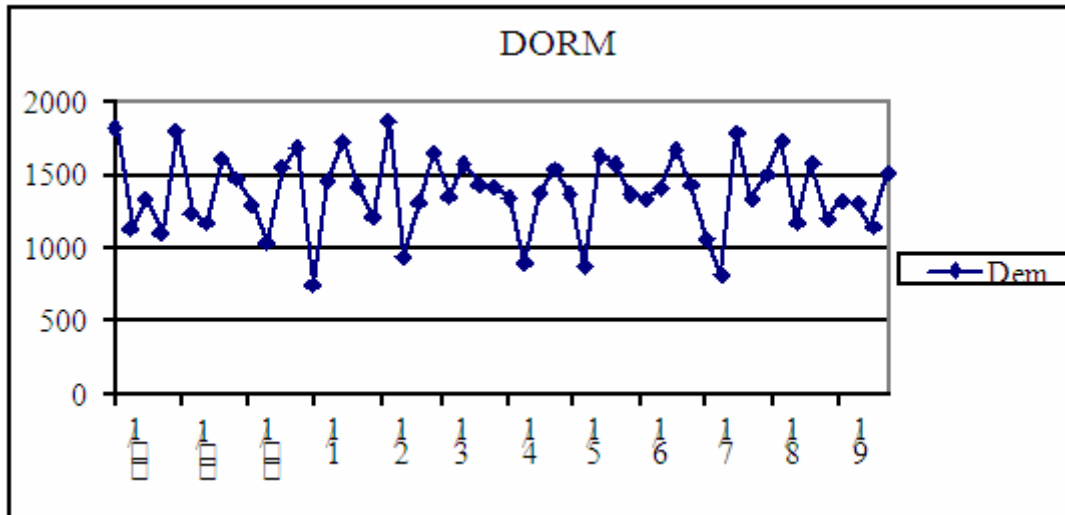


Figure 4-17: Patient’s demand of Dormicum from October 2005 to September 2006

From the figure above, the usage of Dormicum is 72,032 units for a year. An average usage rate is approximately 1,380.38 units per week and the demand has trend. But, the usage rate is in the lowest during long vacation period (31st DEC 05 – 6th JAN 06) it’s about 755 unit per week.

The cost of one pack, containing 100 units, is approximately 670 baht. It is about 6.70 baht per unit. The average of M-sale is 2,417 units per month but the average of usage is 6,002.67 units per month. Thus, M-sale has not considered the patient’s real demand.

3. Pariet 10 mg is an antiulcer drug in the class of proton pump inhibitors. Pariet is a same type as Opmeprazole and Losec Mup, so, the usage quantities are similar and related.

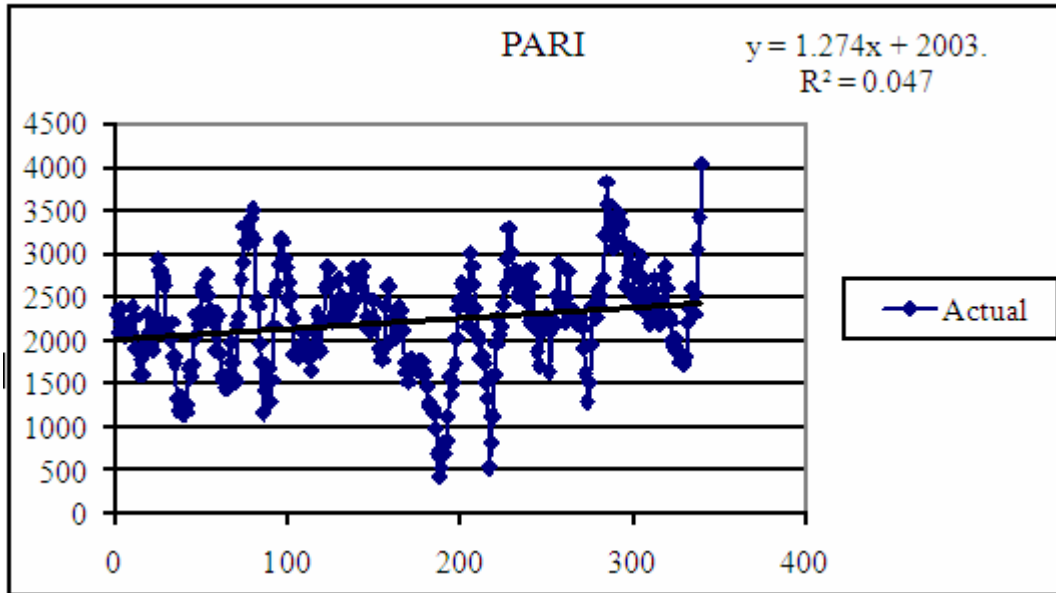


Figure 4-18: Patient's demand of Pariet from October 2005 to September 2006

Pariet is a same type as Losec Mup, but it's cheaper than Losec. The usage of Pariet covers 76,208 units per year. An average usage rate is approximately 1,462.10 units per week as it's more than Losec but less than Omeprazole and the demand has trend. The cost of one pack, containing 14 units, is approximately 524.30 baht. It is about 37.45 baht per unit. (32.57 baht per unit for included free item) The demand of Pariet has trend. In September of each year, the usage rate reaches to 9,078 units while an average usage of 11 months prior is 6,102.73 units per month.

5. Omeprazole, Even though Omeprazole has been prescribed frequently, it still suffers from drug stock-out and it has been distributed in various medicine storerooms.

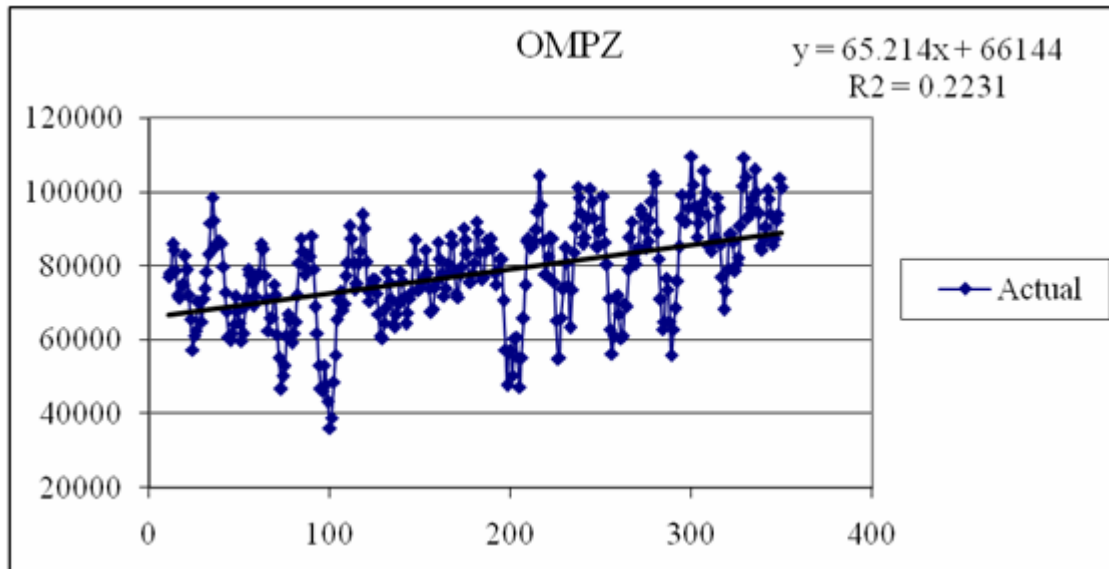


Figure 4-20: Patient's demand for Omeprazole from October 2005 to September 2006

Omeprazole is in the same type of Losec but it's a lower-price medicine. The usage of Omeprazole is 2,616,842 units per year. An average usage rate is approximately 50,190.85 units per week.

The cost of one pack, containing 350 units, is approximately 250 baht. It is about 0.72 baht per unit. (44.46 baht per unit for include free item) Omeprazole has the high demand. Thus, it has been out of stock for 3 times during a study period. The hospital can not purchase a huge number of Omeprazole because space limitation in warehouse.

6. Ilomedin is controlled substance, it is used for anti-coagulation of blood.

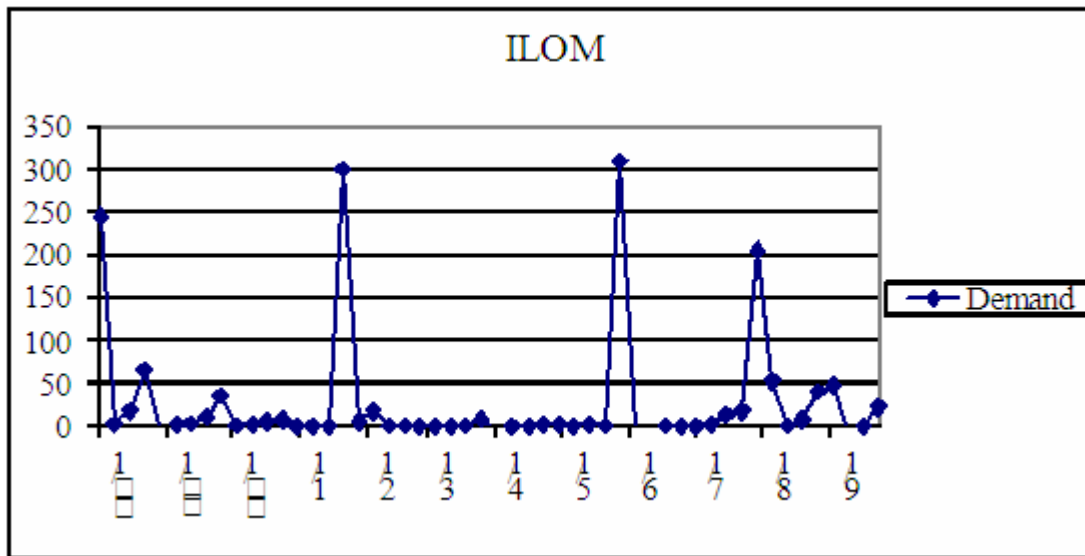


Figure 4-21: Patient’s demand of Ilomedin from October 2005 to September 2006

The cost of one pack, containing 5 units, is approximately 7,490 baht. It is about 1,498 baht per unit.

The usage of Ilomedin is 1,462 units per year. Ilomedin has been prescribed not over 30 doses each time except in the case of patient requests Ilomedin between 300 -180 per one time. Thus, in this case, patient purchases 4 months at a time.

Our findings show that patients’ demand can be divided into three categories:

Type I: the demand has no trend with small variance.

Type II: the demand no trend with large variance.

Type III: the demand has trend with variance.

Then, 5 medicines represent all demand types as follows:

Tuberculin represents the demand of Type I. Dormicum and Losec represent demand of Type II. Omeprazole and Pariet represent demand of Type III. As for Ilomedin, it needs a special order since it has been prescribed for specific patients. Thus, in the new policy we purpose three different methods to determine order quantities and reorder points. In our policy we also take an account for lead-time

deliver and variation in patients' demand. In addition, we use the forecasting technique to determine the order quantity.

4.5 The Propose System

The propose system, it can be redesigned business process of medicine flow by Integration Definition for Function Modeling (IDEF0) that show below.

Figure4-21, we propose a linkage from the ward storeroom to the warehouse. The end patient usage is reflected to the warehouse. Instead of using the pharmacist's experience in setting minimum stock level for reordering point, the central warehouse can monitor the supply chain stock and set the reorder point more accurately to the end patient demand. The patients' medicine dispensed quantity per day is then sent directly from each ward's storeroom (A6) to reorder point calculation (A1). Also stock is updated at the same time as medicine is dispensed from the warehouse. This can be seen that A4 has been put in the A3 function.

Figure 4-22 Show new business process of medicine purchasing that received amount of usage and detail of medicine to calculate ROP and EOQ by DSS software for user to considering quantity of medicine to purchase.

