DEVELOPING INVENTORY MANAGEMENT IN HOSPITAL

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ABSTRACT

Single inventory policy has been applied to entire drugs in the hospital even though drugs have several characteristics. Some drugs are not enough for patients. This may affect patients' lives especially when they are vital drugs. However, the hospital cannot store a large amount of all drugs because of limited space and budget. The objective of this study was to develop the inventory management in the hospital to minimize total inventory cost while the patient service level is still maintained. This study concerned only the medicines which have high consumption value in the large government hospital.

It was found that the single inventory management system could not be efficiently applied for all medicines. This is because of several categories of medicines characterized by their value and clinical importance (ABC/VEN). The study proposed developing inventory polices and the inventory theories to compare with the current Min/Max inventory policy.

The optimal policy is adapted to the drug characteristic. Drugs inventory in the study can be classified by drug value, clinical importance and demand characteristics into three groups. Most of them are drugs with high consumption value and essential clinical importance (AE) which have normal distribution, no trend and static demand. Current Min/Max inventory policy is optimal because it minimizes total inventory cost. Most of drugs with high consumption value and vital clinical importance (AV) are not normally distributed. Dynamic lot sizing policy is optimal because it minimizes the shortage. Drugs with high consumption value and non-essential clinical importance (AN) which have normal and not normal distribution are optimal to current Min/Max inventory policy because it minimizes total inventory cost.

KEY WORDS: INVENTORY MANAGEMENT / HOSPITAL / DRUG / SUPPLY CHAIN

140 pages

การพัฒนาการจัดการสินค้าคงคลังยาในโรงพยาบาล

DEVELOPING INVENTORY MANAGEMENT IN HOSPITAL

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บทคัดย่อ

ปัจจุบันนโยบายสำหรับการบริหารจัดการสินค้าคงคลังยาในโรงพยาบาลมีลักษณะนโยบายเดียวใช้กับยาทุกรายการ ทั้งๆที่ความต้องการยาแต่ละรายการแตกต่างกัน ยาบางรายการจึงไม่เพียงพอต่อความต้องการของผู้ป่วย อาจส่งผลถึงชีวิตของผู้ป่วยได้โดยเฉพาะยาที่สำคัญต่อการรักษามาก และโรงพยาบาลมีงบประมาณและพื้นที่จำกัดไม่สามารถเก็บรักษายาเป็นจำนวนมากได้ งานวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนาการจัดการสินค้าคงคลังยาในโรงพยาบาล สามารถลดต้นทุนรวมของคลังยา แต่รักษาระดับการบริการไว้ได้ งานวิจัยศึกษาเฉพาะสินค้าคงคลังยาที่มีมูลค่าการใช้ต่อปีสูง (ยากลุ่ม A) ในแผนกผู้ป่วยนอกของโรงพยาบาลรัฐขนาดใหญ่แห่งหนึ่ง โดยใช้ข้อมูลการใช้ยาจริงในอดีต

จากการศึกษาพบว่า สินค้าคงคลังยาในแผนกผู้ป่วยนอกของโรงพยาบาล สามารถจำแนกตามมูลค่าการใช้ต่อปีและความสำคัญทางการแพทย์ (ABC/VEN) ตลอดจนรูปแบบลักษณะของความต้องการใช้ยาได้ทั้งหมด 3 กลุ่ม ส่วนใหญ่เป็นยาที่มูลค่าสูงและสำคัญต่อการรักษาปานกลาง (ยา AE) มีการกระจายตัวของความต้องการแบบปกติ ไม่มีแนวโน้ม และมีความต้องการคงที่ นโยบายที่เหมาะสมส่วนใหญ่ยังคงเป็นนโยบายเติมให้เต็ม (Min/Max) ที่โรงพยาบาลใช้ในปัจจุบัน ส่วนยาที่มูลค่าสูงและสำคัญต่อการรักษาสูง (ยา AV) ส่วนใหญ่มีการกระจายตัวของความต้องการแบบไม่ปกติ ควรสั่งซื้อแบบเป็นช่วงเวลาจะทำให้จำนวนสินค้าคงคลังยาขาดน้อยที่สุด และยาที่มีมูลค่าการใช้ต่อปีสูง ยาที่มูลค่าสูงและสำคัญต่อการรักษาน้อย (ยา AN) มีการกระจายตัวของความต้องการทั้งแบบปกติและไม่ปกติ นโยบายที่เหมาะสมยังคงเป็นนโยบาย (Min/Max) ที่โรงพยาบาลใช้ในปัจจุบัน เพราะทำให้ต้นทุนรวมน้อยที่สุด

140 หน้า

CONTENTS

CONTENTS (cont.)

LIST OF TABLES

LIST OF TABLES (cont.)

LIST OF FIGURES

LIST OF FIGURES (cont.)

CHAPTER I
INTRODUCTION

1.1 Background and Importance of the Problem

The healthcare expenditure is generally on drug because drugs are the important products in curative care and hospitals had been taken holding costs of drugs which were stocked excessively to keep high service level as their requirements especially in the developing countries. (1, 2) Holding drug stock extremely makes high holding cost such as expired drugs and deteriorated drugs. Consequently, hospitals ineffective lose annual expenditure (3) and opportunity to service the patients.

Supply chain management is the planning and controlling of the activities and resources in the organization that includes all value added activities along the chain. (4) Hospital is the organization which consists of various vital resources. In case study of some large government hospitals in Thailand, the min/max inventory policy has been applied to all drugs in the hospital without the consideration of demand pattern. The application of this policy makes several inventory problems especially that some patients is not unable to receive the required drugs. The drugs with similar quantity are disposed instead of shortage drugs. The shortage drug should not be occurred or occurred at the acceptable level because the effect of shortage drug is involved with patient safety.

Moreover, if the drug inventory management is improved and drug stock is not high as previous, service level will be kept as high as the hospitals' requirements because most of patients always get medicines in the right quality every time they require (3). Since hospitals can encounter the fluctuation of demand resulting from some factors such as seasonal and disease. The hospital can prevent the deficient drug inventory and hold the probably delayed lead time from some suppliers.

This study develops the drug inventory management strategy explaining inventory planning and control when to order, how much to order, how to handle various types of drug. Collection of actual drug demand, classification of the demand

types, the optimal policy of each demand type are the way to get the inventory management of drug inventory. The optimal inventory management should reduce the total inventory cost while the service level of patient is still maintained. For these reasons, the inventory management in a hospital is investigated in this study.

1.2 Statement of Problem

Presently, hospitals are used only one policy to replenish all drugs in the hospital without concerning drug demand patterns because of the plenty number of drugs. The efficient inventory management should be applied with different types of drug characteristics.

1.3 Objective

This research aims to develop drug inventory management in a hospital, Thailand

1.4 Scope of the Study

This study is concerning only the medicines in Our Patient Department (OPD) of a large private hospital in Thailand retrieved from the record available on HIS (Hospital Information System) in the fiscal year 2011. Only category A of drugs which is about 70 of total annual drug value is concerned. However, medical devices and other consumable devices are not included. The data was also retrieved from the observation and survey of drug inventory and pharmacy department of this hospital and interviewing the related pharmacists. ABC/VEN classification, demand forecasting model and inventory models are applied to specific drug demand characteristic. Hence, the inventory management strategy of drug inventory in the hospital is developed.

1.5 Expected Results

This study will show the developed drug inventory management strategy under hospital unit for each drug characteristic. This explains that only one policy cannot be applied to all drugs which have individual characteristic. Collection of actual drug demand, classification of the demand types, determine the drug characteristics, and the comparison between the current Min/Max policy and the developed inventory policies which are specific to drug demand types are the way to get the more optimal inventory management of drug inventory in the hospital.

1.6 Conceptual Framework

This study shows the developed drug inventory management strategy in the hospital for various types of drug to improve inventory performance of a large private Hospital, Thailand. First of all, the data of drug demand of the fiscal year 2011 are classified based on cost and medical importance by ABC/VEN analysis. Only a drug group with high annual consumption value is selected and then divided into drugs with high consumption value and vital clinical importance (AV), drugs with high consumption value and essential clinical importance (AE) and drugs with high consumption value and non-essential clinical importance (AN).

After that, the current Min/Max inventory policy, developed drug inventory policies and inventory policies from theory are applied to data and compared based on weight Key Performance Indicator (KPI) by using Pairwise ranking.

Finally, find out the factor or characteristic of each drug category which is optimal to particular drug inventory policy and then the strategy of drug inventory management in the hospital is developed. The conceptual framework of this study is shown in Figure 1.1.

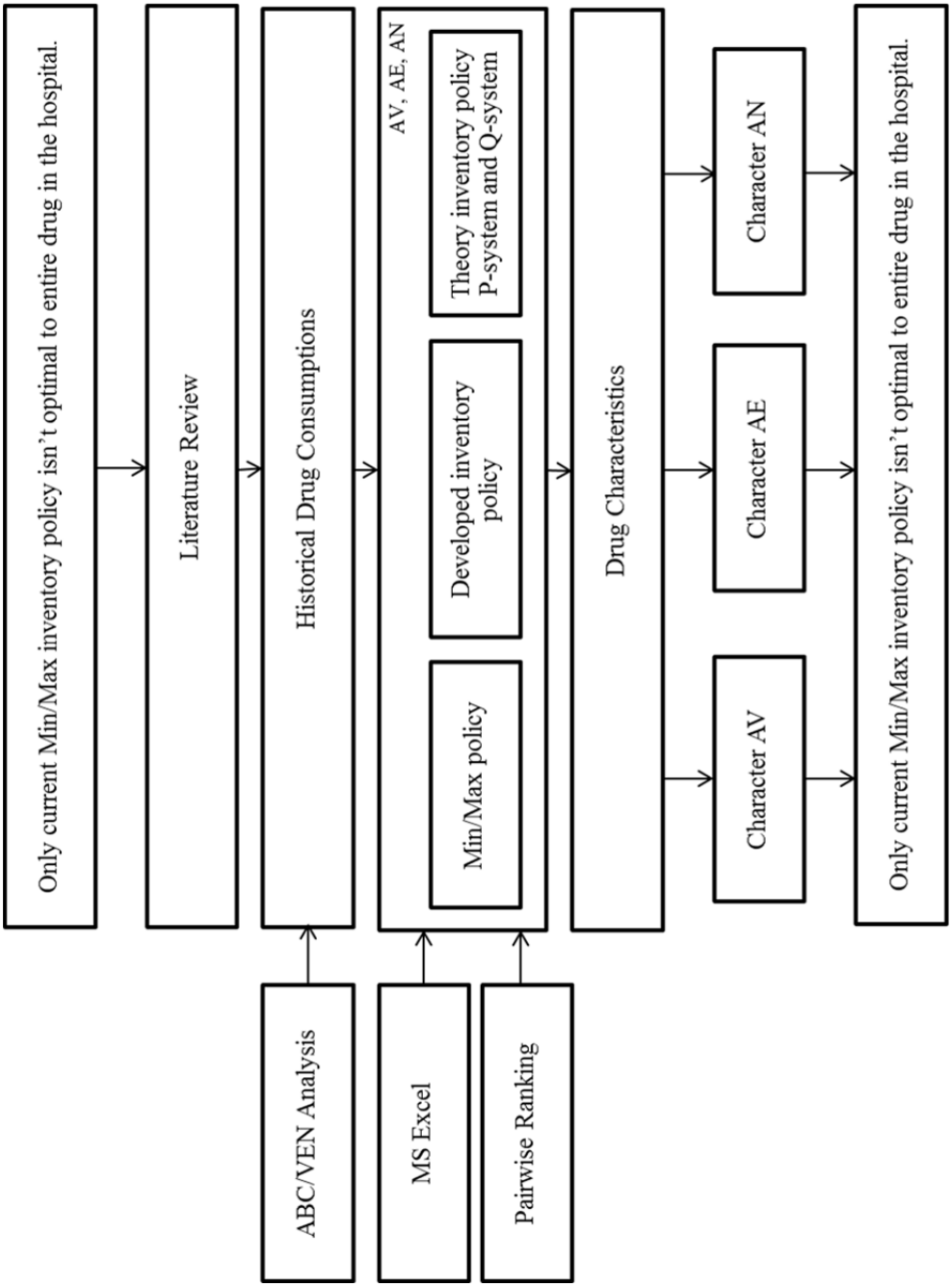

Figure 1.1 Conceptual framework

CHAPTER II
LITERATURE REVIEW

2.1 Drug Inventory Management in Hospital

Drugs or medicines were the selected resources for studying the inventory management in the hospital because these resources flow through all part in the hospital system and reflect the system performances both material and information (6). Central drug inventory was investigated because this department has right to order drug to procurement department, receive drugs from the suppliers and distributed drugs to each ward as required (6, 7).

The drug orders from each ward were placed at central drug department every morning. The daily transaction of drug orders was collected. The order quality is based on the experience of the pharmacists. The drug usage was collected every month called monthly sale or Msale. When the level of drug inventory on hand is less than or equal to 70-80% of Msale, the pharmarcists in drug inventory department will place purchase request (PR) to the procurement department, the suppliers will receive purchase order (PO) from the procurement department in next day and the order quantitiy is the number of drugs that rise the inventory on hand up to 100-150% of Msale. This policy is called Min/Max policy that the hospital applied to all drug in the hospital.

Disadvantage of using one policy to all drugs in the hospital is that inventory problems were occurred such as drug shortage especially vital drugs which should have lowest amount of shortage as much as possible. In this study, the strategy to manage all drugs in the hospital was investigated.

2.2 Inventory Management

The inventory management is very important to any organization because the demand of products is not stable. To support this, the buffer stock is needed to

keep. Inventory management is a trade-off between the costs of maintaining inventory versus the benefits of holding it (6, 8).

Lead time (LT) is the time between ordering items by pharmacists in drug inventory department to the procurement department and receiving items from the suppliers. In this case study, after drug inventory department issues purchase request (PR) the procurement department issues purchase order (PO) to supplier in next day(6). Therefore, lead time is equal to L+1. Lead time is directly effect to the reorder point which is the stock level at which new order is placed that help in avoiding under or over stocking of drug (5, 8-11). Hence, long lead time increases the reorder point because the demand over long lead time is high. Safety stock or buffer stock is quality of drug inventory held as a reserve to safeguard against variation in demands and lead time for procurement (5, 9). Safety stock is one factor to consider the reorder point. Another factor considered to replenish drug is service level which means that the ratio between the number of available products for customers and number of total product demand. For instance, 95% service level means that 95 percent of total the individual product's requirement is able to serve to customers (6). The order quantity model which is widely used is Economic Ordering Quantity (EOQ) model. EOQ was calculated through holding cost and ordering cost (9, 12). It is the quantity of materials to order and minimize total cost of carrying inventories and cost of ordering (5, 9-11). Furthermore, it can be computerized to provide a simple efficient purchasing system (13). Microsoft Excel is widely used to calculate several parameters such as EOQ, ROP, average inventory, inventory costs, and ordering time. (12).

2.3 Inventory Policy

The inventory policy which is used in the general inventory can be divided into 4 policies.

(s,Q) policy assigned s as the size of the reorder point, and Q as the order quantity is constant over time. This policy can be called two-bin system. If the inventory position reaches the reorder point s, then a replenishment order of size Q is occurred. The application of EOQ/ROP could control drug inventory level, decide appropriate reorder point and reduce operation cost(12).

(s,S) inventory policy assigned s as the reorder point and the order was placed if the inventory position is at or below s and the quantity ordered is what is required to make the inventory level reach S.

(R,S) inventory policy assigned R as the points in time at which replenishment orders are released are determined through the review interval. In constant intervals of r periods launch a replenishment order that raises the inventory position to the target order level S. Obviously, the (R,S) policy is an replenish cycle system.

(R,s,S) inventory policy is the combination of (s,S) and (R,S). The inventory level is reviewed every interval R. If the inventory level is less than reorder point s, the purchased order is placed and order up to maximum inventory S.

2.4 Representative drugs

Some previous study selected some drugs to represent the drug inventory problems by interviewing pharmacists in drug inventory department and pharmacy department (6, 10, 11, 14). The developing drug inventory model in the previous study selected six drugs from the problems which are specific to patients, high shortage, trend demand, short expired drugs, high consumption. For instance, drug named ILOMEDIN is used for specific patients, so demand from drug inventory did not reflect on the real demand from patients (6). Drug named Eprex, Metformin and vitamin B were chosen because these drugs had inventory management problems: expensive drug, requirement to keep in refrigerator, high consumption and very long lead time (10).

The expensive drugs of inpatient hospital pharmacy were investigated because the expiration and high inventory of these drugs is costly (9, 12, 15). In addition, only the “A” category of drug items were considered which is account for 70 percent of total expenditure because the “A” category drugs show what a large amount of hospital drug expenditure was spend on and the stricter control should be applied (9). In the study of inventory management system for the Royal Thai Air Force Medical Depot, medicine with high usage value and high importance to life and air force mission (Drug group AV) is investigate because inventory level and holding cost

of AV drugs was high (8, 12). In addition, drug is medical item which is different from others because the result of drug effect to treatment and patients' lives (12).