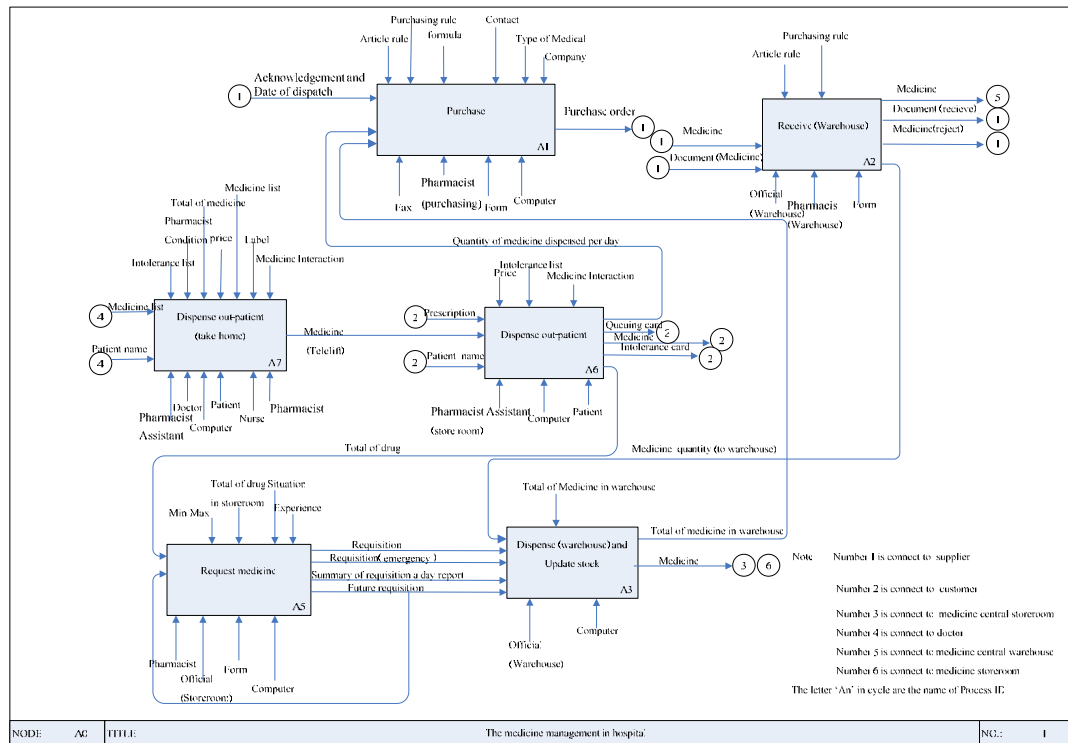


Figure4-22: The proposed system for medicine information management.

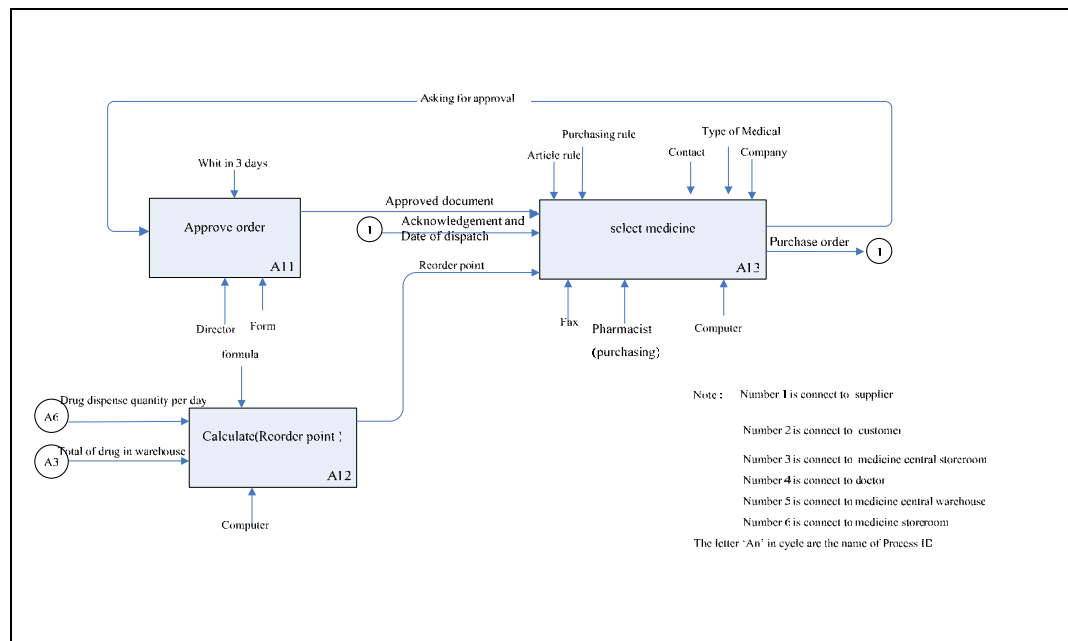


Figure4-23: The proposed system for medicine purchasing

From the study of information system in the part of inventory management system and distribution in hospital, which includes three departments; warehouse, medicine storeroom and purchasing department, the researcher found the unconnected between warehouse and medicine storeroom in each ward. Thus, warehouse can not know patient's demand (end demand) but it received demand from medicine requisitions ordered by medicine storeroom in each ward. Then warehouse officer calculates the reorder points and needed volume from the quantities of medicine requisitions from medicine storeroom. It made the reorder points and amount of order quantity are inconsistent with real demand.

During study, the hospital was implementing ERP (Enterprise resource planning) which includes 4 modules as follows:

1. FI (Finance)
2. CO (Controlling)
3. MM (Materials Management)
4. HR (Human Resource)

The part of MM (Materials Management) is directly related to this research especially in drug stock management and dispensary. The research finding reveals that the redesigned system provides high quality of transaction but the way the hospital did for calculating drug stock and purchasing volume has not fitted with high variant goods as drug. Thus, MM is employed for solving this problem by calculating the optimal point from consumption or usage volume through:

- a. Constant Demand

$$\text{Re-Order Point} = \text{Usage per day} \times (\text{GR time} + \text{Pln.del.lead time})$$

- b. Inconstant Demand

$$\text{Re-Order Point} = \text{Usage per day} \times (\text{GR time} + \text{Pln.del.lead time}) + \text{Safety}$$

stock

$$\text{Safety stock} = R \times \sqrt{W} \times \text{MAD}$$

Note:

Service level X % : R = factor representing service level

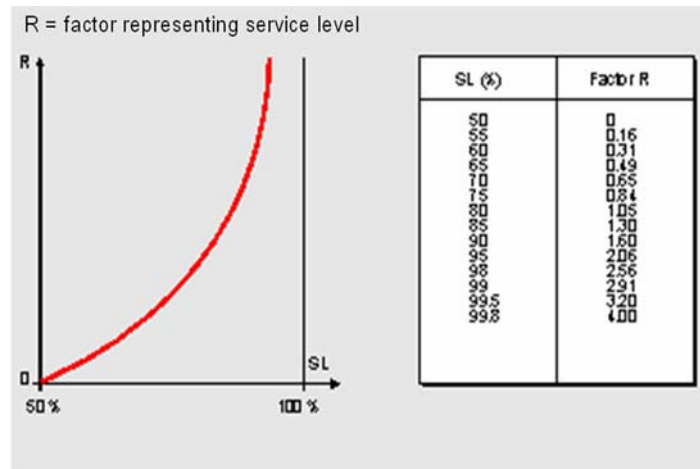


Figure 4-24 Factor representing service level

$$W = (\text{GR time} + \text{Pln.del.lead time}) / \text{work day}$$

$$\text{Usage per day} = \text{Usage} / \text{Amount of day}$$

** GR time + Pln.del.lead time = Lead time in each plant

As above, hospital does not implement module for front since hospital has own front system for dispensation called HIS. Thus, hospital has 2 systems. These are HIS for font system and some ERP module for back system. Both systems were connected by daily usage. From this case study, we found pattern of usage which can be divided into 3 patterns as follows:

Type I: the demand has no trend with small variance.

Type II: the demand no trend with large variance.

Type III: the demand has trend with variance.

Thus, Formula ROP of SAP does not cover all patterns of usage. Then, we developed software for decision support system for inventory management to support pharmacist who need to know pattern of usage for replenishment.

4.6 The Cause of Decision Support System for Inventory Management

The current system of this case, after medicine has been dispensed then sum amount of usage in the end of the day and send to MM module in flatfile format. After that, the amount of usage has been used for MPR to run and forecast in order to define the reorder point for medicine storeroom and central warehouse. But, the formula of MRP is the average of amount of usage not concern nature of each medicine. Thus, EOQ value is not responsible for real demand in the right time.

Especially, medicine in hospital it have pattern in each type of usage. It can be shown above, some medicine has been prescribed highest in short time because of giving an injection to medical student and resident before ward round. Therefore, we should develop decision support software to help determine the Re Order Point (ROP) and Economic Order Quantity (EOQ) for the pharmacist who is responsible for purchase decisions. There is a linkage with the ERP software to perform data processing for the ERP system. The framework of new system is shown below.

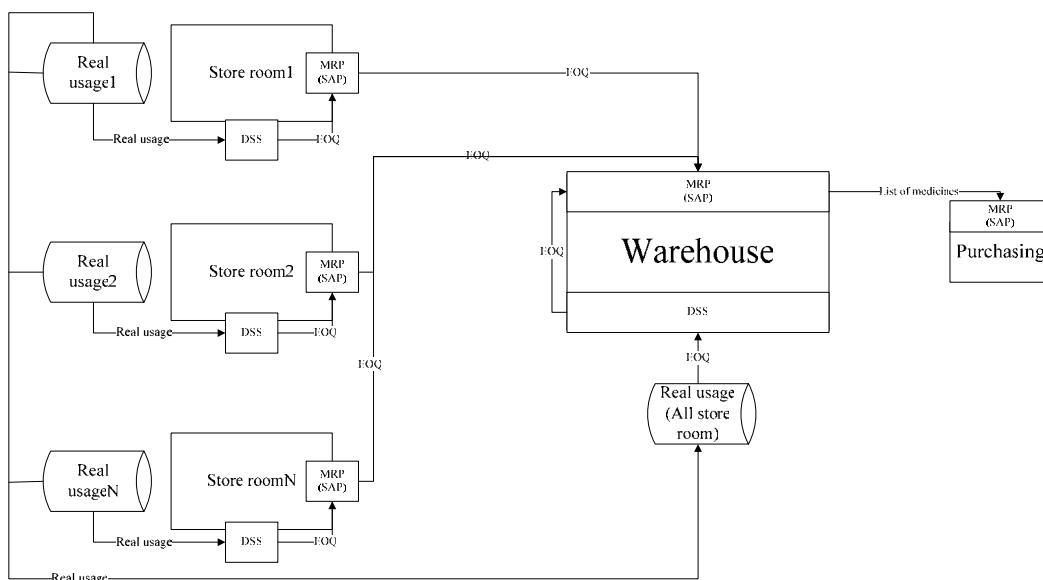


Figure 4-25: Frame work of propose system

The figure above shows position of decision support software in which it can be divided into 2 states. The first state is pharmacists in medicine storeroom use the program for making decision to replenish in each ward. The pharmacists will

consider the pattern of usage in their storeroom and edit volume of medicine that they requisition in ERP software. Then, requisition step is preceded by ERP transaction. The second state is pharmacists in central warehouse consider pattern of all drug usage in hospital and calculate ROP and EOQ in each type of drug/medicine. The purposed system has three different methods to determine order and reorder volume of drugs. In addition, researcher applies the forecasting technique to determine the order volume. This forecasting method was employed from the study of Kritchanchai and Suwandeechochai (2008) which mentioned that redesigned program employed can provide the more precise number of drugs in the stock. (Table 1 in APPENDIX B). Then, export data to ERP software for purchasing process and purchase by transaction of ERP software. Structure of decision support software will be described in the next topic.

4.7. Structure of Decision Support Software

Structure of decision support software can be divided into 2 main sections as follows:

1. Decision support for requisition of medicine storeroom.
2. Decision support for medicine replenishment of central warehouse.

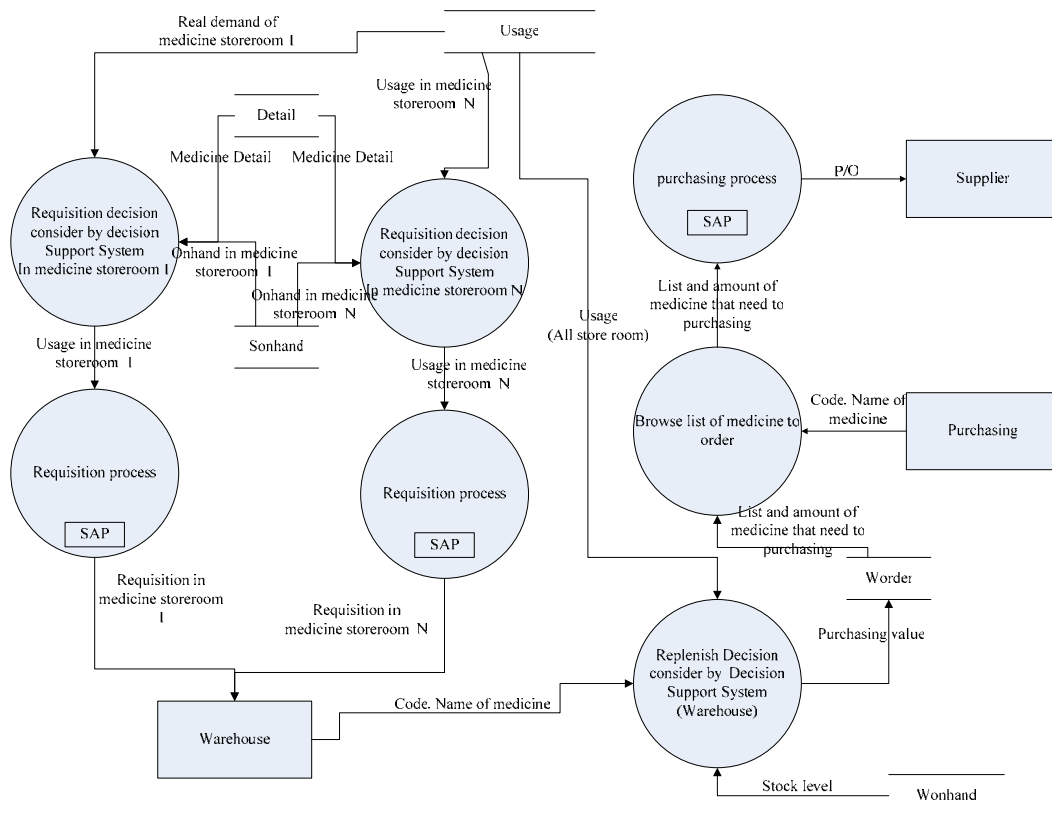


Figure 4-26: Structure of Decision Support Software

The figure 4-25 shows main structure of decision support software, first of all, the decision support for requisition which received data of usage from database (table of usage) together with detail of medicine from table of detail and stock level from table of Sonhand (stock level in medicine storeroom). Then, software plots pattern of usage of each medicine storeroom, So that users consider and key amount of requisition into ERP software. The second, decision support for medicine replenishment of central warehouse received data of usage from database (table of usage) together with detail of medicine from table of detail and stock level from table of Wonhand (stock level in warehouse) to calculate Re Order Point and Economic Order Quantity. After that user choose quantity that is a final decision. Finally, software shows list of medicine to order. Then, purchase department browse list of medicines to purchasing process.

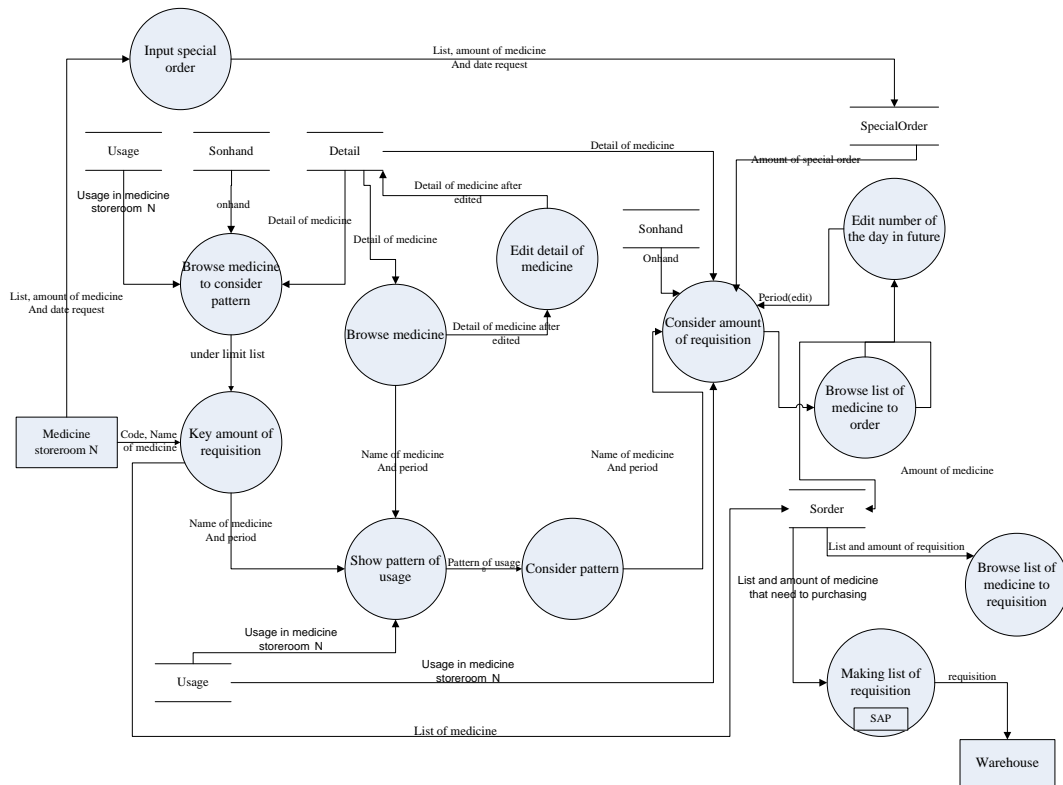


Figure 4-27: Decision support for requisition of medicine storeroom

The figure 4-26 shows decision support for requisition of medicine storeroom, user chooses menu stock to explore stock level in each storeroom. Software can be shown pattern of usage from table of usage to support decision of requisition. Then pharmacist keys amount of requisition to the ERP software. Moreover, pharmacist at each medicine storeroom must know the special situation of the future usage such as Tuberculin has been giving an injection to medical student before round ward.

So, system needs to share information of special order to pharmacist at warehouse who has permission to decision ordering medicine. Thus, pharmacist at each medicine storeroom has to key special order then software will save data to table of Sonder. From there, special order value will be added in the quantity of medicine for purchasing.

and physical stores such as or filing cabinets or stacks of paper. The context diagram of DFD and its detail are shown in Figure. 4-28 and 4-29.

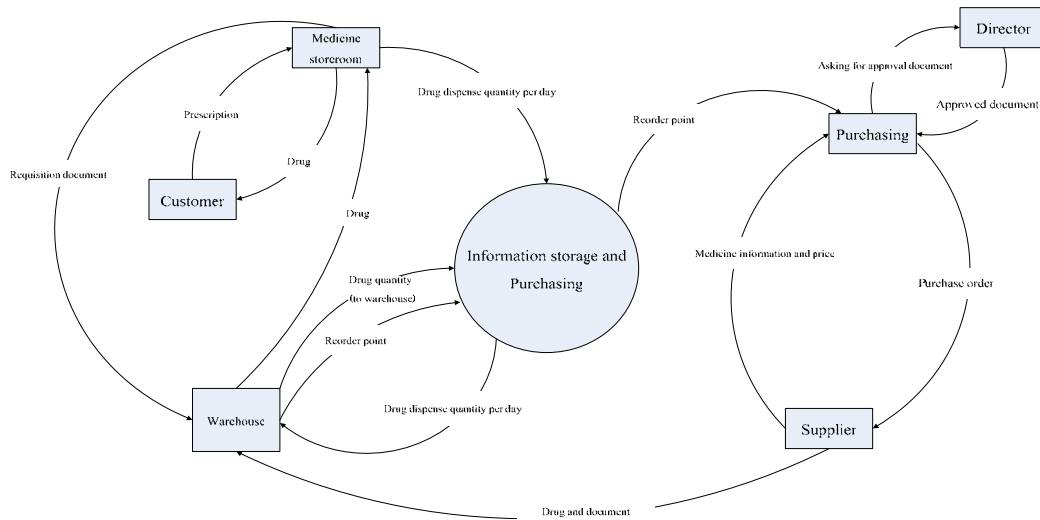


Figure 4-29: The proposed system’s context diagram.

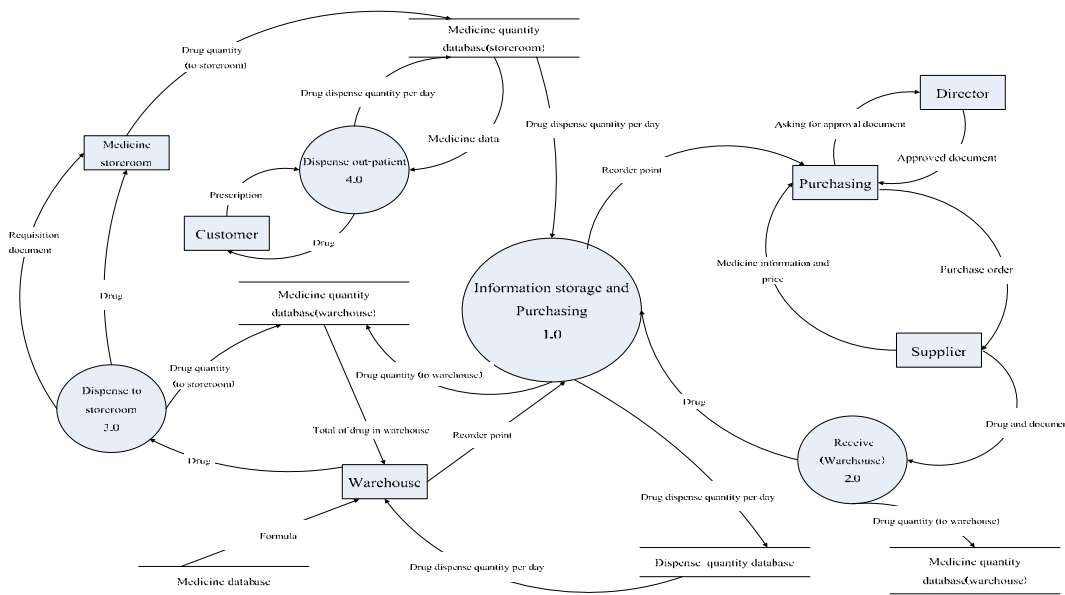


Figure 4-30: The proposed system’s Data Flow Diagram Level 0.

Figure 4-28 and 4-29 show that in this proposed system, each ward’s storeroom

records the patients' medicine usage in a database. The central warehouse could then query data from this database. This information can be used for filling each ward's stock as well as setting the reorder point accurately to the real demand. Also, when the medicine is dispensed from the warehouse or supplied by the suppliers, the data is then recorded and stock is updated.

After the information flow is designed, a software for connecting these functions is developed. The main functions of this software are firstly to enable the warehouse to see the stock in each ward's storeroom

4.7.1 Detail of Database

1. A table that keeps a detail of medicines for using in storeroom and warehouse is call "Detail" table the data dictionary was shown below

Table 4.1 Detail of medicines

Table	Field	Detail	Data type
Detail	Code	Drug Code	Varchar(10)
Detail	DEUGNAME	Drug Name	Varchar(50)
Detail	DUP	Unit Price	float
Detail	QPP	Quantity per pack	int
Detail	LT	Lead time	int
Detail	ROP	Reorder point	datetime
Detail	LORD	Last date of purchasing	Varchar(50)
Detail	Supplier	Supplier Name	int

2. SpecialOrder table is used to keep specific order of medicines. An officer of storeroom who response to take a data into this table.

This information will be used at storeroom and warehouse. The data dictionary was shown below:

Table 4.2 Special Order

Table	Field	Detail	Data type
SpecialOrder	ID	ID	Auto Number
SpecialOrder	Code	Drug Code	Varchar(10)
SpecialOrder	DrugName	Drug Name	Varchar(50)
SpecialOrder	Quantity	Quantity	Int
SpecialOrder	Date	Drug Request Date	Datetime
SpecialOrder	Note	Note	Text

3. Usage table that is a table which keep a quantity of usage medicine per day. It is necessary to use in both of warehouse and storeroom. The storeroom can only use information of its own. The data dictionary was shown below:

Table 4.3 Usage

Table	Field	Detail	Data type
Usage	HN	Patient Code	Varchar(10)
Usage	NAMEHN	Patient Name	Varchar(50)
Usage	DOCTOR_ORD	Doctor Order Date	Datetime
Usage	RX_ISSUE	Dispend Date	Datetime
Usage	ISSQTY	Dispend Quantity	Float
Usage	DRUGNAME	Drug Name	Varchar(50)
Usage	PAYMENT	Can be dispense or not	Varchar(20)
Usage	RXROOM	Medicine storeroom Name	Varchar(10)
Usage	ORDUP	Unit price (sell)	Float
Usage	TOTAL	Total of dispense	Float
Usage	RED	Type of dispense	Varchar(10)
Usage	CODE	Drug Code	Varchar(50)
Usage	DR_CODE	Doctor Code	Varchar(10)
Usage	DR_NAME	Doctor Name	Varchar(50)
Usage	SITE	Ward code	Varchar(10)

4. Sonhand table was used to keep a balance quantity of medicine at storeroom. The data dictionary was shown below:

Table 4.4 Sonhand

Table	Field	Detail	Data type
Sonhand	Code	Drug Code	Varchar(10)
Sonhand	DRUGNAME	Drug Name	Varchar(50)
Sonhand	Onhand	Stock level in storeroom	Int
Sonhand	QPP	Quantity per pack	Int
Sonhand	RXROOM	Medicine storeroom	Varchar(50)