2.5 Historical Data

To analyze demand patterns and apply inventory policy, the input data are the historical drug demand from the medical information system of the hospital and interview data from the pharmacists or staffs in drug inventory department and pharmacy department (6, 7, 10-12). There are many periods of data. For example, some studies used daily demand (6, 7), weekly demand (7, 10), and monthly demand (12) for 1 fiscal year (11, 13) and 3 years (8, 10, 12).

2.6 Drug demand patterns

The previous studies of drug inventory management concerned demand patterns (12).

2.6.1 Normal distribution

Most of the studies had assumption that drug demand and lead time is normally distributed (10, 12). Kolmogorov-Smirnov is usually used to test the normality (8, 10, 12). However, some drug demands have other distributions such as exponential and gamma distribution (8). The specific inventory models were developed for these distributions.

2.6.2 Trend

Some drug demands have trend (12). Run test is tool to test if the demand has trend. If the data has trend, then type of trend is tested by the curve estimation considering R-square (R^2) (7, 8).

2.6.3 Variability

Some drug demands are lumpy (16) because of internal factors and external factors. For example, the internal factors are size of hospital and familiarity of

doctor to drugs (5, 6). The external factors which unable to know before and controlled are disease outbreak (5). In contrast, some drug demand are static (5, 6, 16). Static drug demands are concerned in the study of drug inventory in Chiang Mai University not including lumpy demand (5) and Ramathibodi Hospital (6, 7). The Peterson-silver rule is used to determine the variability of data by V value (16). If V is less than 0.25, the demand is static. Otherwise, the demand is lumpy.

2.7 Inventory Classification

The reason to classify inventory is to reduce the duty to control a plenty of item in the inventory. If all items have strict controlled equally, it wastes unnecessary time and costs.(12) The classification can help to focus on the high prioritized items (12).

2.7.1 ABC analysis

ABC analysis is well known in inventory management to determine where the expenditure is spent, allowing managers to give highest priority on high-cost items (10, 11, 13). For example, the drug inventory management in Udonthani Hospital (11) assigned service level to A items: B items: C items as 71: 16: 13. In Special Medical Service Center at Chiang Mai University (5), service level to A: B: C drugs group was 95: 90: 98.

The inventory is rank A, B, and C. Class A items represent high usage, Class B items represent average, and Class C items represent low usage (13).

Category A accounts for 70-80% of usage value, the total quantity are 10-15% of line items. Category B accounts for 10-15% of usage value, the total quantity are 30-40% of line items. Finally, Category C accounts for 3-5% of value expended, the total quantity are 50-60% of line items (8).

Moreover, ABC inventory analysis is usually used with economic order quantity (EOQ) concept as a tool to manage inventory more efficiently (9, 10, 13). The application of ABC/EOQ system can increase annual inventory saving by improvement in turnover and reduction of standing inventory (13).

However, in some case inventory reduces only -0.51% and the volume of drug group A is more than group B and C which does not agree with the principle.

2.7.2 VEN analysis

VEN (vital, essential, non-essential) classification is another useful tool for defining which items on the formulary list must be held in the stock (13). VEN analysis is often used to prioritize procurement when there are not enough funds to purchase all drug items requested. This system also help pharmacist to determine which items should be kept in stock and which can be ordered when needed (13). V drug would be more likely to keep in stock than N drugs (13). The basic criteria to classify drug by VEN analysis are shown below (12).

V items (Vital drugs) are the most important drugs and needed for clinical therapy such as vaccine and serum. Drug inventory must always stock V items.

E items (Essential drugs) are moderate important drug and used to cure less severe diseases than V items.

N items (Non-essential drugs) (6-10, 12) or D items (Desirable drugs) (17, 20, 21, 24) are the least important drugs and treated to little illness.

2.7.3 ABC/VEN matrix

ABC/VEN is the combination of two dimensions of the classification: ABC and VEN classification (8). ABC/VEN analysis, re-order point (ROP), safety stock and Economic Order Quantity of drug AV, AE and AN were analyzed through the secondary data collected from Hospital Information System (HIS) from the period one year (9).

In order to calculate the re-order point of drug items, the safety stock and demand over lead time are input data. Moreover, the safety stock depends on mean absolute deviation and service level which is determined by the particular organization's policy. As the previous study decided the service level on only 'A', 'B' and 'C' drug category categories which is concerned only value (5, 11, 12), but don't on 'V', 'E', and 'N' drug categories which are level of clinical importance and a special characteristics of drugs. Therefore, this study determined the service level of drugs with high consumption value and vital clinical importance or 'AV' category and

assumed the service level of drugs with high consumption value and essential clinical importance or ‘AE’ category and also of drugs with high consumption value and non-essential clinical importance or ‘AN’ category as shown in Table 2.1.

Table 2.1 Service level of each drug category

Drug Category	Service Level (%)
AV	98
AE	97
AN	96

ABC/FS is a reorder system that build on ABC analysis (13). This system broken A, B and C items into three categories: fast turnover (17), slow movement (S) and no movement in the past year which is C items and reclassified as D for Dead (13).

The literatures that have conducts on data characteristic and method problems are listed in Table 2.2 and 2.3.

Table 2.2 Summary of literature review about data characteristic and method

No.	Reference	Data characteristic	Method/ Tool
1	(6)	Static and random drug demand	Developed inventory Model using mean and SD ROQ/ROP Peterson-silver rule
		Lumpy and random drug demand	Developed inventory Model using probability to calculate ROP Peterson-silver rule
		Lumpy and not random drug demand	Developed inventory Model using regression and probability to forecast demand EOQ/ROP Peterson-silver rule
2	(15)	Perishable drug, IPD Patient type 1) high variable demand with large mean 2) lower variable demand with large mean	Markov decision process (MDP)
		Patient type classified by unique demand characteristic Expensive drug Divided drug into Raw material and finished goods	Simulation
3	(9)	All high value drug (all group A)	VEN/A analysis ROP Safety Stock EOQ

Table 2.2 Summary of literature review about data characteristic and method (cont.)

No.	Reference	Data characteristic	Method/ Tool
4	(12)	AV drug (highest consumption value and most important)	EOQ, ROP, safety stock Simulation by Excel ABC/VEN Forecast demand Informal interviewing
5	(10)	Selected drug by inventory problems 1. expensive and must keep in refrigerator 2. high use rate 3. very long lead time	Reorder point model (s,S) ROP, EOQ ABC Forecast demand by smoothing method Interview staff / observation Test normality (Kolmogorov-Smirnov)
6	(8)	Demand distribution and demand trend: normal and random	ABC/VEN
		Expensive drug value and very important (drug AV)	Forecast demand by Runs Test Curve Estimation to test the linear trend Kolmogorov-Smirnov Test or Chi Square Test Developed ROP for specific demand patterns
7	(11)	Drugs with ten inventory problems. For instance, antibiotics are expensive drugs and have diversity of types.	ABC EOQ/ROP Interview

Table 2.2 Summary of literature review about data characteristic and method (cont.)

No.	Reference	Data characteristic	Method/ Tool
8	(5)	High value Static value	ABC Safety stock ROP EOQ MS Excel Peterson and silver rule
9	(7)	Drug usage in fiscal year 2008 Trend/No trend demand Normal/Exponential/Gamma distributed demand	Boxplot ABC/VEN Forecast demand Run test K-s test or Chi-square test Simulation

Table 2.3 Conclusion of Drug Characteristics and Method-Tool used in previous studies

		Drug Characteristic										Tools/Method																
		Drug Demand					LT ยา																					
No.	Reference	Static demand	Lumpy	Trend demand	seasonal	Normal Distribution	Static lead time	Lumpy	Long lead time	Critical to medical therapy	High value	ABC	VEN	Developed ROP	Developed EOQ	ROP	EOQ	Probability	Regression Model	3month weight average	Winter's Forecating	Kolmogorov-Smirnove Test	Curve Estimation	MDP: Markov Decision Problem	Safety Stock	Simulation	VHP
1	(5)	✓								✓	✓	✓				✓	✓			✓							
2	(6)	✓	✓	✓			✓	✓		✓	✓			✓	✓			✓	✓						✓		
3	(7)			✓		✓				✓	✓	✓	✓	✓								✓	✓				
4	(9)		✓					✓		✓	✓	✓	✓			✓	✓								✓		
5	(10)					✓			✓		✓					✓	✓					✓					
6	(11)										✓	✓				✓	✓										
7	(12)	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓			✓	✓	✓			✓				✓	✓	
8	(14)		✓						✓																		✓
9	(15)		✓								✓													✓		✓	

CHAPTER III
METHODOLOGY

This study identifies the optimal drug inventory policy which can maximize inventory performance under the different drug characteristics. In general, three main drug inventory policies, which are the current Min/Max inventory policy, developed inventory policies and inventory theories, are applied and compared according to previous studies about drug inventory management. The pairwise ranking and costs of inventory performance based on three main drug inventory policies are also compared. Factors of drug characteristics from the optimal drug inventory policies are then explored. The details can be divided into eight main parts:

3.1 Research Planning

3.2 Data Collecting and Analysis

3.3 Classification of Drug Inventory by ABC/VEN Analysis

3.4 Min/Max Inventory Policy

3.5 Mathematical Formula

3.6 The Drug Inventory Models Depended on Drug Demand Characteristics

3.7 The Inventory Theory

3.8 Pairwise Ranking

3.1 Research Planning

Research planning is the first step and important part to study. This part can be divided into four sections:

3.1.1 Problem identification

3.1.2 Scope of the study

3.1.3 Hypothesis

3.1.4 Research process

3.1.1 Problem Identification

From the observed activities in the real situation, interviewing of pharmacists in Pharmacy Department and Central Drug Inventory of a large public hospital located in Bangkok, Thailand, and research reviewing about drug inventory management (6, 7), current drug ordering policy of the hospital called “Min-Max” policy is applied to all drug in the hospital. This causes some inventory problems both shortage and overstock in some drugs. Some drugs are not adequate for patients. Then, patients may receive another drug which may be the similar therapeutic property but difference price. In case of no drug to serve, the procurement department is unable to generate purchase order (PO) in time. Consequently, the hospital has to borrow drug from the supplier and send PO next time. In the other hand, the quantities of some drugs in the drug inventory are excessive. This overstock inventory increase high holding cost while decrease the utilization of the storage area.

Therefore, if drug inventory can be controlled as the optimal quantity, patients should receive their required drugs at the right time and hospital will manage its expenditure more effectively.

From these reasons, the current inventory policy, developed inventory models the theory of inventory management are applied and investigated in this study.

3.1.2 Scope of the Study

This study is concerning only the medicines in Out Patient Department (OPD) of a large public hospital in Thailand retrieved from the record available on HIS (Hospital Information System) in the fiscal year 2009-2011. Only drugs with high consumption value about 70 of total annual drug value is concerned with the purpose

of reducing expenditures and increasing effectiveness of drug utilization. However, medical devices and other consumable devices are not included. The other data was also retrieved from the observation and survey of drug inventory and pharmacy department of this hospital and interviewing the related pharmacists.

3.1.3 Hypothesis

The presumption of this study is that only Min/Max policy cannot be applied to all drugs in the hospital because drug has several characteristics.

3.1.4 Research Process

Collect data: Literature review, interview and survey at real site

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Classify Drugs by ABC/VEN analysis

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Select only drugs with high consumption value (subcategory AV, AE and AN)

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<table>
<tr><td rowspan="11">Apply current Min/Max policy</td><td colspan="8">Apply developed inventory policies:</td><td rowspan="11">Apply inventory theory P-system</td><td rowspan="11">Apply inventory theory Q-system</td></tr>
<tr><td colspan="8">Remove extreme drug demand value by boxplot
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<tr><td colspan="8">Analyze drug demand to identify characteristics:</td></tr>
<tr><td colspan="3">Trend analysis</td><td colspan="5">Run test and Regression Analysis</td></tr>
<tr><td colspan="3">Normality Test</td><td colspan="5">Kolmogorov-Smirnov</td></tr>
<tr><td colspan="3">Variability Test</td><td colspan="5">Peterson-Silver rule</td></tr>
<tr><td colspan="8">⇩
Apply inventory model depended on characteristics of drug demand:</td></tr>
<tr><td colspan="3">1) No trend
Normal
Static</td><td colspan="3">2) No trend
Normal
Lumpy</td><td>3) Trend, Normal</td><td>4) Not normal</td></tr>
<tr><td>⇩
M1</td><td>⇩
M2</td><td>⇩
M3</td><td>⇩
M1</td><td>⇩
M4</td><td>⇩
M5</td><td>⇩
M6</td><td>⇩
M5</td></tr>
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Remarks: M1-M6 Inventory models are described in Table 3.3

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Compare current policy with developed policies and inventory theories

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Develop drug inventory management for all drug characteristics

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Conclude and report the study

3.2 Data Collecting and Analysis

The data used in this study are shown in Table 3.1.

Table 3.1 Data and data sources used in this study

Data	Data Sources/Reference
1. Observe study in Pharmacy and Drug Inventory Department	A large public hospital in Bangkok, Thailand
2. Interview Data	Pharmacists in Pharmacy and Drug Inventory Department, (6, 7)
3. Drug Demands of OPD during 2008 to 2011	Receive from database of medical department of the hospital
4. Drug Price in 2011	Receive from database of medical department of the hospital
5. VEN Drug Name 2011	Receive from database of medical department of the hospital
6. Holding cost and ordering cost	Refer cost from previous research (18)
7. Lead time	Interview pharmacists at Drug Inventory

In addition, literature reviews were also examined to reveal the previous study about drug inventory in healthcare in Thailand. The historical drug demand and interview are used to input data (6, 7, 10-12). There are many periods of data such as 1 fiscal year (11, 13)and 3 years (8, 10, 12). Some studies used daily demand (6, 7), weekly demand (7, 10), and monthly demand (12).

3.3 Classification of Drug Inventory by ABC/VEN Analysis

Drug Demands of OPD in the fiscal year 2011 were analyzed and categorized into nine subcategories by ABC/VEN analysis. Table 3.2 shows nine subcategories of the combination of ABC/VEN analysis. There were AV, AE, AN, BV, BE, BN, CV, CE and CN.

Table 3.2 Nine subcategories by ABC/VEN analysis

	A	**B**	**C**
V	AV	BV	CV
E	AE	BE	CE
N	AN	BN	CN

3.3.1 ABC Analysis

Pareto ABC analysis is the method used for supporting stock management which has hundreds or many more stock volume. The objective of this method is to reduce the complexity and increase the efficiency of the stock management. All products in the stock are classified by total value of sold product. (19)

In this study, the annual consumption value of entire drugs in OPD in the fiscal year 2011 were arranged from low to high value and then divided into three groups: A, B and C. The method to classify inventory by ABC analysis can be divided into three steps (3, 5, 7-12) :

1. Annual demand and unit price data of all drugs in drug inventory were collected.

2. Annual Value which is annual demand multiply with unit price was calculated and then annual values of all drugs were arranged from low to high and accumulate percentage value also be calculated.

3. All drugs were defined drug category as A, B or C according to accumulate percentage value following this criteria.

Category A whose annual drug value are 80% of total drug value, the total quantity are 10-15% of total product list.

Category B whose annual drug value are 15% of total drug value, the total quantity are 30-40% of total product list.

Category C whose annual drug value are 5% of total drug value, the total quantity are 50-60% of total product list.

3.3.2 VEN Analysis

Because drug in the hospital is complex, different from other general industries and the effect of drug shortage is on the human lives, ABC classification is not enough to support drug inventory management. ABC classification has a limitation that focus on only drug value not including how much of each drug important to patients' lives. Therefore, VEN system is used to classify drug inventory by critical value (17, 20, 21). In VEN system, the drug names were assigned by pharmacists in the Hospital once a year into three groups. There are V, E and N.

Category V, shorten from vital, has very important drugs to the patients which cannot be replaced by another drug and always be available in the hospital.

Category E, shorten from essential, has important drugs which can be replaced by some another drug.

Category N, shorten from non-essential, has non-vital drugs which can be replaced by another drug and can be shorten in the hospital.