5. SOrder table keeps data from the storeroom requisition action (add, edit, delete) of ordering list page in a software. The data dictionary was shown below:

Table 4.5 SOrder

Table	Field	Detail	Data type
SOrder	Code	Drug Code	Varchar(10)
SOrder	DRUGNAME	Drug Name	Varchar(50)
SOrder	EOQ	Quantity of special order	Int
SOrder	DateOrder	Request Date	Datetime
SOrder	COMMENT	Cause of request	text

6. WOrder table keeps data from the warehouse order action (add, edit, delete) of ordering list page in software. The data dictionary was shown below:

Table 4.6 WOrder

Table	Field	Detail	Data type
Worder	Code	Drug Code	Varchar(10)
Worder	DRUGNAME	Drug Name	Varchar(50)
Worder	EOQ	Quantity of purchase	Int
Worder	NOrder	Final quantity of purchase	Int
Worder	TotalPrice	Total price	Float
Worder	Date	Date of purchase request	datetime

7. WOnhand table keeps a quantity inventory of warehouse. The data dictionary was shown below:

Table 4.7 WOnhand

Table	Field	Detail	Data type
Wonhand	Code	Drug Code	Varchar(10)
Wonhand	DRUGNAME	Drug Name	Varchar(50)
Wonhand	Onhand	Stock level	Int
Wonhand	QPP	Quantity per pack	Int

From above, we know a structure and a database of software. Then, the process and characteristic of a program which will be explained with a picture of user interface of a software as follows:

4.7.2 A Prototype of Decision Support System

A prototype of decision support system is an application prototype for logistics flow of medicine in the hospital. This software will be linked in 3 parts there are medicine storeroom,warehouse and purchasing. These showed as follow:

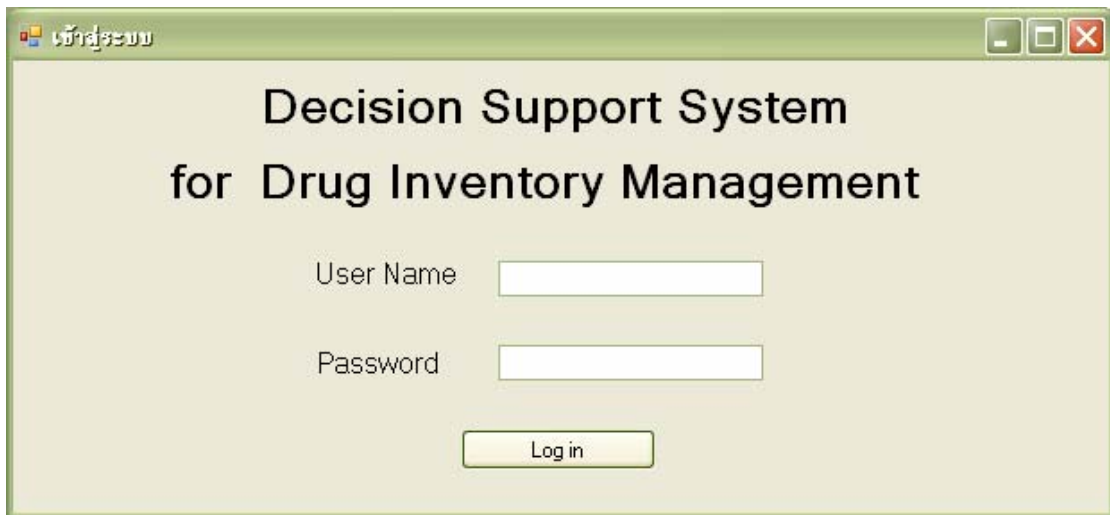


Figure 4-31: Login to program

The login process divides the user into 3 classes that is ware house, storeroom and purchasing. When users log in to main page, the menu lists are 5 lists as

1. Warehouse: warehouse users such as pharmacist be stationed at warehouse. That can be allowed to use this menu.
2. Storeroom: Storeroom users such as pharmacist be stationed at Storeroom. That can be allowed to use this menu.
3. Purchase: Purchasing users such as pharmacist be stationed at purchasing site or who has authority to order.

User: The user management that is added on edit the user detail.

4. Help: This Section will be shown the manual of application.

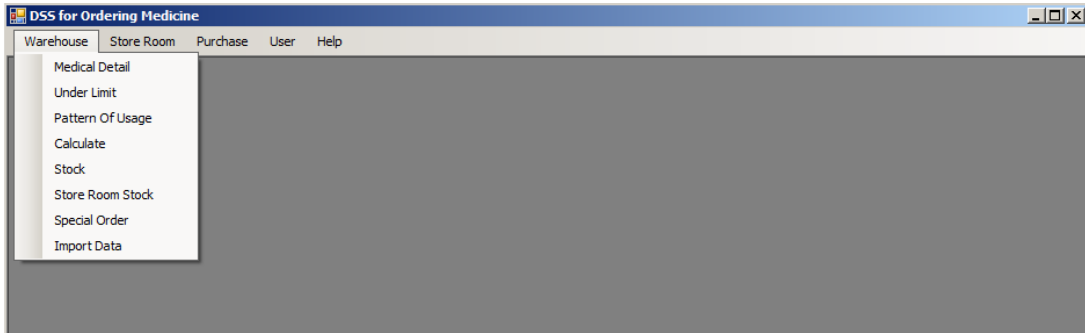


Figure 4-32: Main page of program

From the figure 4-30 the submenu in each main menu will be explained respectively. The first main menu is warehouse menu worked in warehouse. So, the submenu from this main menu is for pharmacist who is stationed at warehouse.

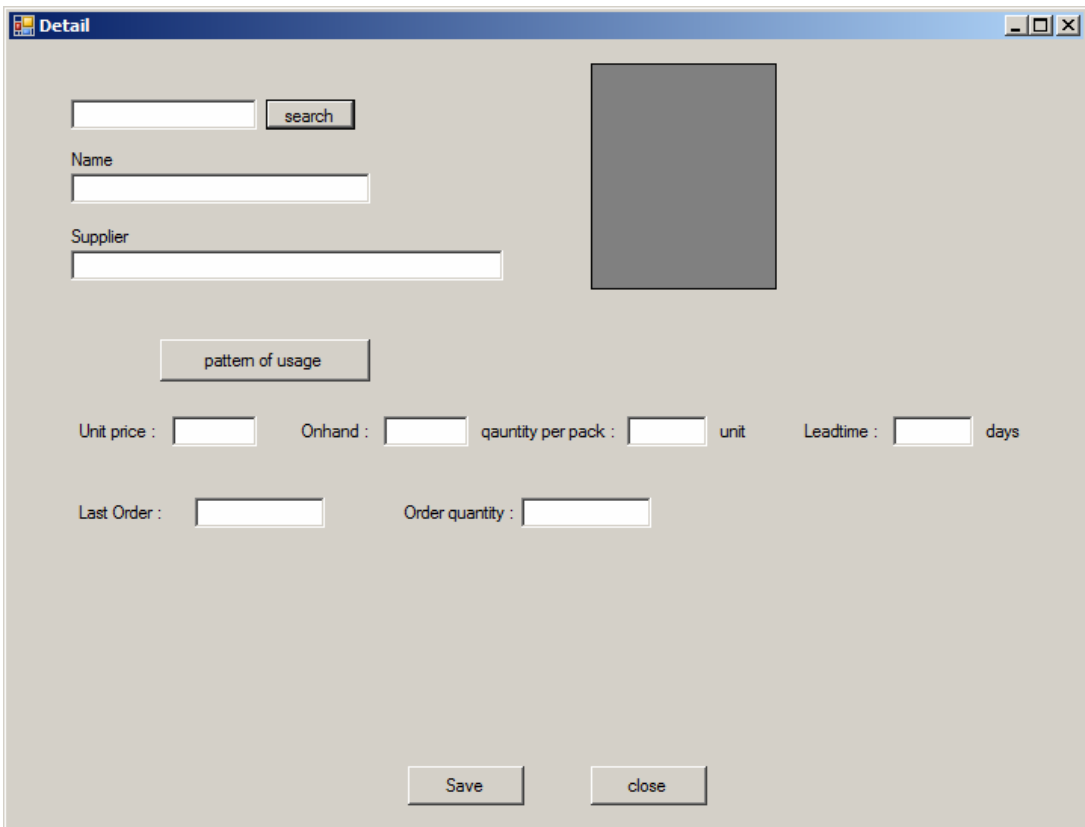
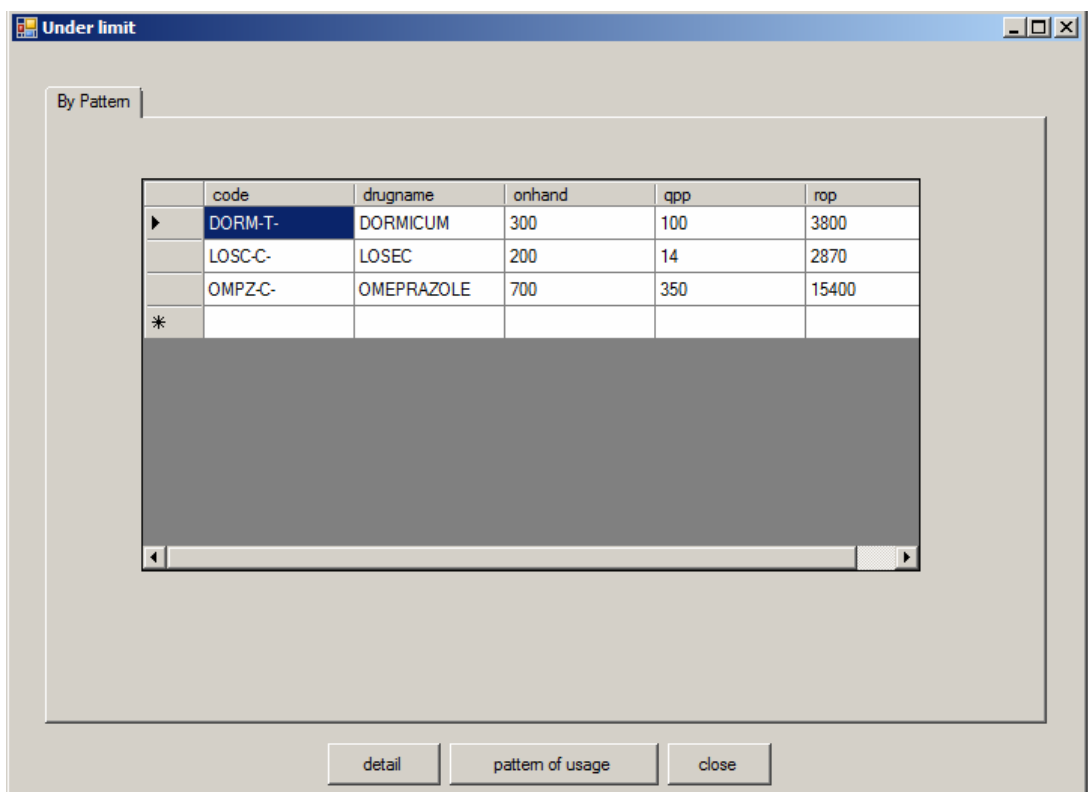


Figure 4-33: Medicine Detail

Medicine Detail is displayed the medicine detail in each type which pharmacist can search it from medicine code. The medicine detail that was shown in

the screen will be shown the data such as drug name, supplier, unit price, on hand, quantity per pack, lead time, order status, order quantity and order date as show in figure 4-32 as the users can edit these data immediately. When recording data, the data will be recorded in database as soon as possible. The users can see the pattern of usage medicine in figure 4-33



The screenshot shows a window titled "Under limit" with a tab labeled "By Pattern". Inside the window is a table with the following data:

	code	drugname	onhand	qpp	rop
▶	DORM-T-	DORMICUM	300	100	3800
	LOSC-C-	LOSEC	200	14	2870
	OMPZ-C-	OMEPRAZOLE	700	350	15400
*					

Below the table is a scrollable area that is currently empty. At the bottom of the window are three buttons: "detail", "pattern of usage", and "close".