3.4 Min/Max Inventory Policy

This policy computes drug's average monthly consumption which is a key measure and recommended minimum and maximum inventory levels. Purchasing department of hospital will place order when inventory level reduces below 80% of average monthly consumption ($\widehat{\boldsymbol{Y}}_{\boldsymbol{i}}$) and the order quantity is ordered up to 150% of average monthly consumption as equation below (7).

$$\min \widehat{\boldsymbol{Y}}_{\boldsymbol{i}} = 80(0.5X_{\text{i-1}} + 0.5\widehat{\boldsymbol{Y}}_{\boldsymbol{i-1}})$$

$$\max \widehat{\boldsymbol{Y}}_{\boldsymbol{i}} = 150(0.5X_{\text{i-1}} + 0.5\widehat{\boldsymbol{Y}}_{\boldsymbol{i-1}})$$

When $\min \widehat{\boldsymbol{Y}}_{\boldsymbol{i}}$ is re-order point

$\max \widehat{\boldsymbol{Y}}_{\boldsymbol{i}}$ is the maximum stock level

$\widehat{\boldsymbol{Y}}_{\boldsymbol{i}}$ is forecasted drug demand on the *i*th month or average consumption on the *i*th month

$\widehat{Y}_{i-1}$ is forecasted drug demand on the *i-1*th month or average consumption on the *i-1* th month

X_{i-1} is total drug demand on *i-1*th month or actual drug demand on the *i-1* th month

3.5 Mathematical Formula

3.5.1 Boxplot

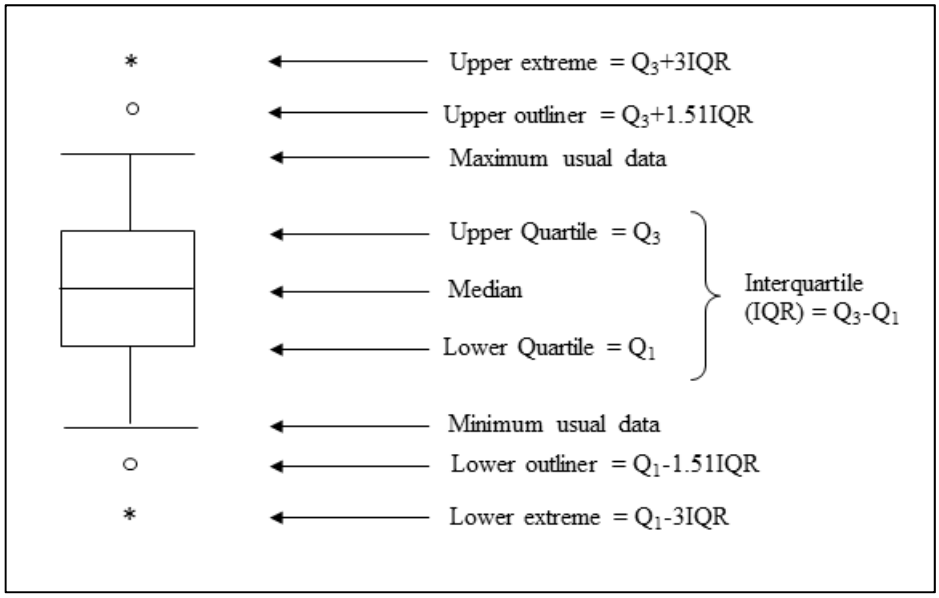


Figure 3.1 The structure of boxplot

Boxplot is a technique that shows the detail about data distribution and statistical parameter: median, 1st Quartile and 3rd Quartile. Moreover, boxplot can reveal the unusual data according to median called outliner and extreme (7). In this study, boxplot are used to remove outliner and extreme drug demand to avoid bias or error when trend analysis is tested in the next steps. Figure 3.1 shows the structure of boxplot.

3.5.2 Run Test

Run test is nonparametric test to show whether the data is random or not. The assumption is that the data is independent and from the same population.

Assumption

1. The sample data are arranged according to some scheme (such as time series)

2. The data falls into two separate categories (such as above and below a specific value).

3. The runs test is based on the order in which the data occur; not on the frequency of the data.

Run test has six steps (7, 22)

1. Find mean

Mean $=(x_1+x_2+\ldots=X_n)/n$

2. Assign

Binary = 0 to data which is less than mean

= 1 to data which is more than mean

3. Count the group which is contain the same sign

For example,

MYFT2C-	Binary	Counting Runs
540	0	1
1033	0	1
860	0	1
1678	0	1
2066	1	2
580	0	3
700	0	3
…	…	…

4. Hypothesis H_0: Data is random (No trend)

H_1: Data is not random (Trend)

5. Statistical formula

$$\boldsymbol{Z = \frac{R - E(R)}{Stdev(R)}}$$

Assign R as the number of group which is contain the same sign

$\boldsymbol{E(R)} = (2n_0n_1/n_0+n_1)+1$

$$\boldsymbol{Stdev(R)} = \sqrt{\frac{(\boldsymbol{2n_0n_1})(\boldsymbol{2n_0n_1 - n_0 - n_1})}{(\boldsymbol{n_0 + n_1})^{\boldsymbol{2}}(\boldsymbol{n_0 + n_1 - 1})}}$$

Z is random variable

6. Run test is two-tailed test. The reject region is $Z > Z_{\alpha/2}$ or $Z < -Z_{\alpha/2}$

3.5.3 Regression Analysis

Regression analysis is used to test if drug demand (independent variable) which were test by Run test and reject H_0 has linear relationship with time (a dependent variable). In this study, regression analysis was tested by MS excel and determine R^2. R^2 is a statistical measure of how well a regression line approximates real data points (goodness of fit' of the line) and a descriptive measure between zero and one. R-squared is derived from

R-squared = 100 * SS(regression) / SS(total)

3.5.4 Test of Normality

Kolmogorov-Smirnov goodness of fit test was used to decide if a sample comes from a population with a specific distribution (22). In the other word, it were using normal and other distribution test (10).

Hypothesis

H_0: $F_O=S_0$or Observed and expected demand are not significantly different

H_1: $F_O \neq S_0$ or Observed and expected demand are significantly different.

Assign:

F_O = Observed frequency

S_O = Expexted frequency

Formula and calculation

$D_{cal}= \max |F_O(x_i)-S_n(x_i)|$; i = 1, 2, 3, …, n

Assign:

D_{cal} = D value from calculation

max = maximum value

|…| = absolute value

$F_O(x_i)$ = Function of observed relative cumulative frequency

$S_n(x_i)$ = Function of expected relative cumulative frequency

Therefore, D_{cal} is the maximum of difference between $F_O(x_i)$ and $S_n(x_i)$ without a negative sign.

Decision

If $D_{cal} \geq D_{table}$, reject H_0 (Observed and expected demand are significantly different)

If $D_{cal} < D_{table}$, accept H_0 (Observed and expected demand are not significantly different)

Assign: D_{table} = D value from table

In case of $n \geq 35$, $D_{table} = \frac{1.36}{\sqrt{n}}$ as same as the quantity of drugs which is more than 35. (22)

3.5.5 Peterson-Silver Rule

Peterson-silver rule was used to decide if the demand is stable or showed variability coefficient (16). It showed the relationship between variance of demand per period and square of average demand per period. The calculation was shown below.

Formula and calculation

$$VC = \frac{Variance\ of\ demand\ per\ period}{Square\ of\ demand\ per\ period}$$

$$= \frac{n\sum_{t=1}^{n} D_t^2}{\left(\sum_{t=1}^{n} D_t\right)^2} - 1$$

Assign

n = number of period

D_t = demand quantity for period

t = period of time

Decision

If VC is less than 0.25, the demand is static and EOQ can be used.

If VC is more than or equal 0.25, EOQ cannot be used because demand is lumpy and should be used dynamic lot sizing.

3.6 The Drug Inventory Models Depended on Drug Demand Characteristics

The model and policy in this study is corresponding to demand patterns and simple to use (6, 7).

Assign

D = weekly demand

S = maximum inventory level (unit)

s = reorder point (unit)

I = inventory level at reorder point (unit) assign $I \leq s$

Q = order quantity (pack)

P = amount of drug in packaging (unit)

L = time between date of drug ordering and drug receiving or lead time (day)

M = time period to store drug (day)

N = number of day in a week (day)

Sl = service level or probability that drugs are enough for patients assign $0<sl<1$

K = special demand that known before (unit)

d_t = demand forecasting at week *t* in case of demand with linear pattern assign t= number of week after December 2011 (t=0, 1, 2, …)

The models are applied to developed inventory policies depended on drug demand characteristics which can be divided into four groups. The inventory models are described in Table 3.3.

Table 3.3 Developed inventory policies which are applied depended on drug demand characteristics

Group	Type of drug demand	Developed Inventory Policy Model	Inventory Policy	Formula	Reference
1	No trend Normal Static	M1	(s,S)	$\mathbf{s} = \frac{\mathbf{L} \cdot \boldsymbol{\mu}_{\mathbf{week}} + \mathbf{z}\sqrt{\mathbf{nL}} \cdot \boldsymbol{\sigma}_{\mathbf{week}}}{\mathbf{n}}$ $\mathbf{S} = \boldsymbol{M}\frac{\boldsymbol{\mu}_{\boldsymbol{week}}}{\boldsymbol{n}} + \boldsymbol{k} + \boldsymbol{s}$	(7)
		M2	(s,Q)	s = $\mu(L+1)$ Q = $\boldsymbol{max}\left\{\left\lceil\frac{\mu N+S-I}{y}\right\rceil, \boldsymbol{mo}\right\}$	(6)
		M3	(s,Q)	s = $\boldsymbol{\mu}_{\boldsymbol{day}} \times \boldsymbol{LT}$ Q = $\sqrt{\frac{2AD}{h}}$	(16)
2	No trend Normal Lumpy	M1	(s,S)	$\mathbf{s} = \frac{\mathbf{L} \cdot \boldsymbol{\mu}_{\mathbf{week}} + \mathbf{z}\sqrt{\mathbf{nL}} \cdot \boldsymbol{\sigma}_{\mathbf{week}}}{\mathbf{n}}$ $\mathbf{S} = \boldsymbol{M}\frac{\boldsymbol{\mu}_{\boldsymbol{week}}}{\boldsymbol{n}} + \boldsymbol{k} + \boldsymbol{s}$	(7)
		M4	(s,Q)	s = $\frac{\mathbf{L}\cdot\boldsymbol{\mu}_{\mathbf{week}}+\mathbf{z}\sqrt{\mathbf{nL}}\cdot\boldsymbol{\sigma}_{\mathbf{week}}}{\mathbf{n}}$ Q = $\boldsymbol{max}\left\{\left\lceil\frac{\mu N+S-I}{y}\right\rceil, \boldsymbol{mo}\right\}$	(6)
		M5	Dynamic Lot Sizing	Fixed period	(16)
3	Trend Normal	M6	(s,Q)	$\mathbf{s} = \int_{t=c}^{t=d} \boldsymbol{f}(\boldsymbol{d_t})\boldsymbol{dt} + \boldsymbol{z}\sqrt{\boldsymbol{L}}\,\boldsymbol{\sigma}_{\boldsymbol{day}}$ $\mathbf{Q} = \int_{t=a}^{t=b} \boldsymbol{f}(\boldsymbol{d_t})\boldsymbol{dt} + \boldsymbol{k}$	(7)
4	Not Normal	M5	Dynamic Lot Sizing	Fixed period	(16)

3.6.1 Inventory Models for Drug Group 1 (No trend, Normal, Static)

Drug demand with no trend, normal distributed and static (drug group 1) can be applied with the developed inventory policy models: M1, M2 and M3

3.6.1.1 Developed inventory policy model: M1

The inventory policy of this model is that the reorder point and the order was placed if the inventory position is at or below reorder point (*s*) and the quantity ordered is what is required to make the inventory level reach maximum level (*S*).

1) Reorder point (s) for the developed inventory policy model: M1

Assumption

1. Weekly demands are normally distributed which have mean μ_{week} and standard variation σ_{week} every week.

2. Daily demands are normally distributed which have mean $\mu_{\text{day}} = \frac{\mu_{\text{week}}}{\text{n}}$ and standard variation $\sigma_{\text{day}} = \frac{\sigma_{\text{week}}}{\sqrt{\text{n}}}$ every day.

3. Demands over lead time L day are normally distributed which have mean $\mu_{\text{L}} = \text{L}\mu_{\text{day}}$ and standard variation $\sigma_{\text{L}} = \sqrt{\text{L}}\sigma_{\text{day}}$

Formula and calculation

Reorder point is calculated from probability that demand over lead time is less than or equal to drug inventory level at reorder point and the probability is equal to service level as shown equation as below.

$$P(D_L \leq s)=\text{sl} \quad (1)$$

From equation (1) for drug demand over lead time with normal distribution, mean $\mu_{\text{L}}$and standard variation σ_{L}, reorder point can be derived as below.

$$P\left(\frac{D_L - \mu_L}{\sigma_L} \leq \frac{s - \mu_L}{\sigma_L}\right) = sl$$

$$P\left(z \leq \frac{s - \mu_L}{\sigma_L}\right) = sl$$

$$z\sigma_L \leq s - \mu_L$$

$$s \geq \mu_L + z\sigma_L$$

For $\mu_L = L\mu_{day}$ and $\sigma_L = \sqrt{L}\sigma_{day}$,

$$s \geq L\mu_{day} + z\sqrt{L}\sigma_{day}$$

For $\mu_{day} = \frac{\mu_{week}}{n}$ and $\sigma_{day} = \frac{\sigma_{week}}{\sqrt{n}}$,

$$s \geq L \cdot \frac{\mu_{week}}{n} + z\sqrt{L} \cdot \frac{\sigma_{week}}{\sqrt{n}}$$

$$s \geq \frac{L \cdot \mu_{week}}{n} + \frac{z\sqrt{nL} \cdot \sigma_{week}}{n}$$

$$s \geq \frac{L \cdot \mu_{week} + z\sqrt{nL} \cdot \sigma_{week}}{n}$$

$$\mathrm{s} = \frac{\mathrm{L}\cdot\mu_{\mathrm{week}}+\mathrm{z}\sqrt{\mathrm{nL}}\cdot\sigma_{\mathrm{week}}}{\mathrm{n}} \quad (2)$$

2) Maximum inventory level (S) for the developed inventory policy model: M1

Maximum drug inventory level for storage drugs for *M* days is calculated between day1 and day *M* and special demand that known before and reorder point as shown below.

$$S = M\mu_{day} + k + s$$

For $\mu_{\mathrm{day}} = \frac{\mu_{\mathrm{week}}}{\mathrm{n}}$,

$$\mathrm{S} = \mathrm{M}\frac{\mu_{\mathrm{week}}}{\mathrm{n}} + \mathrm{k} + \mathrm{s} \quad (3)$$

3.6.1.2 Developed inventory policy model: M2

The inventory policy of this model is that if the inventory position reaches the reorder point *s*, then a replenishment order of size *Q* is occurred.

1) Reorder point (s) for the developed inventory policy model: M2

Assumption

1. Weekly demands are normally distributed which have mean μ_{week} and standard variation σ_{week} every week.

2. Daily demands are normally distributed which have mean $\mu_{\mathrm{day}} = \frac{\mu_{\mathrm{week}}}{\mathrm{n}}$ and standard variation $\sigma_{\mathrm{day}} = \frac{\sigma_{\mathrm{week}}}{\sqrt{\mathrm{n}}}$ every day.

3. Demands over lead time L day are normally distributed which have mean $\mu_{\mathrm{L}} = \mathrm{L}\mu_{\mathrm{day}}$ and standard variation $\sigma_{\mathrm{L}} = \sqrt{\mathrm{L}}\sigma_{\mathrm{day}}$

Formula and calculation

Reorder point is calculated from demand over lead since the inventory department request drugs to purchasing unit and the purchasing unit place order in the next day as equation shown as below.

$$s = \mu(L + 1) \quad (4)$$

2) Order Quantity (Q) for the developed inventory policy model: M2

Order quantity is calculated by the maximum and round number up of demand over storage days and difference between maximum drug inventory level and inventory level at reorder point. The order is placed as the unit of boxes.

$$Q = \max\left\{\left\lceil\frac{\mu N+S-I}{y}\right\rceil, mo\right\} \quad (5)$$

3.6.1.3 Developed inventory policy model: M3

The inventory policy of this model is that if the inventory position reaches the reorder point *s*, then a replenishment order of size *Q* is occurred.

1) Reorder point (s) for the developed inventory policy model: M3

Assumption

1. Weekly demands are normally distributed which have mean μ_{week} and standard variation σ_{week} every week.

2. Daily demands are normally distributed which have mean $\mu_{day} = \frac{\mu_{week}}{n}$ and standard variation $\sigma_{day} = \frac{\sigma_{week}}{\sqrt{n}}$ every day.

Formula and calculation

Reorder point is calculated from demand over lead time as shown equation as below.

$$s = \mu_{day} \times LT \quad (6)$$

2) Order Quantity (Q) for the developed inventory policy model: M3

This model is method to calculate economic order quantity (EOQ) which is basic and most widely used in general inventory management both

regular industry and hospital. This model is suitable for drug group 1 which has normally distributed and static demand.

Assumption

1. Single item
2. Demand is known and constant
3. No order lead time
4. No shortage
5. All of ordered products is received at the same time

Assign

D: Ordering cost each time (Baht/time)

h: Annual holding cost per unit (Baht/Unit)

A: Annual demand (Units/Year)

Q: Order quantity each time (Units/time)

Formula and calculation

$$Q = \sqrt{\frac{2AD}{h}} \quad (7)$$

3.6.2 Inventory Models for Drug Group 2 (No trend, Normal, Lumpy)

3.6.2.1 Developed Inventory Policy Model: M1

The description of reorder point (*s*) and maximum level (*S*) is same as the developed inventory policy model: M1 of drug group 1.

3.6.2.2 Developed Inventory Policy Model: M4

The inventory policy of this model is that if the inventory position reaches the reorder point s, then a replenishment order of size Q is occurred.

1) Reorder point (s) for the developed inventory policy model: M4

The assumptions, formula and calculation of reorder point (s) for the developed inventory policy model: M4 are same as M1.

2) Order Quantity (Q) for the developed inventory policy model: M4

The assumptions, assign, formula and calculation of order quantity (Q) for the developed inventory policy model: M4 are same as M2.

3.6.2.3 Developed Inventory Policy Model: M5

Dynamic Lot Sizing is method used with lumpy demand or not normally distributed demand. Dynamic lot sizing used for inventory management can be divided into 3 types: simple rules, heuristic methods and optimization methods (16). In this study, the simple lot sizing method is used.

3.6.3 Inventory Models for Drug Group 3 (Trend, Normal)

3.6.3.1 Developed Inventory Policy Model: M6

1) Reorder point (s) for the developed inventory policy model: M6

The reorder point models can be used for the developed inventory policy model: M6 which have trend and normally distributed demand.

Assumption

1. Weekly demands are normally distributed which have mean at week t=f(d_t) and standard variation σ_{week} every week.

2. Daily demands are normally distributed which have mean $\int_{t=a}^{t=a+1} f(d_t)dt$ and standard variation $\sigma_{day} = \frac{\sigma_{week}}{\sqrt{n}}$ every day.

3. Demands over lead time L day are normally distributed which have mean $\mu_L = \int_{t=c}^{t=d} f(d_t)dt$ and standard variation $\sigma_L = \sqrt{L}\sigma_{day}$

Formula and calculation

Reorder point is calculated from equation $P(D_L \leq s)$=sl for drug demand over lead time with normal distribution, mean $\mu_L$and standard variation σ_L, reorder point can be derived as below.

$$P\left(\frac{D_L - \mu_L}{\sigma_L} \leq \frac{s - \mu_L}{\sigma_L}\right) = sl$$

$$P\left(z \leq \frac{s - \mu_L}{\sigma_L}\right) = sl$$

$$z\sigma_L \leq s - \mu_L$$

$$s \geq \mu_L + z\sigma_L$$

$$s = \int_{t=c}^{t=d} f(d_t)dt + z\sqrt{L}\,\sigma_{day} \quad (8)$$

Assign

d-c = lead time

c = date that order drug

d = date that receive drug

Remark: Reorder point calculation will use the developed decision program by Microsoft Excel with function NORMINV (sl, demand over leadtime, S.D.)

2) Order Quantity (Q) for the developed inventory policy model: M6

Assign

b-a = number of day to storage drug (M)

a = date begin to storage drug

b = date finish to storage drug

Formula and calculation

This model is for drug group 3 which has trend, and normal distribution. Order quantity is calculated to storage drug for *M* day or between day *a* to day *b* added with special demand that known before and round number up.

$$Q = \int_{t=a}^{t=b} f(d_t)dt + k \quad (9)$$

3.6.4 Inventory Models for Drug Group 4 (Not Normal)

3.6.4.1 Developed Inventory Policy Model: M5

Dynamic Lot Sizing is method used with lumpy demand or not normally distributed demand. Dynamic lot sizing used for inventory management can be divided into 3 types: simple rules, heuristic methods and optimization methods (16). In this study, the simple lot sizing method is used.

The data in this study were analyzed and classified by using the developed program by Microsoft Excel 2010.

3.7 The Inventory Theory

3.7.1 P-system

P-system or Periodic Review System derivative usually called fixed order interval system every P units of time a replenishment order is placed to raise the inventory position to the order-up-to-level S. The value of P is usually pre-specified.

P = Q/R

When P = a unit of time a replenishment order is placed

Q = Economic Order Quantity (EOQ)

R = demand per unit of time (week)

The order-up-to-level T must be sufficient to cover demand through a disposition period of duration P + L.

T = $\overline{\boldsymbol{D'}} + \boldsymbol{SS'}$

When T = target inventory

$\overline{\boldsymbol{D'}}$ = average demand over duration P+L

$\boldsymbol{SS'}$ = safety stock = $Z\sigma'$;

σ' = Standard deviation of demand per period,

Z = number of standard deviations above average demand during lead time

3.7.2 Q-system

Q-system or fixed order quantity system attempt to determine the specific point, R, at which an order will be placed and the size of that order, Q. The fixed-order quantity is also called the Q-system since the order quantity Q is fixed. With a fixed-order quantity system, an order of size Q is placed when the inventory available (currently in stock and on order) reaches the point R. R is determined as the average demand over the lead time (that is, the time between ordering and receiving) plus a safety stock to reflect variation in demand over time.

OP = reorder point

D =average weekly demand (constant)

L = lead time in weeks (constant)

Z = safety factor (number of standard deviations for a specified service probability)

σ_L = standard deviation of demand over the lead time

$OP = D(L) + Z\sigma_L$

Service level is the percentage of customer demands satisfied from inventory.

3.8 Pairwise Ranking

Pairwise ranking is a tool that helps us to identify the most important needs. It can help to prioritize a small list and make decisions in a consensus-oriented manner.

The ways to do it are divided in to three steps.

3.8.1 Construct a pairwise matrix

Each box in the matrix represents the intersection (or pairing) of two items, in this case is KPIs (Key Performance Indexes) of inventory performances. The list has four KPIs, the pairwise matrix would look like Figure 3.2, with the top box representing KPI1 paired with KPI2:

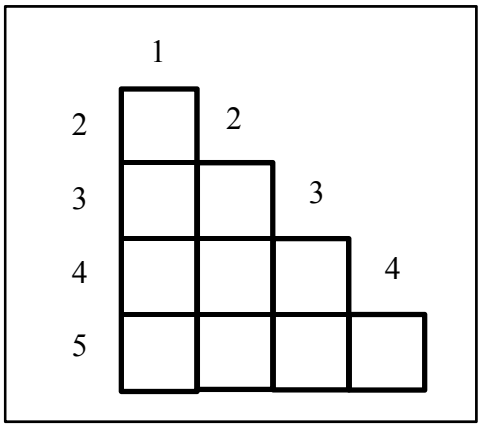


Figure 3.2 The pairwise matrix

3.8.2 Rank each pair

For each pair, we have the group (using a recommendation from a logistic expert or a specialist) determine which of the two ideas is preferred. Then, for each pair, write the preferable KPIs in the appropriate box. Repeat this process until the matrix is filled as shown in Figure 3.3.

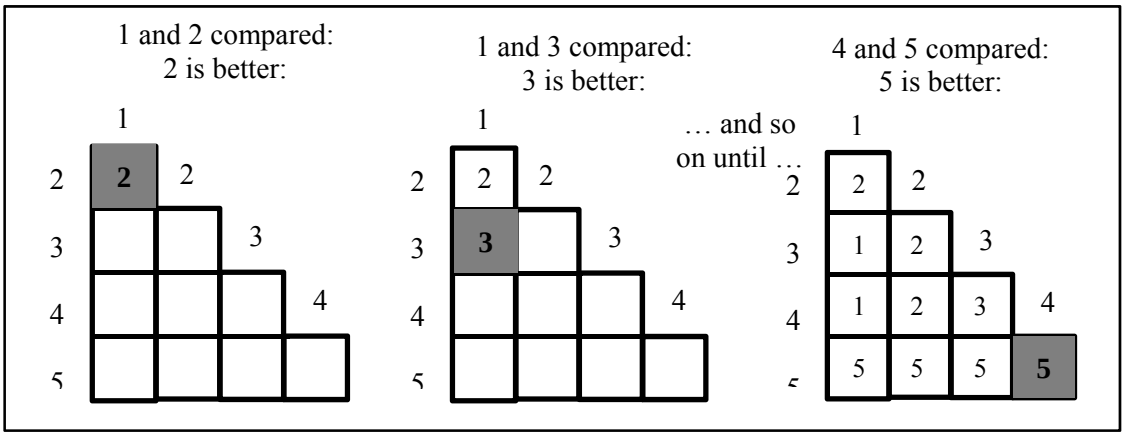


Figure 3.3 Ranking each pair

3.8.3 Count the number of times

The number of times each alternative appears in the matrix is counted and all items are ranked as shown in Figure 3.4. Rank the alternatives by the total number of times they appear in the matrix. To break a tie (where two ideas appear the same number of times), look at the box in which those two ideas are compared. The idea appearing in that box receives the higher ranking.

Alternative 5 ranks 1st overall

Alternative (KPIs)	1	2	3	4	**5**
Count	2	3	1	0	**4**
Rank	3rd	2nd	4th	5th	**1th**

Figure 3.4 Counting the number of times each alternative and ranking all items

CHAPTER IV
RESULTS

Because the number of drugs in the central drug room of Out Patient Department (OPD) in fiscal year 2011 are 1,951 drug SKUs and each drug has its individual characteristics both consumption value and vital criteria, entire drugs in the drug inventory are first classify into groups by ABC/VEN classification and selected only the 'A' category of drugs which account is considered for 70 percent of the total expenditure because this large expense can be reduced considerably. For VEN analysis, 'A' category of drugs can be divided into drugs with high consumption value and vital clinical importance (AV), drugs with high consumption value and essential clinical importance (AE) and drugs with high consumption value and non-essential clinical importance (AN) to study. Next the historical demands of selected drugs are analyzed for trend, distribution and variability by statistical analyses, which are Run Test, Kolmogorov-Smirnov and Peterson-Silver Rule respectively, to apply three developed inventory policies which are customized to each demand characters. Then, current Min/Max inventory policy in the hospital is compared to developed inventory policies and theory inventory policies; P system and Q system. The discussion, suggestion and conclusion of the results are shown in the Chapter V.

This chapter is divided into two main parts as following:

4.1 Drug Classification

4.2 The comparison among current Min/Max inventory policy, developed inventory policies and the inventory policies from theory; P system and Q system

4.1 Drug Classification and Demand Characteristics

4.1.1 Collection Data

In this study, weekly drug consumptions of central drug room, Out Patient Department (OPD) in fiscal year 2011 are major data which collected from database of Medical Information Department of a large public hospital. The sample data of Cellcept 500mg (CELC-C-) between October 2010 through September 2011 was shown in Table 4.1.

Table 4.1 Sample consumptions of Cellcept 500mg (CELC-C-) from hospital's database in fiscal year 2011

Week	Weekly demand of CELC-C-
1	49470
2	16428
3	31648
4	28794
5	23556
6	18426
7	33427
8	23264
9	27401
10	23057
11	27542
12	27271
13	27246
14	30511
15	25953
16	12067
17	29804
18	25183
19	24281
20	38693

Table 4.1 Sample consumptions of Cellcept 500mg (CELC-C-) from hospital's database in fiscal year 2011 (cont.)

Week	Weekly demand of CELC-C-
21	15696
22	34471
23	27315
24	17786
25	27935
26	30256
27	30066
28	28580
29	27277
30	17617
31	37629
32	32569
33	24686
34	24557
35	32169
36	29300
37	26017
38	33853
39	33515
40	22521
41	30912
42	25521
43	30188
44	15234
45	23420
46	27008
47	23572
48	26332

Table 4.1 Sample consumptions of Cellcept 500mg (CELC-C-) from hospital's database in fiscal year 2011 (cont.)

Week	Weekly demand of CELC-C-
49	35138
50	26400
51	26729
52	34461
53	37966

4.1.2 Result of AV AE AN Classification

Because this study focus on the drugs which expend the large expenditure of the hospital, drug demand of OPD in fiscal year 2011 were classified by ABC/VEN analysis according to both value consumption and vital criteria. Next, only drugs with high value consumption or 'A' category of drugs with several level of clinical importance were only investigated in this study. There are 1) high consumption value and vital clinical importance (AV), 2) drugs with high consumption value and essential clinical importance (AE) and 3) drugs with high consumption value and non-essential clinical importance (AN). The result of ABC/VEN classification is shown in Appendix and is summarized as shown in Table 4.2.

Table 4.2 Summary result of drug inventory classification by ABC/VEN analysis

ABC-VEN Categories	No.	%No.	%Value
AV	29	1.33	11.24
AE	175	7.82	58.21
AN	4	0.18	0.64
BV	43	1.91	2.41
BE	264	11.73	15.9
BN	20	0.89	1.03
CV	158	7.02	1.04
CE	1111	49.38	7.44
CN	147	6.53	0.81
Total	**1,951**	**86.80**	**98.72**

Remark: There is no VEN data for 297 of drug items (13.2 percent of drug items or 1.28 percent of drug consumption value) in 'B' and 'C' category.

4.1.3 Result of Characterization by Demand Characters

According to the assumption of the developed inventory policies which are specific to drug demand characters, the historical consumptions data of 'A' category of drugs with high consumption value from the record available on Hospital Information System (HIS) or hospital's database between January 2008 through December 2011 was analyzed by boxplot to remove outliner, Run test to determine the randomness or trend data, Kolmogorov-Smirnov to test normality and Peterson-silver rule to test the viability as shown in Table 4.3.The data were analyzed by using Microsoft Excel 2010.

Table 4.3 Sample results of classification of drug demand patterns in high consumption value (A drugs)

Drug	Trend analysis	Regression	Distribution	Variability
ALBK-I-	Yes	Yes	Lognormal	-
ALPI-I-	-	-	Lognormal	-
ALUV-T-	Yes	Yes	normal	Lumpy
AMBS-I-	Yes	No	normal	Lumpy
BARA1T-	Yes	No	Lognormal	-
BARA-T-	Yes	Yes	normal	Static
CELC-C-	Yes	Yes	normal	Static
GAMR1I-	Yes	No	Lognormal	Static
HEPS-T-	No	-	normal	Static

Entire 'A' category of drugs with high value consumption

The summary results of analysis 'A' category of drugs by demand characteristics are shown in Table 4.4.

Table 4.4 Summary result of classification of drug demand patterns in high consumption value (A drugs)

Group	Trend	Distribution	Variability	No. of drug
1	No	normal	Static	90
2	No	normal	Lumpy	27
3	Yes	normal	-	14
4	-	Not normal	-	77
			Total	**208**

To focus on each clinical important (VEN), the summary results of analysis 'A' category of drugs in Table 4.4 can be divided into three subcategories: Drugs with high consumption value and vital clinical importance (AV), drugs with high consumption value and essential clinical importance (AE) and drugs with high consumption value and non-essential clinical importance (AN).

Drugs with high consumption and vital clinical importance (AV)

The summary results of analysis 'AV' category of drugs by demand characteristics are shown in Table 4.5.

Table 4.5 Summary result of classification of drug demand patterns in high consumption value and vital clinical importance (AV drugs)

Group	Trend	Distribution	Variability	No. of drug
1	No	normal	Static	7
2	No	normal	Lumpy	3
3	Yes	normal	-	-
4	-	Not normal	-	19
				29

Drugs with high consumption and essential clinical importance (AE)

The summary results of analysis ‘AE’ category of drugs by demand characteristics are shown in Table 4.6.

Table 4.6 Summary result of classification of drug demand patterns in high consumption value and essential clinical importance (AE drugs)

Group	Trend	Distribution	Variability	No. of drug
1	No	normal	Static	81
2	No	normal	Lumpy	24
3	Yes	normal	-	14
4	-	Not normal	-	56
				175

Drugs with high consumption and non-essential clinical importance (AN)

The summary results of analysis ‘AN’ category of drugs by demand characteristics are shown in Table 4.7.

Table 4.7 Summary result of classification of drug demand patterns in high consumption value and non-essential clinical importance (AN drugs)

Group	Trend	Distribution	Variability	No. of drug
1	No	normal	Static	2
2	No	normal	Lumpy	-
3	Yes	normal	-	-
4	-	Not normal	-	2
				4

According to the Table 4.5-4.7, it can be concluded that (Table 4.8):

1. Drugs with high consumption value and vital clinical importance (drug category ‘AV’) can be divided into group 1 (Normal Distribution with no trend and static demand), group 2 (Normal Distribution with no trend and lumpy demand) and group 4 (Not normal distribution)

2. Drugs with high consumption value and essential clinical importance (drug category ‘AE’) can be divided into group 1 (Normal Distribution with no trend and static demand), group 2 (Normal Distribution with no trend and lumpy demand),

group 3 (Normal Distribution with trend demand) and group 4 (Not normal distribution)

3. Drugs with high consumption value and essential clinical importance (drug category 'AN') can be divided into group 1 (Normal Distribution with no trend and static demand) and group 4 (Not normal distribution)

Table 4.8 The summary drug groups in each drug category (AV, AE and AN)

Category	Group	Drug Demand Characteristics
AV	1	Normal Distribution with no trend and static demand
	2	Normal Distribution with no trend and lumpy demand
	4	Not normal distribution
AE	1	Normal Distribution with no trend and static demand
	2	Normal Distribution with no trend and lumpy demand
	3	Normal Distribution with trend demand
	4	Not normal distribution
AN	1	Normal Distribution with no trend and static demand
	4	Not normal distribution

4.2 The Comparisons among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System

To show the optimal policy for each drug, the results of applying three groups of inventory policies are compared. There are current Min/Max inventory policy using monthly demand (Msale), developed policies for specific demand characters and also the inventory policy from theory; P-system which the time between order is fixed and amount ordered each time varies, and Q-system which the amount of certain order drug is fixed but the time between order varies was investigated.