Figure 4-34: Under limit list

Under limit list, this will show a quantity on hand that lower than reorder point. The users can select the medicine name to see the pattern of usage medicine from this screen (the pattern of usage show in figure 4-33). If the users want to see a detail will be shown (the detail page will show in figure 4-34)

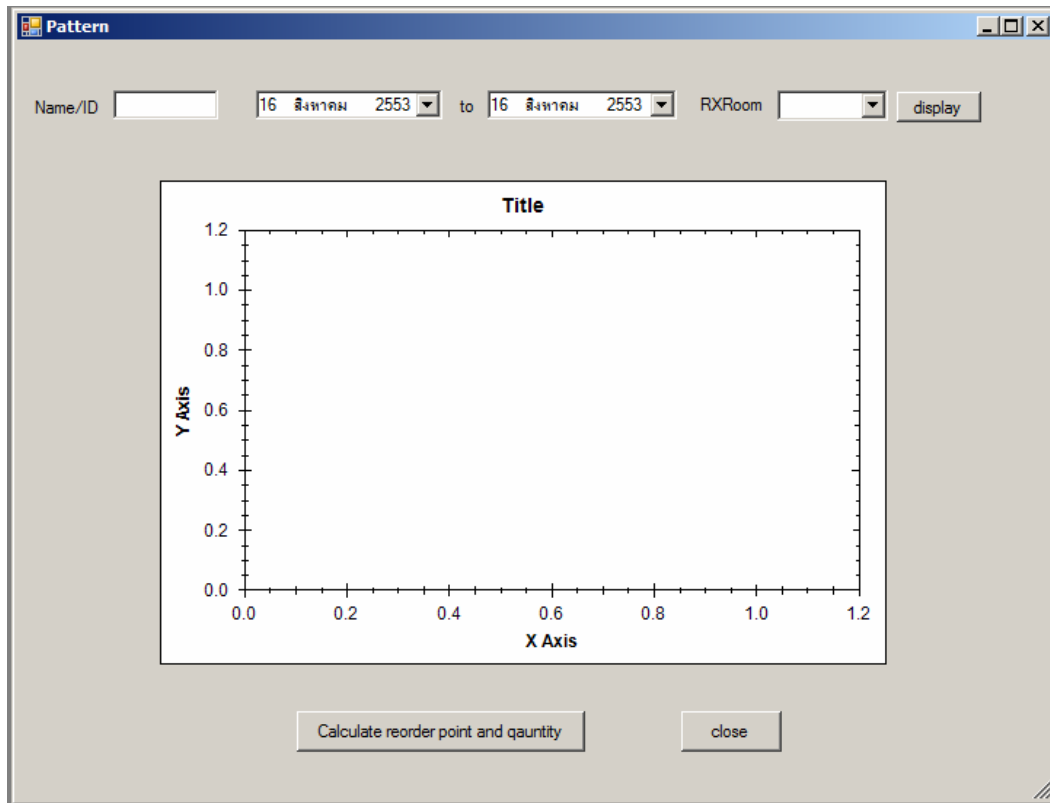


Figure 4-35: Pattern of usage

Pattern Of Usage, this page will show the pattern of usage medicine in decision support to order medicine in the next time.

Calculate

ID Name

quantity per pack : Leadtime days Service Level %

Unit price : minimum order

start date : 1 มกราคม 2549 (default by pattern)

choose by user

the demand has no trend with small variance.

the demand no trend with large variance.

the demand has trend with variance.

reorder point boxs

quantity boxs

order boxs

Figure 4-36 Calculating

Editperiod

ช่วงเวลาในอดีตที่นำมาคำนวณ วัน

ช่วงเวลาที่ต้องการเก็บสต็อก วัน

Figure 4-37: Edit period

Calculating, this page shows a calculating of quantity to purchase and it will be presented to users in 3 patterns as follow:

- Using quantity of order and quantity of inventory from the formula of chapter 6. The program will show service level that is suitable and the users will decide to change the service level value. Also the special order is for a specific order medicine that user can see the list from special order page

- As the figure 4-35, user can choose the formula by them. The formula is shown as follows:

Type I: the demand has no trend with small variance.

Type II: the demand no trend with large variance.

Type III: the demand has trend with variance.

In each formula, the user can edit the duration time to calculate. As show in figure 4-36.

	CODE	DRUGNAME	ONHAND	QPP
▶	TUBP-I-	TUBERCULIN	5000	5
	DORM-T-	DORMICUM	3000	100
	LOSC-C-	LOSEC	2000	14
	OMPZ-C-	OMEPRAZOLE	7000	350
	PARI-T-	PARIET	2000	14
*				

Figure 4-38: Stock level in warehouse.

Stock: This shows a quantity of inventory at the present at the warehouse page. The detail of this page such as code, drug name quantity, users can choose the code name of medicine to see the pattern from this page or to see the detail of medicine.

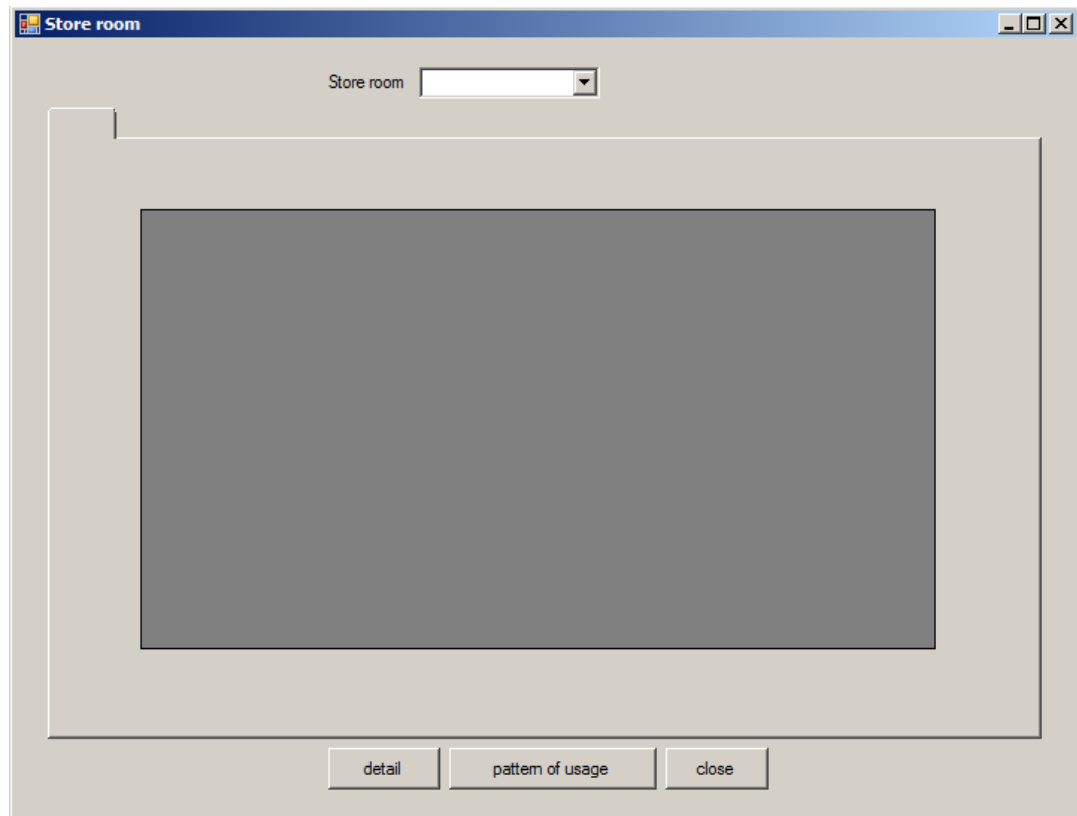


Figure 4-39: Storeroom stock

Storeroom: This shows current volume of drugs in the inventory at each storeroom. Users can select the medicine storeroom they want to check. The program will show details such as the pattern of medicine usage or descriptions of medicines.

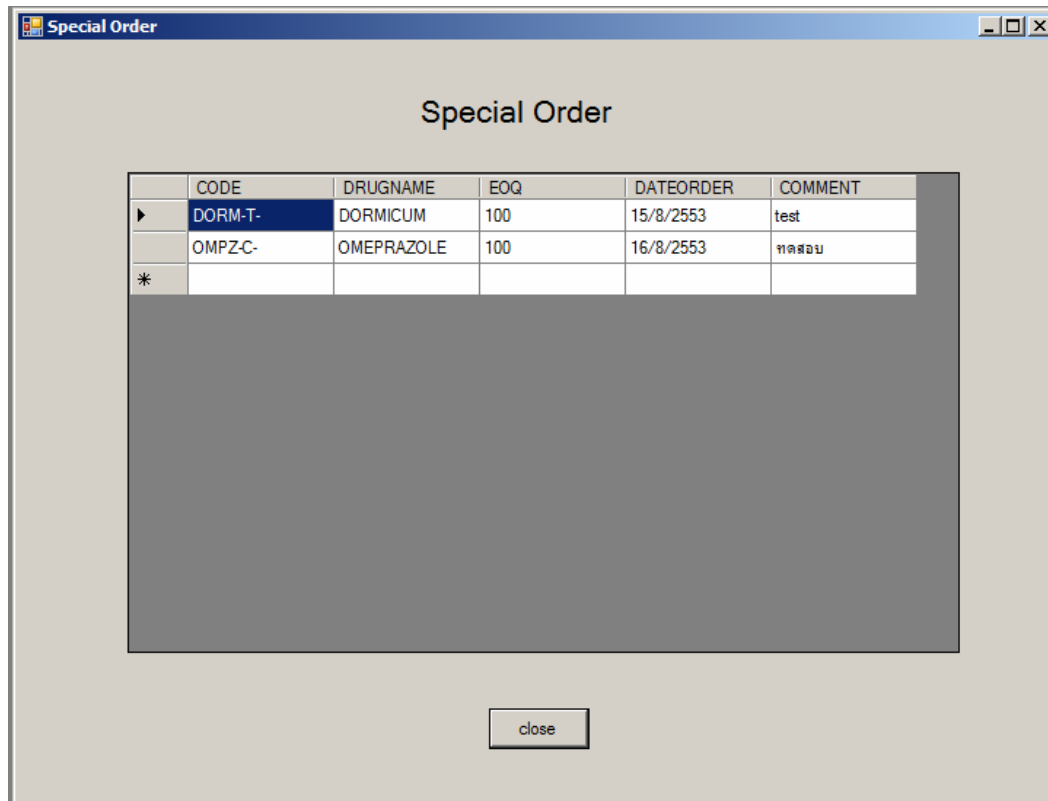


Figure: 4-40 Special order

Special order: this shows specific demanded medicines understanding the demand of medicine to calculate a quantity of purchasing. The detail of this page such as codename, drug name and usage date.

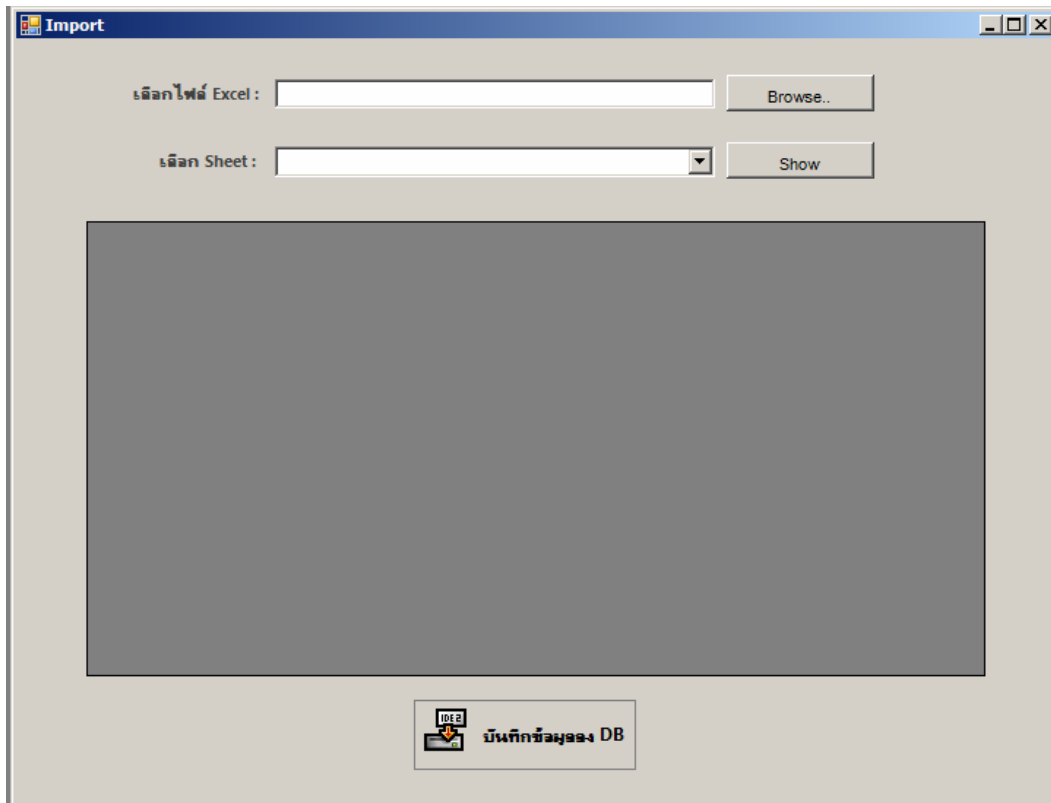


Figure 4-41 Import Data

Import Data: this part imports data from excel file, that was previous exported from HIS into the DSS database.