4.2.1 The Pairwise Ranking

In addition, drugs are the products which are different from other common products because drugs have health impact and the patients have to take them to cure or relieve their illness. The right drugs should be delivered to them at the right time and place. However, there are insufficient funds to buy and stock all desired medicines. Hence, not only the criteria of the drug consumption are considered, but also the criteria of the medical important. The pairwise ranking is a tool that helps to identify the most important needs. The pairwise ranking form was given to an expert, who is the specialist in field of healthcare logistic, to compare the Key Performance Indication's priority in each subcategory: AV which are high consumption value and vital drugs, AE which are high consumption value and essential drugs, and AN which are high consumption value and non-essential drugs. The results and summarize are shown in Table 4.9-4.14 respectively.

Table 4.9 The result of the pairwise ranking high consumption with value and vital drug category (AV)

	Average Inventory	**No. of order**	**Day short**	**No. of shortage**	**Time short**
Average Inventory		Average Inventory	Day short	No. of shortage	Time short
No. of order			Day short	No. of shortage	Time short
Day short				No. of shortage	Day short
No. of shortage					No. of shortage
Time short					

Table 4.10 The summary result of The pairwise ranking high consumption value and vital drug category (AV)

KPI	**No. of Prefer**	**Rank**
No. of shortage	4	1
Day short	3	2
Time short	2	3
Average Inventory	1	4
No. of order	0	5

Table 4.11 The result of the pairwise ranking with high consumption value and essential drug category (AN)

	Average Inventory	**No. of order**	**Day short**	**No. of shortage**	**Time short**
Average Inventory		Average Inventory	Average Inventory	Average Inventory	Average Inventory
No. of order			Day short	No. of shortage	Time short
Day short				No. of shortage	Day short
No. of shortage					No. of shortage
Time short					

Table 4.12 The summary result of the pairwise ranking high consumption value and essential drug category (AN)

KPI	**No. of Prefer**	**Rank**
Average Inventory	4	1
No. of shortage	3	2
Day short	2	3
Time short	1	4
No. of order	0	5

Table 4.13 The result of the pairwise ranking with high consumption value and non-essential drug category (AN)

	Average Inventory	**No. of order**	**Day short**	**No. of shortage**	**Time short**
Average Inventory		Average Inventory	Average Inventory	Average Inventory	Average Inventory
No. of order			Day short	No. of shortage	Time short
Day short				No. of shortage	Day short
No. of shortage					Time short
Time short					

Table 4.14 The summary result of the pairwise ranking with high consumption value and non-essential drug category (AN)

KPI	No. of Prefer	Rank
Average Inventory	4	1
No. of shortage	3	2
Day short	2	3
Time short	2	3
No. of order	0	5

According to Table 4.10, 4.12 and 4.14, the results of the pairwise ranking high consumption value and vital, essential and non-essential drug category (AV, AE and AN) can be summarized as shown in Table 4.15

Table 4.15 The summary result of the pairwise ranking high consumption value and vital, essential and non-essential drug category (AV, AE and AN)

Category	Pairwise ranking
AV	Amount shortage
AE	Average Inventory
AN	Average Inventory

According to Table 4.15, the most important Key Performance Indicator (KPI) for the drugs category with high consumption value and vital clinical importance (AV) is the amount of drug shortage (Amount shortage). Hence, the optimal policy for drugs in category AV is the inventory policy which can minimize amount of drugs shortage.

The most important KPI for both drug category AE and AN, which are drugs with high consumption value, essential and non-essential clinical importance respectively, is average inventory. Hence, the optimal policies for drugs in category AE and AN are the inventory policy which can minimize amount of average inventory.

The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking in drug category AV, AE and AN are shown in

Figure 4.1-4.9 respectively. The optimal policy is the highest amount of items which is optimized to particular. The details are shown in Appendix B.

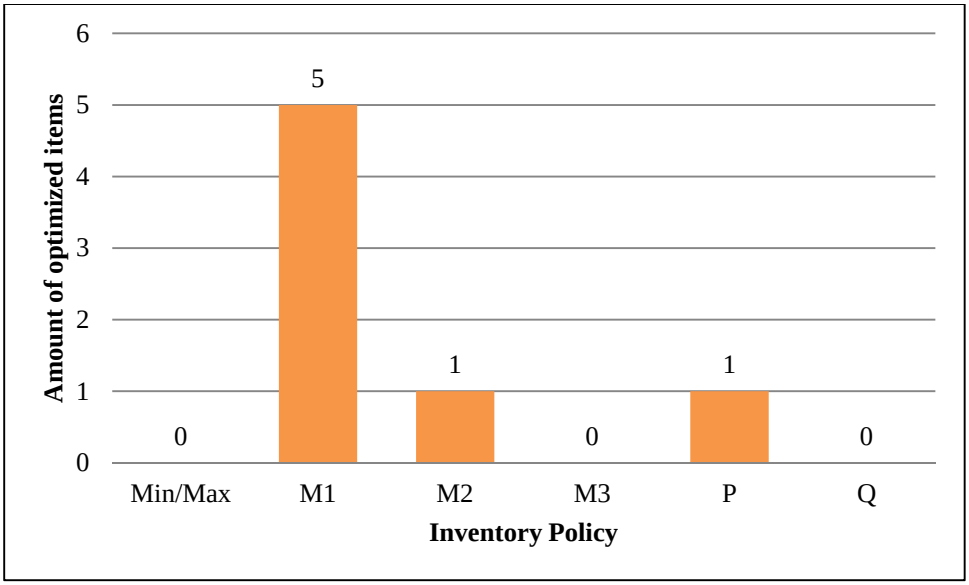


Figure 4.1 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking KPI number of shortage in drug category AV with no trend, normally distributed and static demand (group1)

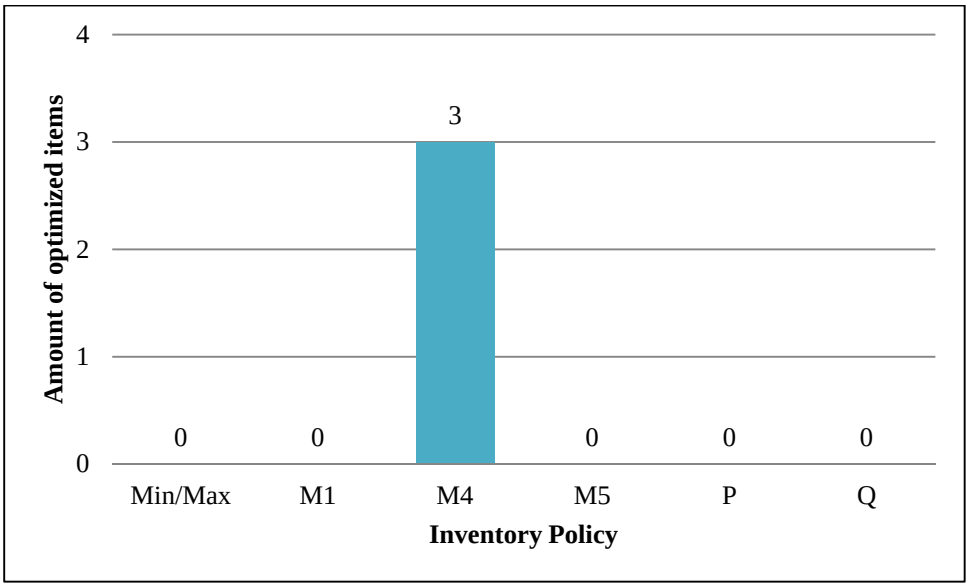


Figure 4.2 The results of comparison among current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking KPI number of shortage in drug category AV with no trend, normally distributed and lumpy demand (group2)

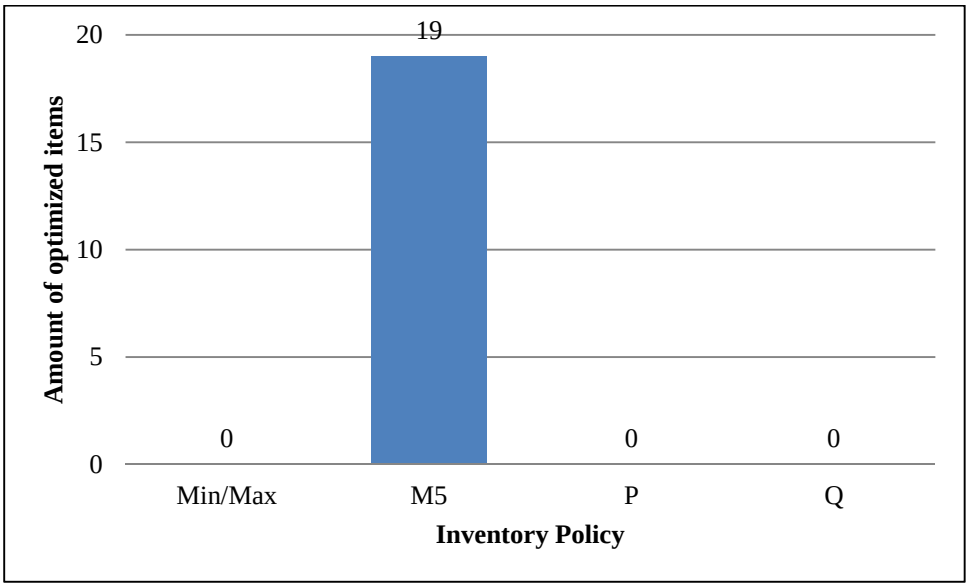


Figure 4.3 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking KPI number of shortage in drug category AV with not normally distributed demand (group4)

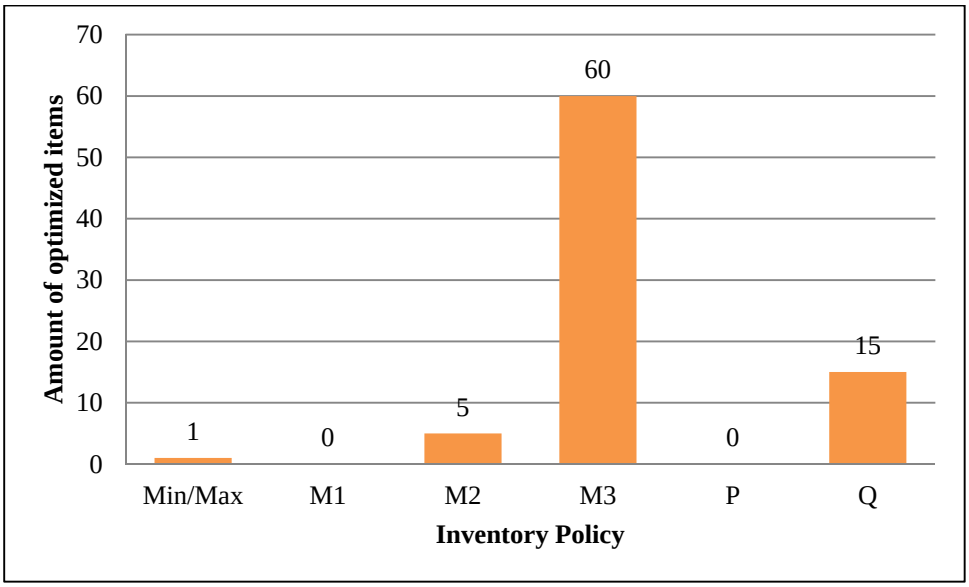


Figure 4.4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking KPI average inventory in drug category AE with no trend, normally distributed and static demand (Group1)

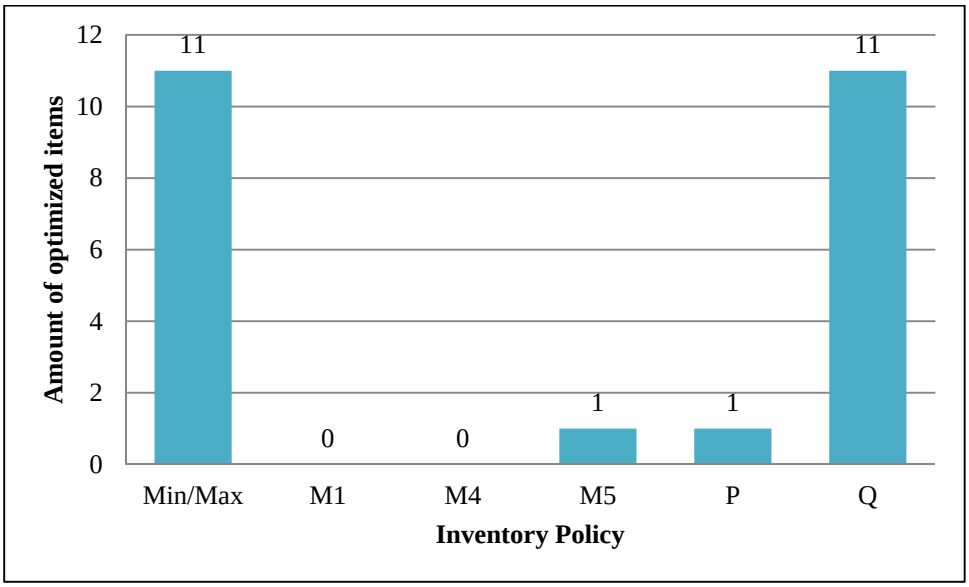


Figure 4.5 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking KPI average inventory in drug category AE with no trend, normally distributed and lumpy demand (Group2)

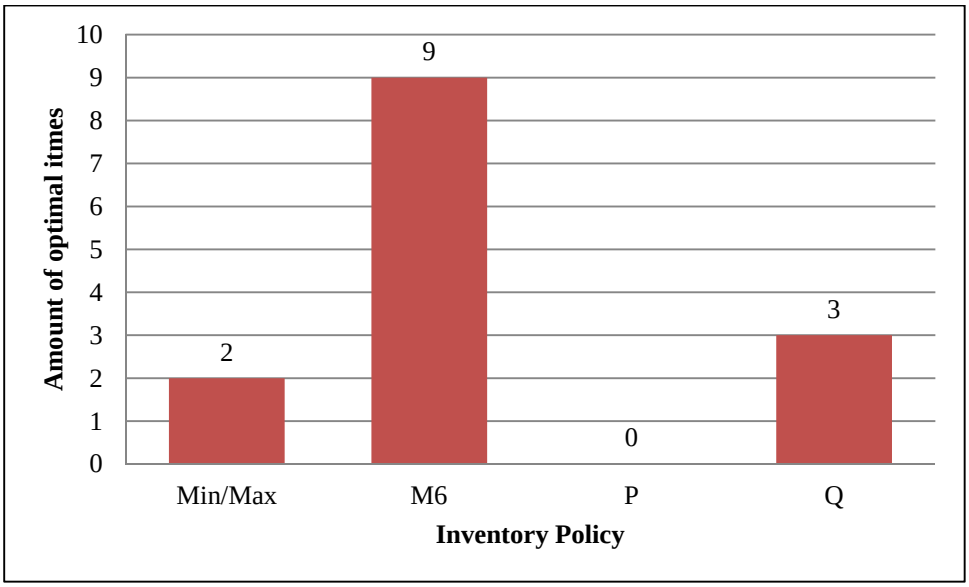


Figure 4.6 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking KPI average inventory in drug category AE with trend and normally distributed demand (Group3)

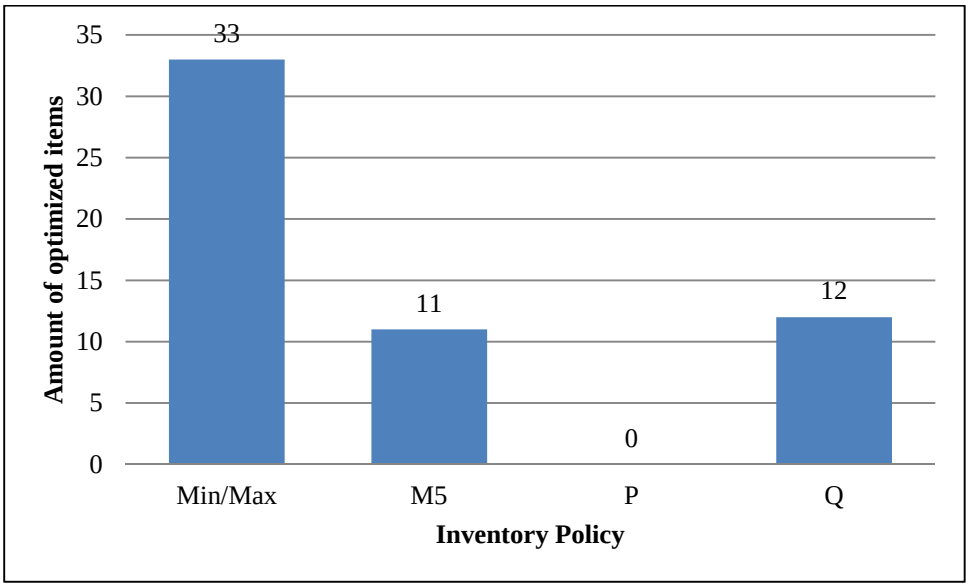


Figure 4.7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking KPI average inventory in drug category AE with not normally distributed demand (Group4)

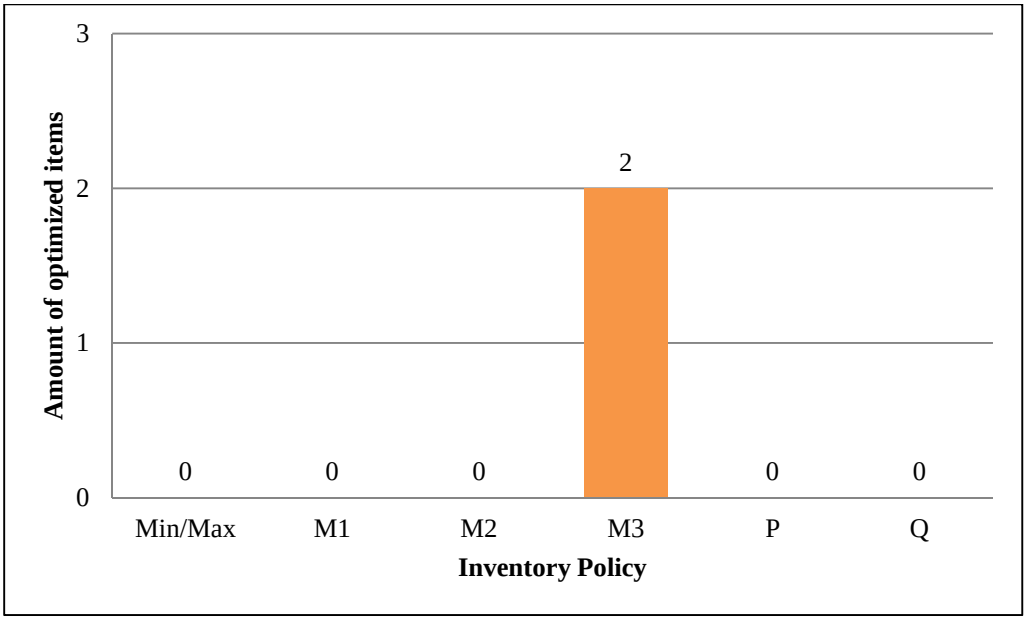


Figure 4.8 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking KPI in drug category AN with no trend, normally distributed, static demand (Group1)

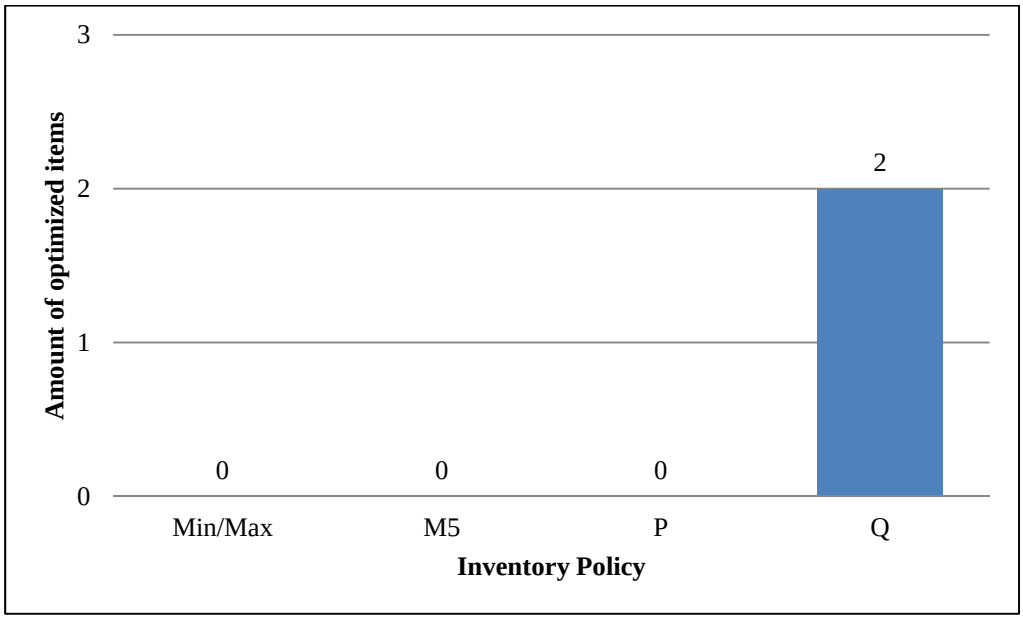


Figure 4.9 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by pairwise ranking KPI in drug category AN with not normally distributed demand (Group4)

To summarize the optimal inventory policy for each drug category from the comparisons by using pairwise ranking in Figure 4.1-4.9, the summary inventory policy for each drug characteristics considered by pairwise ranking are shown in Table 4.16.

Table 4.16 The summary optimal policies of drug category AV, AE and AN which considered pairwise ranking

Drug category	Group	Optimal Policy	Pairwise Ranking
AV	1	M1	Minimum number of shortage
	2	M4	
	4	M5	
AE	1	M3	Minimum average inventory
	2	Min/Max, Q	
	3	M6	
	4	Min/Max	
AN	1	M3	Minimum average inventory
	4	Q	

Drugs with high consumption value and vital clinical importance (AV) whose demands are normally distributed with no trend and static demand (group 1) are optimal with developed inventory policy M1. The one whose demands are normally distributed with no trend and lumpy demand (group 2) are optimal with developed inventory policy M4 and the one whose demands are not normally distributed (group 4) are optimal with developed inventory policy M5.

Drugs with high consumption value and essential clinical importance (AE) whose demands are normally distributed with no trend and static demand (group 1) are optimal with developed inventory policy M3. The one whose demands are normally distributed with no trend and lumpy demand (group2) are optimal with current Min/Max inventory policy, the one whose demands are normally distributed with trend are optimal with developed inventory policy M6 and the one whose demands are not normally distributed (group 4) are optimal with current Min/Max inventory policy.

Drugs with high consumption value and non-essential clinical importance (AN) whose demands are normally distributed with no trend and static demand (group 1) are optimal with developed inventory policy M3 and the one whose demands are not normally distributed (group 4) are optimal with Q-system.

4.2.2 Total Inventory Cost

Since entire drugs are still storage in the hospital drug inventory to serve the patients' demand and also the process of ordering drugs from the supplier has cost, the total inventory cost (6), which is composed of holding cost (HC), ordering cost (OC) and shortage cost (23), are investigated in this study to compare the current total inventory costs from applying Min/Max policy with others.

The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by the total inventory costs of drugs in drug category AE and AN are shown in Figure 4.10-4.15 respectively. It is noted that drugs with high consumption value and vital clinical importance (AV) are still considered by Pairwise Ranking because these drugs should minimum shortage to maintain high service level in order to save patients' lives as much as possible. The details of result are shown in

Appendix. The dark bold number in the row 'total' of each table is represented the optimal inventory policy which minimizes total inventory cost for particular drug item.

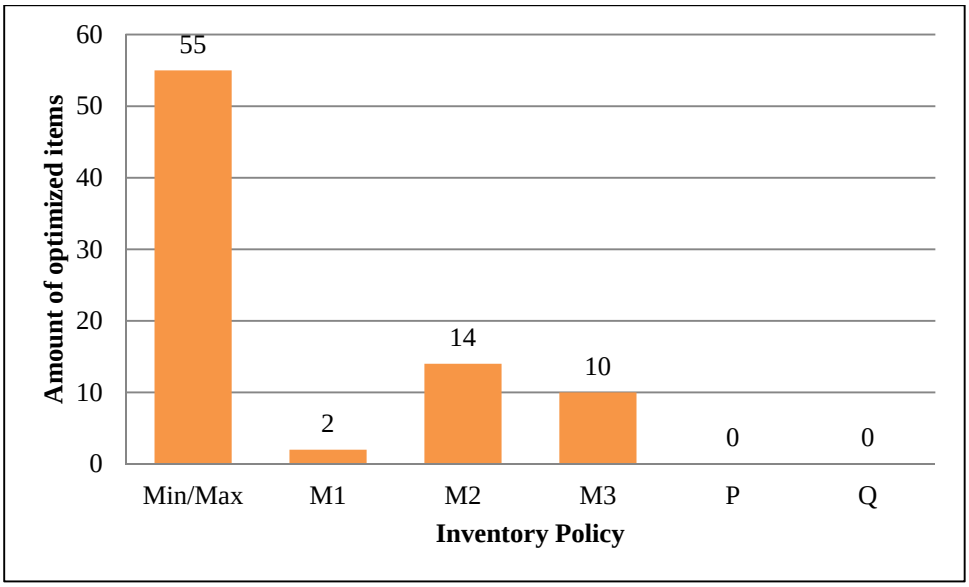


Figure 4.10 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (Group1)

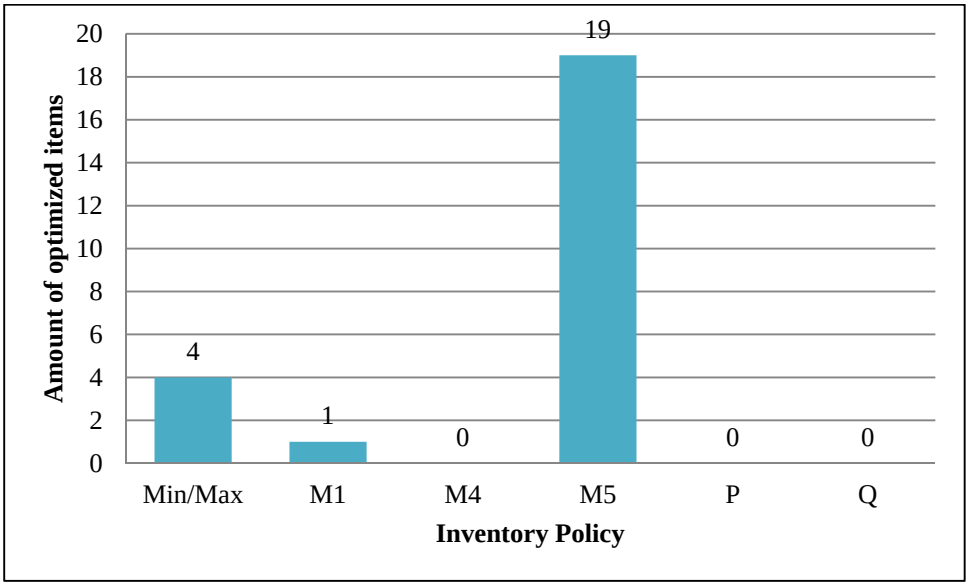


Figure 4.11 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and lumpy demand (Group2)

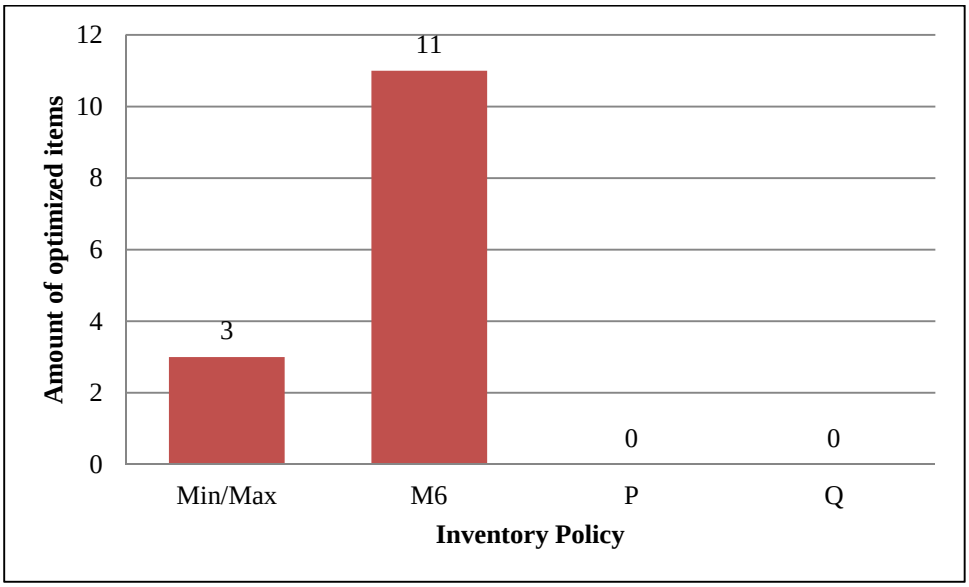


Figure 4.12 The total inventory costs of high consumption value and essential drugs (AE) with trend and normally distributed demand (Group 3)

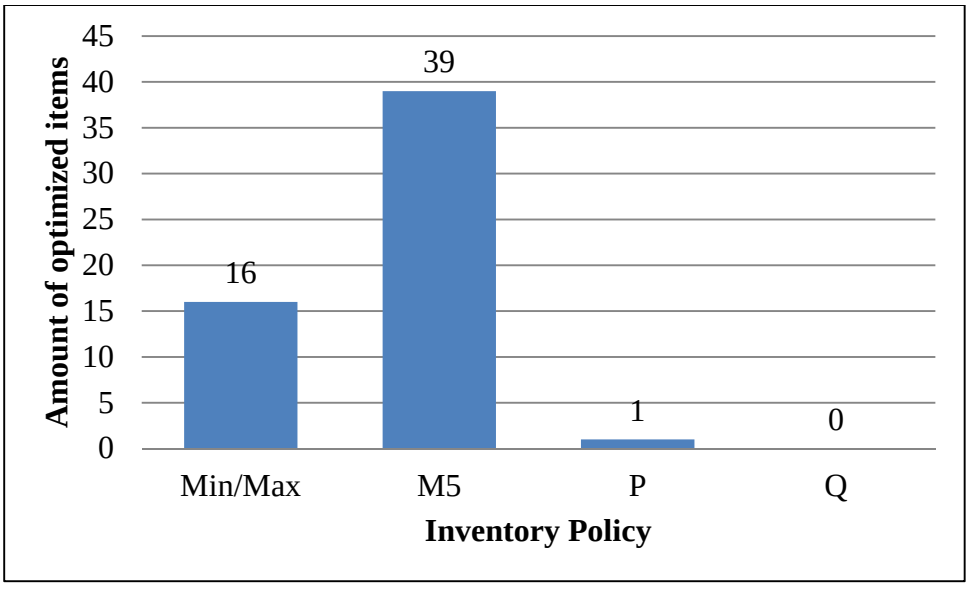


Figure 4.13 The total inventory costs of high consumption value and essential drugs (AE) with not normally distributed demand (Group 4)

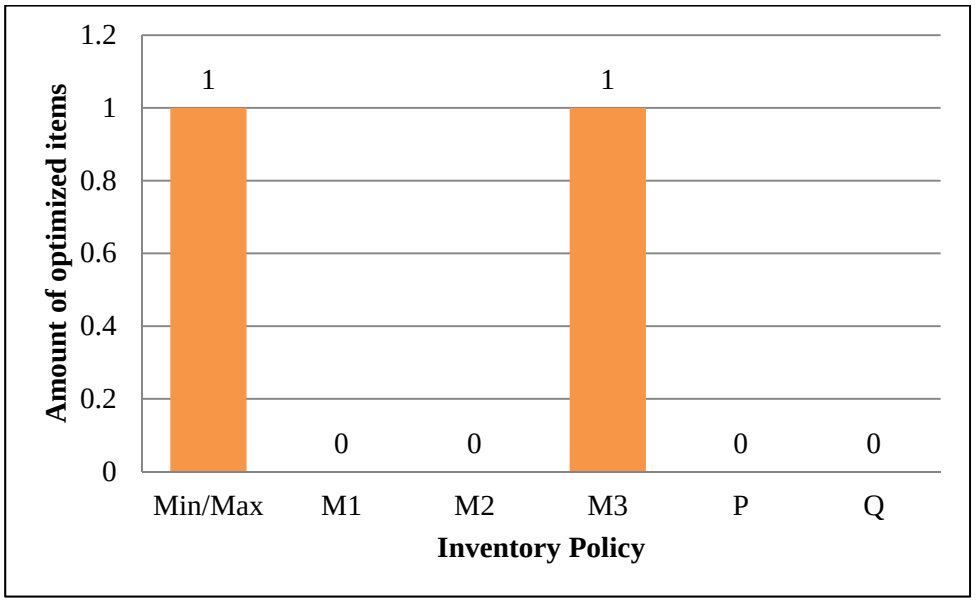


Figure 4.14 Drugs with high consumption value and non-essential drugs (AN) with no trend, normally distributed and static demand (Group 1)

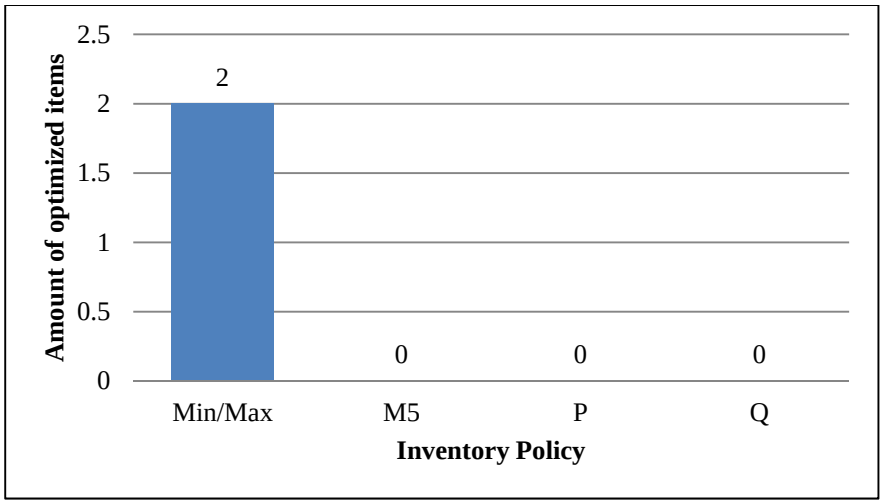


Figure 4.15 Drugs with high consumption value and non-essential drugs (AN) with not normally distributed demand (Group 4)

To summarize the optimal inventory policy for each drug category from the comparisons by total inventory cost in Figure 4.10-4.18, the summary optimal inventory policy which minimized total inventory cost are shown in Table 4.17. The optimal policy is the highest amount of items which is optimized to particular

inventory policy. The details are shown in Appendix C. The dark bold numbers indicate the minimum total inventory cost which is optimal for the particular drug item.