When users browse the excel file and select it, a list of sheets in the MS excel file format will be shown in a dropdown menu, and users can select sheet name from this menu to import into the database as shown in figure 4-40

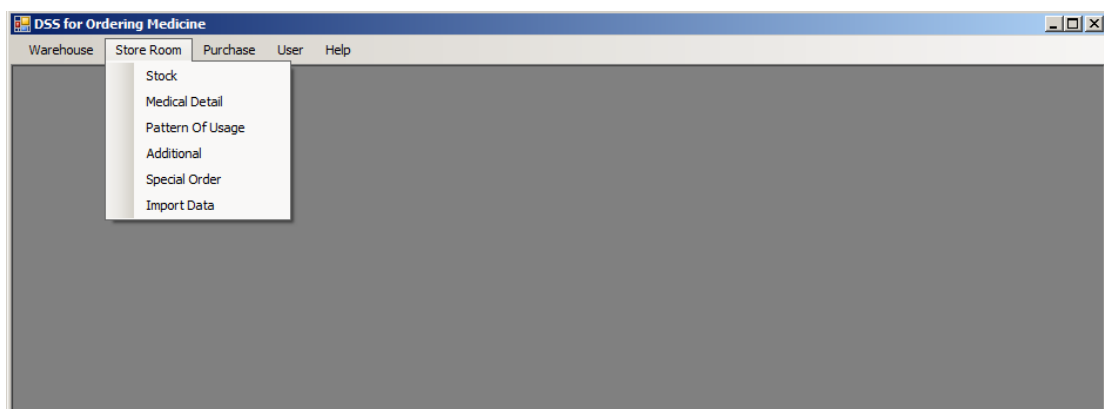


Figure 4-42: Sub menu of second main menu

Medical Detail menu displays more information of a medicine grouped by type which pharmacist can search it from medicine code. The medicine detail that was shown in the screen will be shown the data such as drug name, supplier, unit price, on hand, quantity per pack, lead time, order status, order quantity and order date as show in figure 4-32. Users can see the pattern of usage medicine in figure 4-34.

Pattern of Usage: this shows the behavior of usage medicine. The difference thing is the usage information will be used in each storeroom, not all rooms. Users have to fill in codename then select duration time and storeroom. The program will show the graph on the screen to support the decision of users to purchase medicine in the next time.

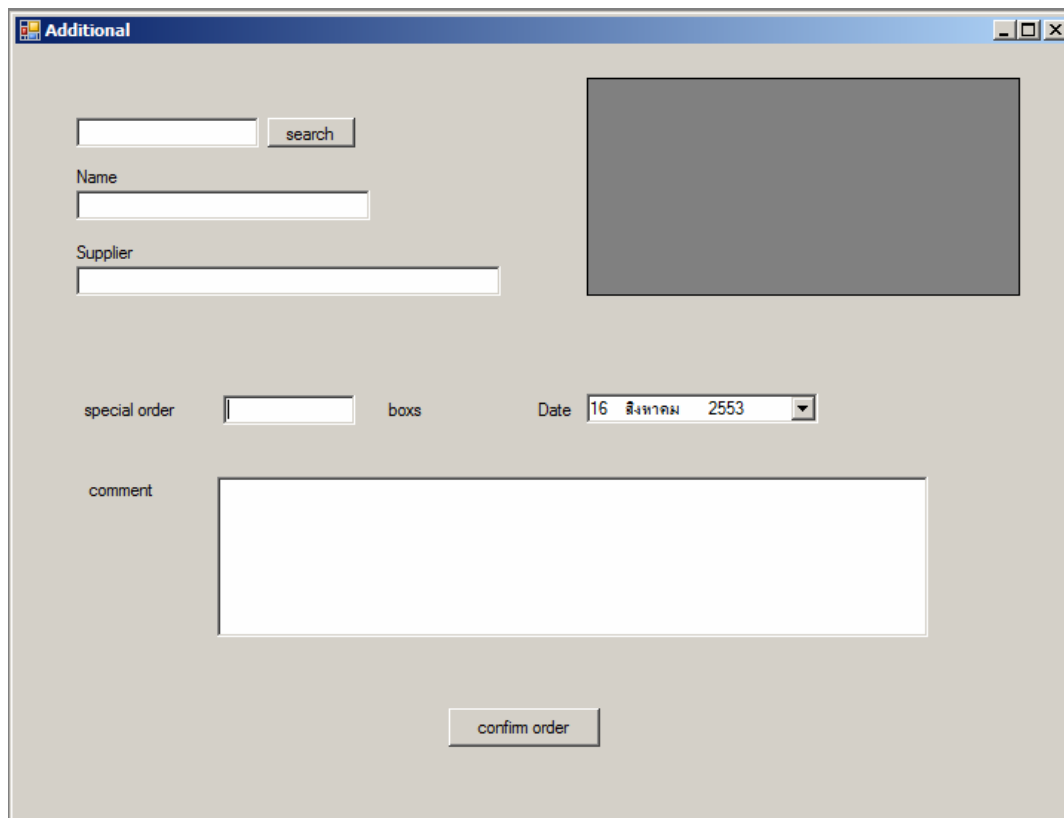


Figure 4-43: Additional

Additional page for a specific order: User will select the codename from the lists after click search button. When the codename was selected, the detail of medicine will be appeared such as name and supplier. Users fill in the number of demand of

specific medicine and button to record the data into database. This information will be show in Special Order page as figure 4-39.

Stock: this page shows a quantity of inventory at present. The details consist of codename, drug name and quantity. Users can call the pattern of usage by clicking pattern of usage button to see the behavior of usage medicine. The detail of medicine page also can be called from this page.

Special Order, this page shows a specific order. The details of this page consist of code name, drug name, quantity and order date.

Import Data, this will import data from excel file that export from HIS into database. When users browse the excel file and select it, a list of sheets in a MS excel file format will be showed in dropdown menu and users can select sheet name from it to import into database.

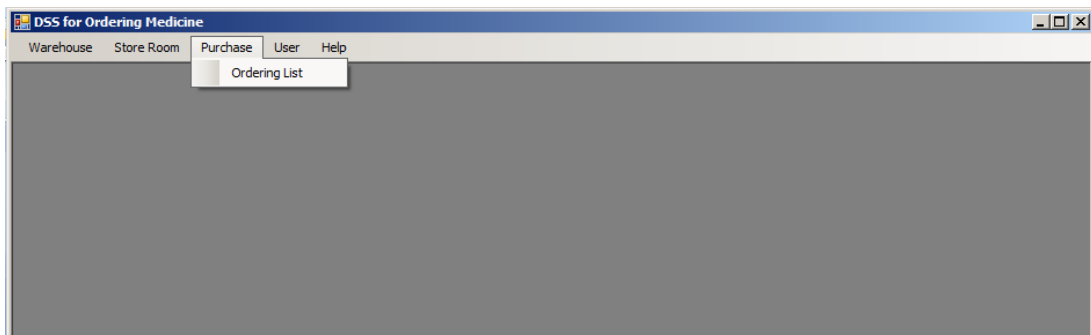


Figure 4-44: Sub menu of the third main menu

Purchase, this page is used by the users for purchasing. The list of its main menu is as follows:

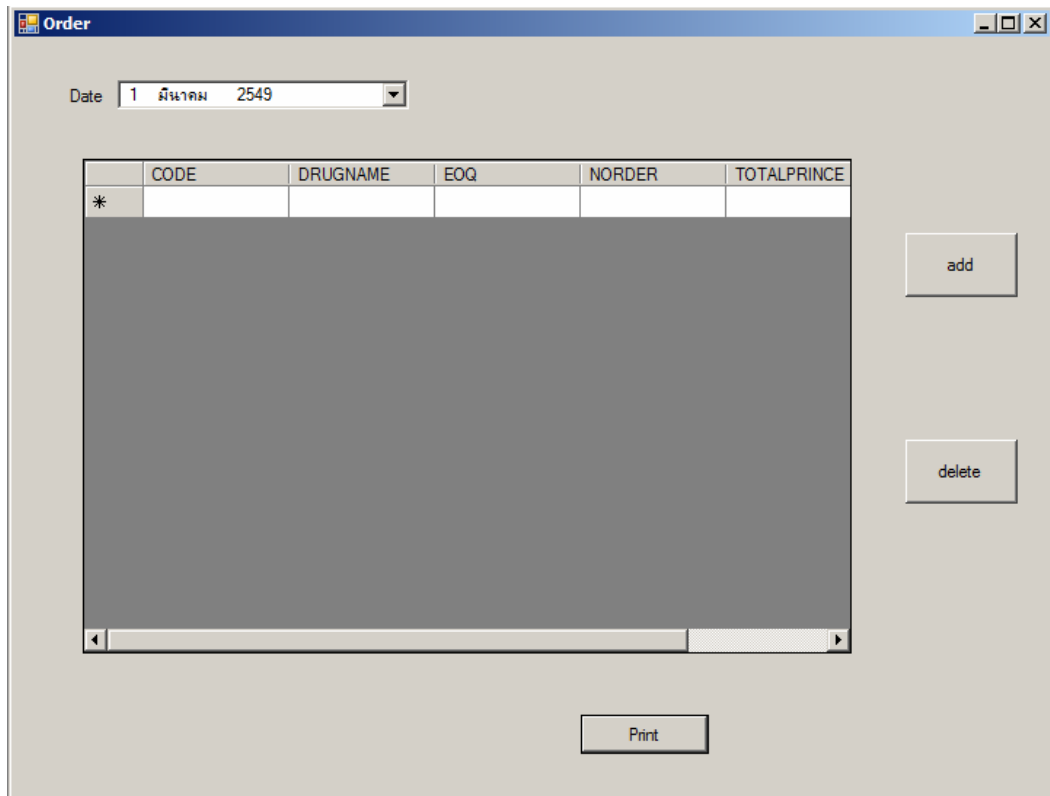


Figure 4-45: Ordering lists

Ordering list: this page shows the list of medicines that were calculated. The lists connect data to database for adding or deleting. The detail of this page consists of codename, drug's name, quantity order, total price, unit price and supplier. Forth main menu: User works to manage the user such as add, edit the detail of user

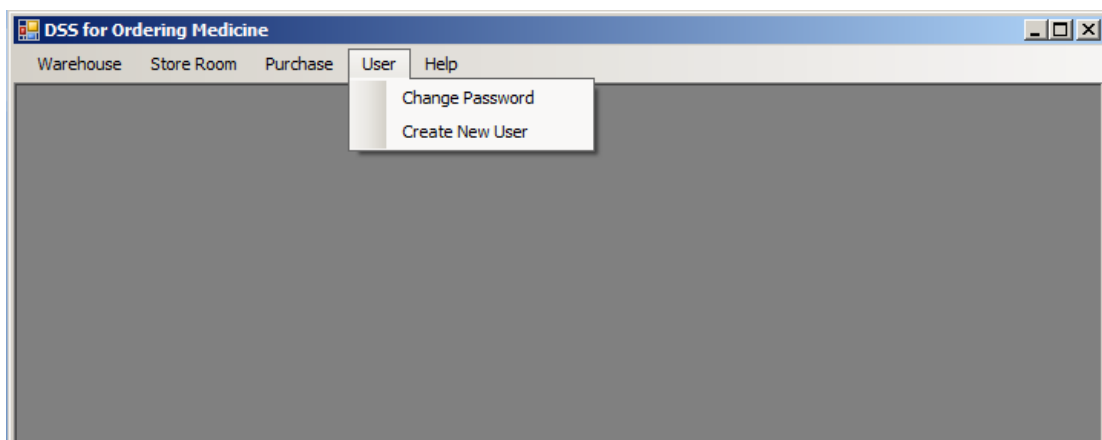
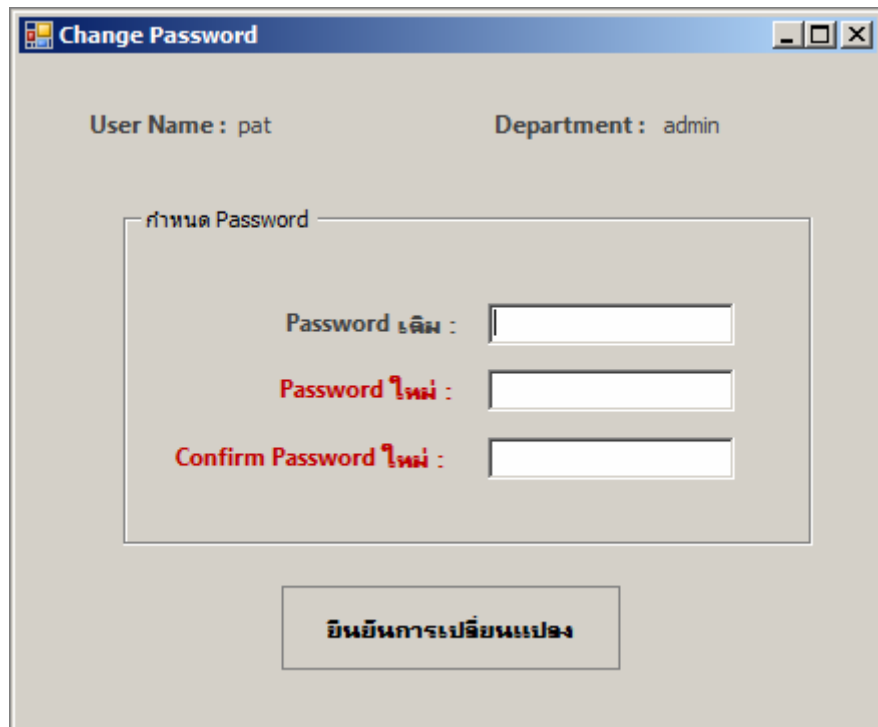


Figure 4-46: Submenu of forth main menu.