Table 4.17 The summary optimal policies of drug category AE and AN which considered total cost

Drug Category	Group	Policy
AE	1	Min/Max
	2	M5
	3	M6
	4	M5
AN	1	Min/Max, M3
	4	Min/Max

Drugs with high consumption value and vital clinical importance (AV) whose demands are normally distributed with no trend and static demand (group 1) are optimal with developed inventory policy M1. The one whose demands are normally distributed with no trend and lumpy demand (group 2) are optimal with developed inventory policy M5 and the one whose demands are not normally distributed (group 4) are optimal with developed inventory policy M5.

Drugs with high consumption value and essential clinical importance (AE) whose demands are normally distributed with no trend and static demand (group 1) are optimal with current Min/Max inventory policy. The one whose demands are normally distributed with no trend and lumpy demand (group 2) are optimal with developed inventory policy M5, the one whose demands are normally distributed with trend are optimal with developed inventory policy M6 and the one whose demands are not normally distributed (group 4) are optimal with developed inventory policy M5.

Drugs with high consumption value and non-essential clinical importance (AN) whose demands are normally distributed with no trend and static demand (group 1) are optimal with current Min/Max inventory policy and developed inventory policy M3 and the one whose demands are not normally distributed (group 4) are optimal with current Min/Max inventory policy.

4.2.3 Optimal Policy

Vital drugs should be available for patient all the time according to the result of pairwise ranking even though the total cost is not minimum, but essential and non-essential drugs should not be used the result of Pairwise Ranking which is minimal average inventory because the minimal average inventory in some drug items are resulted from increasing total inventory cost. For example as shown in Table 4.18, if we use Pairwise Ranking to indicate to optimal inventory policy of drug item ACTE1T-, which is the drug with high consumption and vital clinical importance (AV), the result reveals that developed inventory policy M3 is optimal, but total inventory cost is very high because of very high shortage cost. This drug item should be considered by minimal total inventory cost instead and the optimal policy should be current Min/Max inventory policy.

Table 4.18 The result of the example drug item ACTE1T- to show comparison between Pairwise Ranking and Total inventory cost

KPI	Min/Max	Cost	M1	Cost	M2	Cost	M3	Cost
Average Inventory	4,372	1,744,499.26	5,581	2,226,632.28	3,519	1,404,116.91	**2,876**	1,147,654.54
Time order	16	92.40	8	46.20	11	63.53	43	248.33
Day short	4		4		16		134	
No short	690	275,334.94	690	275,334.94	3,126	1,247,131.50	72,356	28,870,101.92
Time short	1		1		6		12	
Total Cost		**2,019,926.60**		2,502,013.41		2,651,311.93		30,018,004.78

To summarize the optimal inventory policy which the drugs with high consumption value and vital clinical importance (‘AV’ category) should be considered minimal shortage according to Figure 4.1-4.3, and the drugs with high consumption value both essential and non-essential clinical importance (‘AE’ and ‘AN’ category) should be considered minimal total inventory cost according to Table 4.10-4.15 respectively.

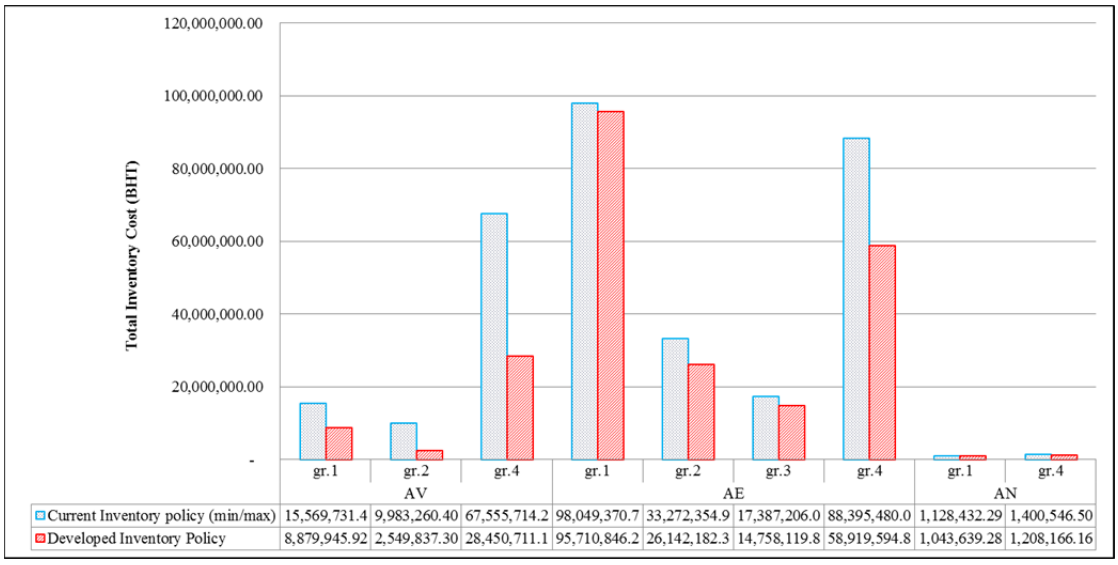
Table 4.19 shows the summary and factors of the optimal inventory polices based on the demand characteristics composed of trend, distribution and variability.

Table 4.19 The summary optimal policies of drug category AV, AE and AN which considered pairwise rankings and total cost

Drug Category	Group	Drug Characteristics	Considered	Optimal Policy	Inventory Model
AV (drugs with high consumption value and vital)	1	Normal distribution with no trend and static demand	Pairwise rankings: Minimum number of shortage	M1	(s,S) for Normal distribution demand
	2	Normal distribution with no trend and lumpy demand		M4	(s,Q) for pack size ordering
	*4	Not normal distribution		M5	Dynamic lot sizing
AE (drugs with high consumption value and essential)	*1	Normal distribution with no trend and static demand	Minimum total cost	Min/Max	-
	2	Normal distribution with no trend and lumpy demand		M5	Dynamic lot sizing
	3	Normal distribution with trend demand		M6	(s,Q) based on simple linear regression
	4	Not normal distribution		M5	Dynamic lot sizing
AN (drugs with high consumption value and non-essential)	*1	Normal distribution with no trend and static demand	Minimum total cost	Min/Max	-
				M3	(s,Q) based on EOQ
	*4	Not normal distribution		Min/Max	-

Remark: *Major group of each drug category

In order to know the performance of the optimal policies for each drug characteristics which are proposed in this study, the total inventory cost of each drug category are compared as shown in Figure 4.16. The result shows that the optimal policy can reduce total inventory cost of all drug categories. The current Min/Max policy makes the total inventory cost as 332,742,096.59 Baht but the optimal policies makes 237,663,043.11 Baht. In the other words, the optimal policies reduce the total inventory cost as 95,079,053.48 Baht or 28.57 percent.



Current Inventory policy (min/max)	15,569,731.4	9,983,260.40	67,555,714.2	98,049,370.7	33,272,354.9	17,387,206.0	88,395,480.0	1,128,432.29	1,400,546.50
Developed Inventory Policy	8,879,945.92	2,549,837.30	28,450,711.1	95,710,846.2	26,142,182.3	14,758,119.8	58,919,594.8	1,043,639.28	1,208,166.16

Figure 4.16 Comparison between Min/Max policy and optimal policies

CHAPTER V
DISCUSSION AND CONCLUSIONS

This chapter is divided into three main parts as follows:

5.1 Drug Classification and Demand Characteristics

5.2 Comparison among current Min/Max policy with others

5.3 Conclusion

5.1 Drug Classification and Demand Characteristics

Major drugs with high consumption value (‘A’ category) in this large public hospital are essential clinical importance (‘AE’ category) which effective against less severe but significant forms of disease, but not absolutely vital. However, drugs with high consumption value and vital clinical importance clinical importance (‘AV’ category) are a few. An inventory manager should strongly focus on this category because it important to patient’s life and spend a large fund. Almost drugs are essential and vital except drugs with high consumption value and non-essential (‘AN’ category) are four items.

The major demand characteristics of drugs with high consumption value (‘A’ category) are normally distributed and static, but don’t have trend as same as the high consumption value and essential drugs (‘AE’ category). These drugs are consumed thoroughly with stable demand. However, most of drugs with high consumption value and vital clinical importance (‘AV’ category) are not normally distributed because these drugs are not consumed thoroughly the years, they will be consumed when the case of severe disease is happened. Drugs with high consumption value and non-essential clinical importance (‘AN’ category) are both normally and not normally distributed, and depend on the usual consumptions thoroughly the years.

5.2 The Comparisons among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System

The purpose of this study is to find out what are the factors or the reasons that optimize particular drug to optimal inventory policy and manage drug inventory in the hospital. Key Performance Indicators (KPIs) are indicated the performance of inventory management. KPIs in this study are average inventory, time of ordering, days of shortage, amount of shortage and time of shortage.

Drugs with high consumption value and vital clinical importance (‘AV’ category)

Drugs are different from ordinary products in the general manufacture because they have levels of clinical importance. Hence, only KPIs and total cost from theory of inventory management is not enough to manage drug inventory efficiently especially drugs with high consumption value and vital clinical importance (‘AV’ category). The pairwise ranking is used to identify the most important KPIs for each drug category. The results show that these drugs should minimize shortage because drugs for critically life-saving should always be available for every case even the holding cost is higher, unless it may be effect to patient’s life.

For most drugs with high consumption value and critically life-saving (‘AV’ category) which are not normally distributed, the inventory position and ordering should be placed by the period such as every week or two weeks and order quantities vary from period to period, depending on the usage rates because this minimize shortage. The special demand should not be included.

If drugs with high consumption value and vital clinical importance (‘AV’ category) have normally distributed, no trend and static demand, the mathematical inventory models which were developed from the safety stock and re-order point based on mean and variance which are parameters of normal distribution and order up to maximum which can be stored for 45 days should be applied to decide when and how many drugs to order. The order quantity each time varies according to demand

However, if drugs with high consumption value and vital clinical importance (‘AV’ category) have normally distributed, no trend and lumpy demand, the order will be placed when the inventory level reduce to reorder point which is demand over lead time and variance of demand, and the quantity is ordered in form of packages and maximum quantity because of economy of scale and minimum ordering time.

These inventory policies minimize shortage cost of ‘AV’ category which should always be available for patients all the time as require.

Drugs with high consumption value and essential clinical importance (‘AE’ category)

The optimal inventory policy of drugs with high consumption value and essential clinical importance (‘AE’ category) should minimize total inventory cost. From the result, we can see that existing Min/Max inventory policy, which is the ordering of these drugs can be placed when inventory level is 80% of monthly sales and drug order quantity is up to 150% of monthly sale the ordering is placed at fixed time period and requires a larger safety stock to support drug consumption and drug order quantity is up to maximum. The order quantity each time varies adapted to demand is the optimal inventory policy of drugs with normal distribution without trend and static demand. But if the drug characteristic is normal distribution without trend and lumpy demand or not normal distribution, fixed period is optimal. The fixed period is the ordering is placed at fixed time period calculated from how long the Economic Order Quantity (EOQ) can be covered demand per unit of time, and drug order quantity is up to maximum. The order quantity each time varies according to demand.

However, drugs which have normally distribution with trend should be applied with the developed inventory policy from simple regression model, which is the ordering of these drugs are placed at reorder point which comprises of average demand and safety stock over lead time and order quantity which comprise of average demand for demand data with trend, because this inventory policy minimizes the total inventory cost.

It is noticed that the drugs which have normally distribution with trend is not suitable with minimum/maximum inventory policy which exists in the hospital.

The pairwise ranking which identifies that average inventory is the most important for high consumption value and essential (AE) and non-essential (AN) drugs cannot be used because this increases shortage cost. To reduce lower service level, the pairwise ranking is avoided for 'AE' and 'AN' category and the total inventory cost analysis is instead.

Drugs with high consumption value and non-essential clinical importance ('AN' category)

Almost drugs with high consumption value and non-essential clinical importance ('AN' category) both normally and not normally distributed demand are optimal to current Min/Max inventory policy which the ordering of this drug category is placed when inventory level is 80% of monthly sales and drug order quantity is up to 150% of monthly sale, or the ordering is placed at fixed time period and requires a larger safety stock to support drug consumption and drug order quantity is up to maximum. The order quantity each time varies according to demand. In addition, if drugs with high consumption value and non-essential clinical importance ('AN' category) are normally distributed demand, they can also be used and optimal to the policy that order when the inventory level reduced to the reorder point which is demand over lead time and order quantity is Economic Order Quantity (EOQ).

However, the inventory policy for drugs in the hospital should be revised every year because the VEN classification or the classification of clinical important is revised by hospital's committee every year. The ABC classification also revised every year because it uses annual demand consumption value to classify drug items.

5.3 Conclusion

This study investigates the historical data of drug consumption in 2008-2011 from the Out Patient Department (OPD), a large private teaching hospital. The entire drugs are classified depend on their value and clinical importance by ABC/VEN

analysis. We selected only drugs with high consumption value called ‘A’ category and divided into high consumption value and vital drugs (AV), high consumption value and essential drugs (AE) and high consumption value and non-essential drugs (AN). The data is analyzed for trend analysis, distribution test and variation test. The most drugs with high consumption value have usual and stable consumption. The order should be placed and ordered followed by current Min/Max policy.

However, if we focus on the clinical importance, we will found that high consumption value and vital drugs (AV) do not have usual consumption because these drugs are not dispensed every day. These drugs have different demand characteristics both distribution and variance. The proper way to order drugs should be placed when the inventory level reduces to the reorder point or ordered at the period of fixed time.

It is noticed that entire order policy is passive. We must wait the inventory level reach to the re-order point or minimum or wait time and then ordering is placed. If the suppliers and hospital inventory manager can share drug stock level each other, the replenishment is placed when the drug stock is lower. This is called Vendor Managed Inventory (VMI). It may help to reduce total inventory cost especially shortage cost and holding cost of both supplier and the hospital.