Change Password

User Name : pat Department : admin

กำหนด Password

Password เดิม :

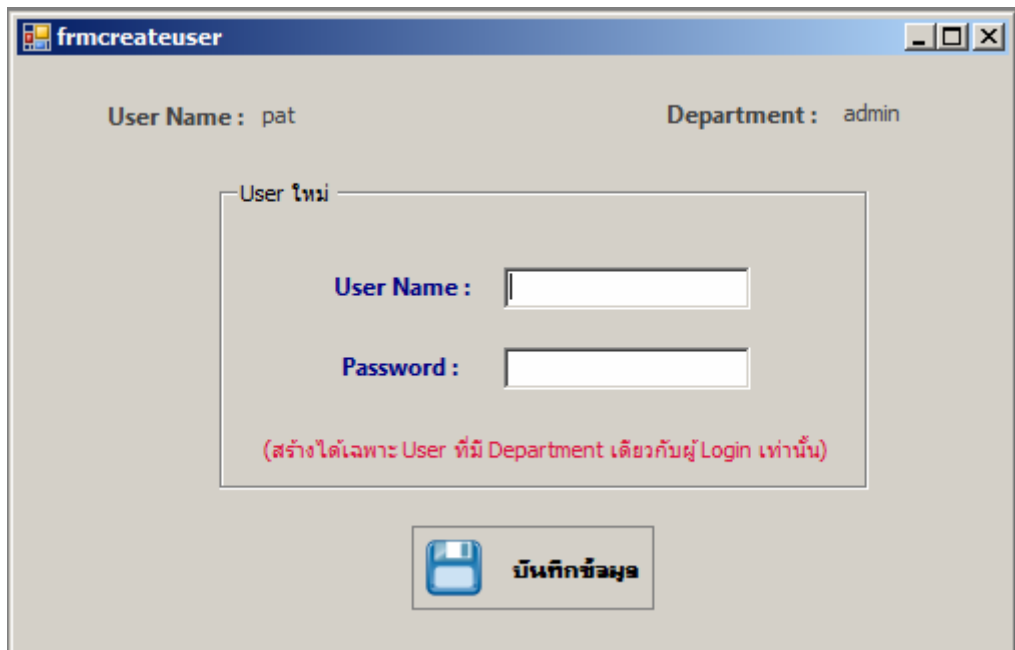
Password ใหม่ :

Confirm Password ใหม่ :

ยืนยันการเปลี่ยนแปลง

Figure 4-47: Change password

Change password is used for changing a password of users.



frmcreateuser

User Name : pat Department : admin

User ใหม่

User Name :

Password :

(สร้างได้เฉพาะ User ที่มี Department เดียวกับผู้ใช้ Login เท่านั้น)

บันทึกข้อมูล

Figure 4-48: Create New User

Create New User: this page is used to create the new user for only site.

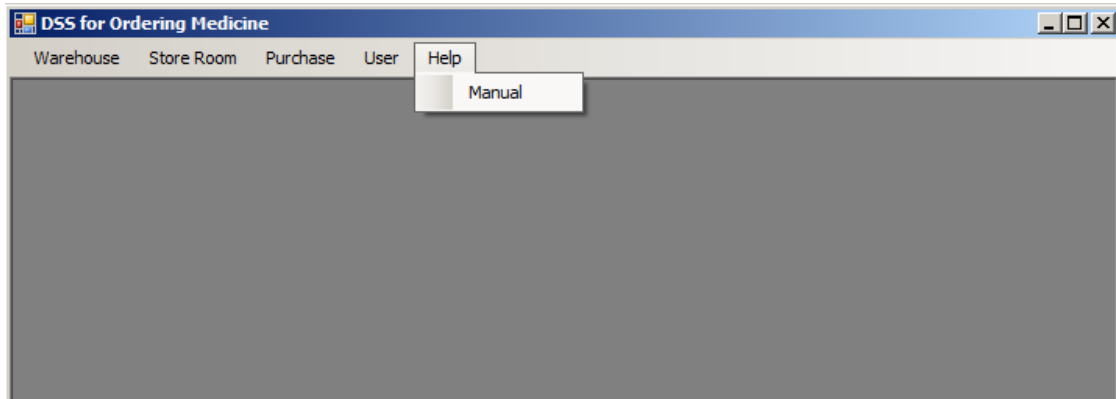


Figure 4-49: Submenu of fifth main menu

Fifth main menu: Help is used to show the manual.

4.7.3 Summary of software

An application prototype has 2 main sections; decision support for requisition of medicine storeroom and decision support for medicine replenishment of central warehouse. It is related with 3 departments; medicine storeroom, warehouse and purchasing department. It show decision to replenish by pattern of usage for medicine storeroom and warehouse,

1. Software uses ROP and EOQ from formula of pattern of usage 3 patterns.

Software can be shown service level and user can edit it, and user can save special order to include to replenish level.

2. Software shows pattern of usage then user chooses formula which suits with a pattern.

Type I: the demand has no trend with small variance.

Type II: the demand no trend with large variance.

Type III: the demand has trend with variance.

3. Final decision of EOQ up to user.

This research shows a new design for information system in a hospital supply chain, particularly in medicine stock management. Instead of using

pharmacist's experience in setting stock reorder point, the central warehouse can now monitor the stock usage and stock left in the supply chain and setting reorder point by decision support software. It can be shown the reduced of average inventory in the purposed system. Thus, from the results above, it demonstrates that model can provide a framework to support decision makers in quantity of medicine to purchase. User can view the decision support by graphic from this software. The results of DSS approach are satisfactory. This result is comparable with fact of information. However, this DSS application develops by representative sample 6 medicines. The pattern of usage may change upon difference pattern.

4.8 System Evaluation

Evaluation with User's Opinion Questionnaire

Collection of data: Questionnaires medicine-stored room

Population: The pharmacists in center who use program

Number of Population: 9 (2 drug warehouse 7 medicine-stored room)

Statistics: Percentage

As the result of questionnaires from pharmacists in medicine-stored room, we found that they give the feedback to reengineering information system in supply chain of hospital by calculating the sum of using by program to help in decision to manage drug in order to assist in decision in medicine flow process of hospital that is shown with each dept. as follow:

Table 4.8 Results of the evaluation with user’s opinion questionnaire

Topic	Percentage
1. Personal Data	
1.1 Gender	
Male	2
Female	7
1.2 Department	
Warehouse Store	2
Medicine-stored room	7

Table 4.9 Results of the evaluation with user’s opinion questionnaire about assisting program of drug management in central warehouse

Topic	Percentage				
	least	less	medium	much	The most
1 You think that the program of helping decision in drug management is essential in decision of purchasing drug order.					100%
2 You think that the program of helping decision in drug management is essential in decision of filling drugs in drug room.				50%	50%
3 You think what is the most important to help the program of helping decision in drug management.					
3.1 Drug details					100%
3.2 Feature of drug dispensary to patients (Graph)					100%

Topic	Percentage				
	least	less	medium	much	The most
3.3 Formula of purchasing drug for 3 features.					100%
4 The flexibility of calculating program ROP and EOQ.				100%	

Table 4.10 Results of the evaluation with user's opinion questionnaire about reengineering information system in supply chain of hospital (central warehouse)

Topic	Percentage				
	least	less	medium	much	The most
3.1 To keep drug stock with more certainty.			50%	50%	
3.2 The quantity of drug warehouse is reduced.			50%	50%	
3.3 Work quickly				100%	
3.4 Work comfortably				100%	

Table 4.11 Results of the evaluation with user's opinion questionnaire about the assisting program of drug management in medicine-stored room

Topic	Percentage				
	least	less	medium	much	The most
1 You think that the program of helping decision in drug management is essential in decision of purchasing drug order.				100%	
2 You think that the program of helping decision in drug management is				100%	

Topic	Percentage				
	least	less	medium	much	The most
essential in decision of filling drugs in drug room.					
3 You think what is the most important to help the program of helping decision in drug management.					
3.1 Drug details				100%	
3.2 Feature of drug dispensary to patients (Graph)			57%	43%	
3.3 Formula of purchasing drug for 3 features.	86%	14%			
4 The flexibility of calculating program ROP and EOQ.			86%		14%

Table 4.12 Results of the evaluation with user’s opinion questionnaire about reengineering information system in supply chain of hospital (medicine-stored room)

Topic	Percentage				
	least	less	medium	much	The most
3.1 To keep drug stock with more certainty.				100%	
3.2 The quantity of drug warehouse is reduced.			100%		
3.3 Work quickly			100%		
3.4 Work comfortably			29%	71%	

4.9 Conclusion

As to analyze the questionnaire, we found that the pharmacists want to use the assisting program of drug management in decision more than in medicine-stored room and they want to see the feature of using real medicine in order to be the factor of decision in purchasing drug. The medicine-stored room relates to patients closely so the relevant people know the demand of using medicine. However, when the reengineering information system in supply chain of hospital is used, they calculate the quantity of drug using by assisting program in order to help people to decide the medicine flow process in hospital and to keep the drug stock certainly and to work comfortably while the medicine warehouse increases more quickly in working.

Therefore, we can conclude that the reengineering information system in supply chain of hospital calculated by assisting program of drug management helps in decision to manage the medicine, decision in the medicine flow process of hospital also help the pharmacists keep the medicine in stock more certainly. Also, it can generate convenient in working process and it can be a factor of decision in purchasing drug of medicine warehouse effectively.

CHAPTER V

DISCUSSION

The objectives of this research are to analyze the medicine flow of across three major functions in the hospital and re-designed business process together with develop the application prototype for supporting logistics flow of medicine in the hospital.

5.1 Reengineering the information system in the hospital supply chain

Finding from this research found that almost all of medicines flowing in the hospital were obviously separated among sections without any linkage. Also concerned data and information were kept in different database while there is necessary information needed to be used together. In addition, the system did not link to each other, but through the working process. For example, in this study, the medicine store room and the central warehouse link to each other by the drug dispensary process. Thus, as a researcher, I intend to develop the information system for the hospital based on needs of users section by section. Later, my process allows users to test it before formal launching. Testing the system by the users is very important step since unexpected problems might be found and solved beforehand. However, connection among the sections in the system might generate a problem of data conflict and non-presumable effects. Thus, theoretically, the existent system process must be studied for solving its problems before designing and developing the new complete one of application.

This study is related to internal supply chain of the hospital focused on the medicine flow from three sections; the medicine store room, central warehouse and purchasing department. The researcher found that there is no linkage between medicine store room and central warehouse but data related to drug stock can be checked informally in each time when drugs are ordered. This limitation leads the real

demand of end users can not be identified and ended up with an error of supply chain and drug purchasing. Thus, reengineering for the information system is a thing needed to be done by employing the real sum of drugs used to calculate the quantity of proper drug purchasing through DSS(Decision Support System). However, in the hospital, there are two information systems applied, called HIS (Hospital Information System) for front-end and SAP system for back-end. These two needs an Interface point in which all information is flowed together. Theoretically, the DSS system should be placed at the back-end since it is a convenient location for users. Another issue is related to ERP (Enterprise Resource Planning) application in hospital. The ERP system can be functioned well mainly depending on organization's need. Actually, the development of ERP internally in any organization is quite difficult because of human resource constraint. Thus, most organizations often purchase the package ERP to apply in working process but the package ERP system is needed to be studied whether it can function well with other organization systems or not. In this study, the hospital employed SAP system to be applied but this system is more suitable with general industry in which it has solid system of management. But the working process of hospital is quite different from general industry, thus, in case the hospital intends to apply ERP instead of SAP, the ERP employed should be suitable for healthcare purpose in which its function covers front-end and back- end. The careful-designed ERP can reduce some upcoming problems significantly.

5.2 Move to VMI (Vendor Managed Inventory)

As aforementioned, in traditional buyer/seller relationships, both of the actors often strive to optimize their own operations independently, resulting in sub-optimal performance of the combined operation and the supply chain as a whole. However, with VMI, a type of relationship within SCM and a more efficient replenishment practice can be achieved by letting the vendor (supplier) respond to undistorted and timely demand information in order to pull the products through the channel (Holmström, 1998). Similarly, Vendor-ManagedInventory.com (2006) defines VMI as “A means of optimizing supply chain performance in which the manufacturer is responsible for maintaining the distributor's inventory levels”. Waller et al. (1999)

stated that VMI is sometimes referred to as supplier managing inventory depended on where in the supply chain the relationship takes part.

Supply Chain Management and Logistics have played a main role in business plan of producers and customers since the last decades, especially, the business concept of central warehouse; called VMI (Vendor Managed Inventory). VMI becomes playing the important role based on a concept that vendors, sale representatives or trader/distributors take a lead for controlling and managing the stock themselves also delivering and handing goods to their customers in times of replenishment. As the plan designed together between vendor/trader/distributor and ended customer, VMI can be the best way to reduce the problems of over-expense on renting warehouse and overstock of ended customer. With its benefit, VMI can help business run with efficient cost because it can:

- Reduce the cost of warehouse managing included reducing the number of employees and other relevant costly resources
- Reduce purchasing cost and provide the customers receiving correct products; in right place and time.
- Increase efficiency of drug circulation system especially for Shelf-life drug, drugs of specific expired date, seasonal medical products as well as year-rounded product.

In terms of vender, benefit gained from VMI covers:

- Receive advance-timely order from customers. The timely order helps vendor generate production plan as well as cost management effectively.
- Exchange the information between vender and customers. This helps vendors deliver products on hands and in time of their customers also level up service satisfactions among the customers.

This research is aimed to prepare the readiness in order to reach the process of VMI in the hospital that is the result from reengineering. For VMI system, the vendor has to know the quantity of drug store and feature of drugs in hospitals. These information helps vender manage drug stock as well as make decision on drug production effectively; finally the shorten of lead time. But the process of the right VMI is based on the correct data of drug volume in the hospital along with the readiness of information system linkage. A factor generating the perfect VMI is

standard code provided for connecting all points of information flow since the code can give details of right track of drug flow which finally provides uttermost benefit for all patients. Anyway, all referred above is only the idealistic idea but it can be generated whether the hospital begins to manage the drug warehouse. This research is aimed to provide a possible option in order to improve the quality of concerned system in the hospital.

5.3 Limitations of the System

The business process is for the state-owned hospital, which may be not suit with the private hospital. Therefore, you need to know well about your current business process.

CHAPTER VI

CONCLUSION AND RECOMMEDATION

6.1 Conclusion

The research presents a new design for information system in a hospital supply chain, particularly in medicine stock management. Instead of using pharmacist's experience in setting stock reorder point, the central warehouse can now monitor the stock usage and stock left in the supply chain. All functions in this medicine supply chain must share the same database in recording and updating stock level. This can enable the supply chain members to visualize the stock level from anywhere in the chain.

The research also illustrates the use of IDEF0 for business process redesign. It shows the need of business process analysis prior to the redesign of any information system and software implementation. This is even more essential for the future enterprise resource planning (ERP) implementation in the business. The business process analysis and reengineering of information system must be a well-prepared platform for any ERP launch. This enterprise's information flow must be well-understood and clearly architected prior to the implementation.

The research is conducted in parallel with the inventory management system project. The inventory project analyses the pattern of medicine usage from patient's end demand. The reorder point (ROP) and economic order quantity (EOQ) are set appropriately for each pattern. This is then formulated and put in the software presented in this paper. It enables the warehouse to see the end demand and stock input for calculating the ROP and EOQ for this case.

Finally, there are rooms for further study in linking this internal supply chain to the supplier. Having known the medicine stock and demand in the hospital operations, it can then initiate the vendor manage inventory program with suppliers. Also reverse logistics for the expired medicine is of our interest.

6.2 Recommendation

Before implementing ERP, business process mapping is used to model to visualize the actual process and look for improvement to make it more effective. Then, choose the appropriate information technology for your business. In this case, it can be considered as two alternatives:

1. Implementing all packages, that covers Material / Inventory Management, front (point of sale) and VMI (Vender Manage Inventory). The point of this alternative for calculating point of sale from real demand. But this option is not worth investment because of hospital has small retailer (medicine storerooms) (This alternative is suitable for multi-location warehouse scale or else in which the owner has many retailers)

2. Implementing only Material / Inventory Management and customizing authorization as a part of warehouse. Visual stock of medicine storeroom in each ward and linkage between distribute center (warehouse) and retailers (medicine storerooms) is needed. Decisions to replenish by pharmacist because they have logic for purchase conditions in each medicine should be cancelled. This alternative is more suitable for this case but it needs a strong understanding of business process's officers.

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APPENDICES

APPENDIX A

QUESTIONNAIRES

แบบสอบถามความคิดเห็นของเภสัชกรในการใช้งานระบบ

ข้อ 1 ข้อมูลเภสัชกรผู้ใช้งานระบบ

1.1 เพศ ชาย หญิง

1.2 แผนก คลังยา ห้องยา จัดซื้อ

ข้อ 2 ความคิดเห็นเกี่ยวกับโปรแกรมช่วยในการตัดสินใจในการจัดการยา

ความคิดเห็น	น้อย มาก	น้อย	ปานกลาง	มาก	มากที่สุด
2.1 ท่านคิดว่าโปรแกรมช่วยในการตัดสินใจในการจัดการยามีประโยชน์กับการตัดสินใจสั่งซื้อยา					
2.2 ท่านคิดว่าโปรแกรมช่วยในการตัดสินใจในการจัดการยามีประโยชน์กับการตัดสินใจเติมยาของห้องยา					
2.3 ท่านคิดว่าสิ่งใดที่มีความสำคัญในโปรแกรมช่วยในการตัดสินใจในการจัดการยา 2.3.1 ข้อมูลยา 2.3.2 รูปแบบการจ่ายยาให้แก่ผู้ป่วย(กราฟ) 2.3.3 สูตรช่วยคำนวณปริมาณการสั่งซื้อยาทั้ง 3 รูปแบบ					
2.4 ความยืดหยุ่นของโปรแกรมในการคำนวณROPและ EOQ					

ข้อ 3 ความคิดเห็นเกี่ยวกับการริเริ่มเชิงระบบสารสนเทศในโซ่อุปทานโรงพยาบาล

ถ้ามีการริเริ่มเชิงระบบสารสนเทศในโซ่อุปทานโรงพยาบาล โดยการนำเอาการใช้ยามากำหนดด้วยโปรแกรมช่วยในการตัดสินใจในการจัดการยา เพื่อช่วยในการตัดสินใจในกระบวนการไหลของยาในโรงพยาบาล(การเติมยาที่ห้องยา การตัดสินใจสั่งซื้อยา)ท่านมีความคิดเห็นอย่างไร

ความคิดเห็น	น้อยมาก	น้อย	ปานกลาง	มาก	มากที่สุด
3.1 การเก็บสต็อกยามีความแม่นยำมากขึ้น					
3.2 ปริมาณยาคงคลังลดลง					
3.3 มีความรวดเร็วในการทำงานมากขึ้น					
3.4 มีความสะดวกในการทำงานมากขึ้น					

////////////////////////////////////// Thank You //

APPENDIX B

A New Design for Medicine Information System in Hospital Supply Chain.

The purpose system has three different methods to determine order quantities and reorder points. In a new policy also takes an account for lead-time deliver and variation in patient's demand. In addition, we use the forecasting technique to determine the order quantity. This concept from the relate research name's Managing the inventory system in a hospital supply chain by Kritchanchai and Suwandeechochai (2008)

Let L be lead-time starting from making an order until receiving products, Q be the order quantity, and S be a special order. μ and σ are mean and variance of demand (in days) obtained from the historical data, N is the number of days that the warehouse wants to keep inventory for, and y is inventory level which is the sum of on-hand inventory and carrying inventory. Assuming that the lead-time will be known while the central warehouse placing an order.

Type I: Demand has no trend and low variability.

Tuberculin is an example of type I demand. As seen in the previous chapter. In this case the demand has low variability and low mean demand. With the current policy the hospital need to waste 387 vials with the usage of 83 vials during a study period. The reason is that Tuberculin has short shelf life which is only about 5 months. Since the demand is quite stable, then we can approximate the future demand by using the average demand μ . Using this information we suggest that the central warehouse should order when its inventory level, y , is below the total future demand during the lead-time period that is,

$$y \leq \mu(L+1).$$

Q can be determined by the following formula:

$$Q = \mu N + S - y_0 - \mu(L+1)$$

where N is number of days in future 5 months and y_0 is on-hand inventory.

Type II: Demand has no trend but high variability.

In this case only mean cannot be used to approximate future demand when the demand variability is high. To deal with this uncertainty, the new reorder point, r , should be considered. Thus r should depend on lead-time, variance, and mean of demand and it can be calculated from:

$$\Pr(D_L \leq r) = 1 - \alpha$$

where $1 - \alpha$ is a service-level and D_L is total demand during lead-time with mean $\mu * L$ and standard deviation $\sigma \sqrt{L}$. Thus r can be found by finding the inverse normal distribution of D_L .

The order quantity Q can be found by

$$Q = \text{Max} \{ \lceil \mu N + S - y_0 / \text{units per box} \rceil, \text{min orders required} \} - r.$$

Thus an order should be placed when $y \leq r$.

Type III: Demand has trend with high variability.

In fact Type III demand can be either increased or decreased. In this case we use the linear regression method to approximate future demand say $f(x)$ which is in the form of $ax + b$.

The safety stock r can be found by the equation

$$\Pr(D_L + \sum_{i=M}^{M+L} f(x_i) \leq r) \leq 1 - \alpha$$

where D_L is normally distributed with mean 0 and variance $(L+1) * \text{MSE}$ obtained from linear regression. Demand in the next N days can be approximated by

$$\Pr(D_N + \sum_{i=M}^{M+N} f(x_i) \leq Y) \leq 1 - \alpha$$

Thus the order quantity can be obtained by

$$Q = \text{Max} \{ \lceil Y + S - y_0 / \text{units per box} \rceil, \text{min. orders required} \} - r.$$

The order will be placed when $y \leq r$.

To compare ordering by using M-sale calculate re-order point in current system and ordering by using New policy suggestion that the medical central warehouse used. The central warehouse needs to have safety stock for 1.5 months on average. The lead-time is about 10 days. We consider all different types of demand in which Tuberculin represents the demand of Type I, Dormicum and Losec represent demand of Type II and Omeprazole and Pariet represent demand of Type III. The result shows in

Table 1.

Table 1: Results of Comparing between Current and New policy

	Demand	Msale			New policy			
		No. of Orders	Total Quan.	Average Inventory	No of Orders	Total Quan.	Average Inventory	Percentage
TUBP	82	7	480	45	3	105	25	44.44%
DORM	72032	5	70000	12685	11	62800	4933.616	61.11%
LOSC	42435	11	40656	4207	14	41790	2720.126	35.34%
OMPZ	2616840	25	25200000	113532	24	2812950	102459	9.75%
PARI	76208	18	77700	5293	19	82460	4184	20.95%

The results show that the average inventory under DSS suggestion can be reduced from 9.75%-61.11% comparing to the current system. The amount of reduction depends highly on the patterns of demand. The number of ordering for Tuberculin, Type I, reduces to 3 with the reduction of inventory 44.44% of the current situation. For Dormicum and Losec which are Type II demand average inventory of our purposed system reduced by 61.11% and 35.34% respectively. The demand of Omprazole is quite large and the price of Pariet is very high, the central warehouse has trouble with the area of stocking these two items. Our proposed system yields the similar number of orderings as using the current system. In addition, the results show that the average inventory can be reduced from 9.75% and 20.95%.

We apply the concept of supply chain and logistics management in service industry-hospital. The missing link in the chain is found between each ward's storeroom, the central warehouse and the purchasing department. The IDEF0 model evidences the problem in calculating the MSale. The MSale value comes from the medicine

requisition form from the pharmacist in each ward, rather than patients' end demand. The reorder point is then based on moving average value. So, the pharmacists need to have patterned of usage for decision to replenish.

BIOGRAPHY

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