REFERENCES

1. วีระ อิงคภาสกร. มาตรการปฏิรูประบบบริหารเวชภัณฑ์และผลกระทบต่อ รพศ./รพท. หลังวิกฤติเศรษฐกิจ. วารสารนโยบายและแผนสาธารณสุข 2542;2(1):5-16.
2. Diarra K, Coulibaly S. Financing of recurrent health costs in Mali. Health Policy Educ 1990;5(2):125-138.
3. Charupash C. Simulation of drug classification by ABC analysis and Economic Order Quantity model for drug inventory management in Khon Kaen hospital [Ph.D. Thesis in Public Health]. Bangkok: Mahidol University; 2001.
4. Lapierre SD, Ruiz AB. Scheduling logistic activities to improve hospital supply systems. Comput Oper Res 2007;34(3):624-41.
5. พงษ์ดนัย คำแสน. การประยุกต์ใช้ระบบเอบีซีในการควบคุมเวชภัณฑ์คงคลัง ของสถานบริการสุขภาพพิเศษ มหาวิทยาลัยเชียงใหม่. วิทยานิพนธ์ปริญญาบริหารธุรกิจมหาบัณฑิต สาขาวิชาการบริหารธุรกิจ. บัณฑิตวิทยาลัย มหาวิทยาลัยเชียงใหม่; 2549.
6. ดวงพรรณ กริชชาญชัย และคณะ. รายงานฉบับสมบูรณ์โครงการวิจัยและพัฒนาการจัดการโลจิสติกส์และโซ่อุปทานต้นแบบในอุตสาหกรรมบริการ : โรงพยาบาล / เสนอต่อ สำนักงานคณะกรรมการการอุดมศึกษา. กรุงเทพฯ: สำนักงานคณะกรรมการการอุดมศึกษา; 2551.
7. ระวี สุวรรณเดโชชัย, นิสกา ม่วงพัฒน์. รายงานฉบับสมบูรณ์ โครงการ"การวิเคราะห์และพัฒนาตัวแบบที่เหมาะสมสำหรับการจัดการยาคงคลัง: กรณีศึกษาโรงพยาบาล". กรุงเทพฯ: สำนักงานกองทุนสนับสนุนการวิจัย; 2554.
8. Suwansechochai R, Muangpat N. The Analysis and Improvement of Appropriate Model for medical inventory management: Case study hospital. In: Proceeding of the Medical Data Standard Expo Bangkok: CVMC, Faculty of Medicine Ramathibodi Hospital; 2010.
9. Kaur J, Bapna JS, Bhoi N, Singh OP. Management of Hospital Pharmacy in Private Sector. J Health Manag 2006;8(1):129-37.

10. Laieddee C. Improvement of re-order point for drug inventory management at Ramathibodi hospital [M.Sc. Thesis in Pharmacy Administration]. Bangkok: Mahidol University; 2010.
11. วาณี โรจน์สง่า. การเพิ่มประสิทธิภาพของการบริหารคลังเวชภัณฑ์ยา กลุ่มงานเภสัชกรรม โรงพยาบาลอุดรธานี. วิทยานิพนธ์ปริญญาธุรกิจมหาบัณฑิต สาขาวิชาการบริหารธุรกิจ. สำนักวิทยบริการ มหาวิทยาลัยมหาสารคาม; 2545.
12. ชัยยงค์ สุขศรีสมบูรณ์. การพัฒนาระบบการจัดการพัสดุคงคลัง สำหรับคลังยา กองทัพอากาศ. วิทยานิพนธ์ปริญญาวิทยาศาสตรมหาบัณฑิต สาขาการจัดการด้านโลจิสติกส์ (สหสาขาวิชา). บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย; 2550.
13. Chungsiwapornpong W. Survey of drug inventory control process and performance among hospital pharmacy departments in Thailand [M.Sc. Thesis in Pharmacy Administration]. Bangkok: Mahidol University; 2007.
14. Danas K, Ketikidis P, Roudsari A. A Virtual hospital pharmacy inventory: an approach to support unexpected demand. J Med Mark 2002;2(2):125-9.
15. Vila-Parrish AR, Ivy JS, King RE, editors. A simulation-based approach for inventory modeling of perishable pharmaceuticals. In: Proceeding of the 2008 Winter Simulation. Conference San Diego, CA: Institute of Electrical and Rlectronics Engineer; 2008.
16. ธนัญญา วสุศรี, วลัยลักษณ์ อัตธีรวงศ์. การบริหารสินค้าคงคลัง คู่มือผู้เข้าอบรม. พิมพ์ครั้งที่ 3. กรุงเทพฯ: โครงการพัฒนาหลักสูตรและฝึกอบรมโลจิสติกส์และซัพพลายเชน สำนักงานอุดมศึกษาแห่งชาติ; 2552.
17. Vaz FS, Ferreira AM, Kulkarni MS, Motghare DD. A Study of Drug Expenditure at a tertiary care hospital: An ABC-VED Analysis. J Health Manag 2008;10(1):119-27.
18. เฉลิมชัย โชควิสิทธิชัย, วัชรพงษ์ สาระ, วีรยุทธ ทับทิมนาค. การหาปริมาณการสั่งซื้อและจุดสั่งซื้อสำหรับเวชภัณฑ์ประเภทไหลปานกลางและไหลช้า : โรงพยาบาลรามาธิบดี. ปริญญานิพนธ์ปริญญาวิศวกรรมศาสตร์บัณฑิต สาขาวิชาวิศวกรรมอุตสาหการ. มหาวิทยาลัยมหิดล; 2552.
19. ชูเพ็ญ วิบุลสันติ, อุษณีย์ คำประกอบ, พาณี ศิริสะอาด. การจัดการเวชภัณฑ์คงคลังของห้องปฏิบัติการเภสัชชุมชน คณะเภสัชศาสตร์ มหาวิทยาลัยเชียงใหม่. ไทยเภสัชสาร 2546;27(3-4):139-48.

20. Gupta A, Devnani M, Nigah R. ABC and VED Analysis of the pharmacy store of a tertiary care teaching, research and referral healthcare institute of India. Journal of Young Pharmacists 2010;2:201-205.
21. Thawani VR, Turankar AV, Sontakke SD, Pimpalkhute SV, Dakhale GN, Jaiswal KS, et al. Research Paper - Economic analysis of drug expenditure in Government Medical College hospital, Nagpur. Indian J of Pharmacol2004;36(1):15-9.
22. วัฒนา สุนทรธัย. เรียนสถิติด้วย SPSS ภาคสถิติไม่อิงพารามิเตอร์. กรุงเทพฯ: วิทยพัฒน์; 2543.
23. Schulman RDW, Sweet G. Impact of Drug Shortages: Results of Two Independent National Surveys 2011: Available from: http://www.fda.gov/ downloads/Drugs/NewsEvents/UCM274568.pdf [Access 3 June 2007].
24 Devnani M, Gupta AK, Nigah N. ABC and VED Analysis of the Pharmacy Store of a Tertiary Care Teaching, Research and Referral Healthcare Institute of India. J Young Pharm 2010;2(2):201-5.

APPENDICES

APPENDIX A
LIST OF DRUGS WITH ABC/VEN

Table A1 Result of the classification of drugs with high consumption value ('A' category) based on clinical important (V-Vital drugs, E-essential drugs and N-non essential drugs) demand from Central Drug Room, Out Patient Department fiscal year 2011

Drug code	Annual demand	Unit price (Baht)	Annual value (Baht)	% Value	Accumulate %Value	ABC	VEN
PLAV-T-	1041944	88.50	92,212,044.00	2.11	2.11	A	E
CRES1T-	1848107	47.50	87,785,082.50	2.01	4.13	A	E
CELC-C-	1374684	63.00	86,605,092.00	1.98	6.11	A	V
LIPR1T-	2095677	40.00	83,827,080.00	1.92	8.03	A	E
GLIV-T-	68678	1,066.00	73,210,748.00	1.68	9.71	A	E
VIAT-W-	1214815	42.00	51,022,230.00	1.17	10.88	A	E
LIPR2T-	948119	52.50	49,776,247.50	1.14	12.02	A	E
PRGF1C-	284698	135.00	38,434,230.00	0.88	12.90	A	V
BONV-T-	20291	1,839.00	37,315,149.00	0.86	13.75	A	E
ACTE1T-	92292	399.00	36,824,508.00	0.84	14.60	A	E
ALBK-I-	28714	1,238.00	35,547,932.00	0.81	15.41	A	V
EZET-T-	718589	49.00	35,210,861.00	0.81	16.22	A	E
GAMR1I-	2797	12,167.00	34,031,099.00	0.78	17.00	A	V
SADN1C-	736409	45.00	33,138,405.00	0.76	17.76	A	V
TACV1T-	10650	3,086.00	32,865,900.00	0.75	18.51	A	E
PARI1T-	594788	54.00	32,118,552.00	0.74	19.25	A	E
EPRX-I-	18725	1,630.00	30,521,750.00	0.70	19.95	A	E
PRTX-W-	324576	91.00	29,536,416.00	0.68	20.63	A	E
TASN-C-	15512	1,701.00	26,385,912.00	0.60	21.23	A	E
LYRC-C-	453062	58.00	26,277,596.00	0.60	21.83	A	E
NEXM1T-	471231	53.00	24,975,243.00	0.57	22.40	A	E
MERN2I-	16768	1,474.00	24,716,032.00	0.57	22.97	A	E
RECM-I-	14723	1,634.00	24,057,382.00	0.55	23.52	A	E
CRES2T-	366381	65.50	23,997,955.50	0.55	24.07	A	E
TAXL1I0	136464	175.00	23,881,200.00	0.55	24.62	A	E
NERT1C-	698267	33.50	23,391,944.50	0.54	25.16	A	E
TAZC-I-	34144	676.00	23,081,344.00	0.53	25.68	A	E
CELB-C-	781193	29.50	23,045,193.50	0.53	26.21	A	E
PEGS-I-	2047	11,243.00	23,014,421.00	0.53	26.74	A	V
NEUT1I-	13193	1,711.00	22,573,223.00	0.52	27.26	A	V
BARA-T-	77325	282.00	21,805,650.00	0.50	27.76	A	V
LIPR3T-	354181	61.50	21,782,131.50	0.50	28.26	A	E
ERBI-I-	1347	15,833.00	21,327,051.00	0.49	28.75	A	E
MATR2I-	304	69,157.00	21,023,728.00	0.48	29.23	A	E
NEXM2T-	288846	70.50	20,363,643.00	0.47	29.69	A	E
ARCX1T-	499157	40.00	19,966,280.00	0.46	30.15	A	E
XATX-T-	611567	32.00	19,570,144.00	0.45	30.60	A	E

Table A1 Result of the classification of drugs with high consumption value ('A' category) based on clinical important (V-Vital drugs, E-essential drugs and N-non essential drugs) demand from Central Drug Room, Out Patient Department fiscal year 2011 (cont.)

Drug code	Annual demand	Unit price (Baht)	Annual value (Baht)	% Value	Accumulate %Value	ABC	VEN
VFEN2T-	10597	1,827.00	19,360,719.00	0.44	31.04	A	E
HARN1T-	479479	40.00	19,179,160.00	0.44	31.48	A	E
JANU-T-	325676	58.50	19,052,046.00	0.44	31.92	A	E
AMBS-I-	2117	8,861.00	18,758,737.00	0.43	32.35	A	V
SERE3F-	10178	1,827.00	18,595,206.00	0.43	32.78	A	E
XELD2T-	108495	171.00	18,552,645.00	0.43	33.20	A	E
TAXT2I-	588	31,252.00	18,376,176.00	0.42	33.62	A	E
AVOD-C-	310687	58.50	18,175,189.50	0.42	34.04	A	E
VISL-Y-	41726	430.00	17,942,180.00	0.41	34.45	A	E
LUCT-I-	286	62,678.00	17,925,908.00	0.41	34.86	A	E
HEMX3I-	21905	816.00	17,874,480.00	0.41	35.27	A	E
ARMD-T-	82667	215.00	17,773,405.00	0.41	35.68	A	E
ZOMT-I-	1295	13,715.00	17,760,925.00	0.41	36.08	A	E
HECT-I-	195	89,481.00	17,448,795.00	0.40	36.48	A	E
CADX-T-	671557	25.50	17,124,703.50	0.39	36.88	A	E
FOSP-T-	47813	356.00	17,021,428.00	0.39	37.27	A	E
INTX1I0	314852	54.00	17,002,008.00	0.39	37.66	A	E
EBIX-T-	163110	102.00	16,637,220.00	0.38	38.04	A	E
TYGC-I-	6197	2,651.00	16,428,247.00	0.38	38.41	A	E
ACTO2T-	196819	82.50	16,237,567.50	0.37	38.79	A	E
FOSM1T-	44956	356.00	16,004,336.00	0.37	39.15	A	E
AVAT-I-	739	21,603.00	15,964,617.00	0.37	39.52	A	E
FORE-I-	722	21,247.00	15,340,334.00	0.35	39.87	A	E
CASD-T-	46368	328.00	15,208,704.00	0.35	40.22	A	E
EXJA-T-	25638	592.00	15,177,696.00	0.35	40.57	A	E
ALMT-I-	336	44,552.00	14,969,472.00	0.34	40.91	A	E
VALC-T-	12122	1,226.00	14,861,572.00	0.34	41.25	A	V
ARCX2T-	371167	40.00	14,846,680.00	0.34	41.59	A	E
SERM1T-	674362	22.00	14,835,964.00	0.34	41.93	A	E
SADN2C-	81700	180.00	14,706,000.00	0.34	42.27	A	V
ENBL1I-	1000	14,362.00	14,362,000.00	0.33	42.60	A	E
PRVF2T-	272330	52.50	14,297,325.00	0.33	42.93	A	E
MICC2F-	4202	3,357.00	14,106,114.00	0.32	43.25	A	E
REMC-I-	462	30,363.00	14,027,706.00	0.32	43.57	A	E
LANO-I-	16780	824.00	13,826,720.00	0.32	43.89	A	E
ELOX-I-	896	15,362.00	13,764,352.00	0.32	44.20	A	E
ACLS-I-	779	17,128.00	13,342,712.00	0.31	44.51	A	E
TELF2T-	554606	24.00	13,310,544.00	0.31	44.81	A	E
SIGL2T-	265747	50.00	13,287,350.00	0.30	45.12	A	E
ULTR-T-	696757	19.00	13,238,383.00	0.30	45.42	A	E
OXAL-I-	1311	9,961.00	13,058,871.00	0.30	45.72	A	E
NASN-F1	16042	811.00	13,010,062.00	0.30	46.02	A	E
SUPL1T-	459152	27.50	12,626,680.00	0.29	46.31	A	E
ARIP1T-	60868	203.00	12,356,204.00	0.28	46.59	A	E
NOSV-I-	473	26,007.00	12,301,311.00	0.28	46.87	A	V
NEXV-T-	6939	1,733.00	12,025,287.00	0.28	47.15	A	E

Table A1 Result of the classification of drugs with high consumption value ('A' category) based on clinical important (V-Vital drugs, E-essential drugs and N-non essential drugs) demand from Central Drug Room, Out Patient Department fiscal year 2011 (cont.)

Drug code	Annual demand	Unit price (Baht)	Annual value (Baht)	% Value	Accumulate %Value	ABC	VEN
ZOLO-T-	249706	47.00	11,736,182.00	0.27	47.42	A	E
KEPP2T-	236895	49.50	11,726,302.50	0.27	47.69	A	E
CEVT-T-	6400	1,823.00	11,667,200.00	0.27	47.95	A	E
SUPR1I-	15545	750.00	11,658,750.00	0.27	48.22	A	E
HEPS-T-	49591	233.00	11,554,703.00	0.26	48.49	A	V
ENAN1I-	582	19,770.00	11,506,140.00	0.26	48.75	A	E
ENBL-I-	1557	7,212.00	11,229,084.00	0.26	49.01	A	E
ARIP-T-	73824	152.00	11,221,248.00	0.26	49.26	A	E
NERT3C-	674934	16.50	11,136,411.00	0.26	49.52	A	E
INVZ-I-	6737	1,650.00	11,116,050.00	0.25	49.77	A	E
MYFT2C-	104027	106.00	11,026,862.00	0.25	50.03	A	V
MAXM-I-	16937	649.00	10,992,113.00	0.25	50.28	A	E
NCLO-T-	67419	160.00	10,787,040.00	0.25	50.53	A	E
MADI1T-	1099119	9.75	10,716,410.25	0.25	50.77	A	E
TRCL-T-	5791	1,827.00	10,580,157.00	0.24	51.01	A	V
PROS-T-	181776	57.00	10,361,232.00	0.24	51.25	A	E
SPRY1T-	3580	2,886.00	10,331,880.00	0.24	51.49	A	E
ENAN-I-	1465	7,006.00	10,263,790.00	0.24	51.72	A	E
XALT-Y-	18115	565.00	10,234,975.00	0.23	51.96	A	E
NORV1T-	454630	22.50	10,229,175.00	0.23	52.19	A	E
ALMT1I-	991	10,294.00	10,201,354.00	0.23	52.43	A	E
AZTP-T-	508013	20.00	10,160,260.00	0.23	52.66	A	E
HEMX4I-	4385	2,262.00	9,918,870.00	0.23	52.89	A	E
CAMP2I-	645	15,362.00	9,908,490.00	0.23	53.11	A	E
DIVN-T-	439200	22.50	9,882,000.00	0.23	53.34	A	E
SERT2F-	9308	1,057.00	9,838,556.00	0.23	53.57	A	E
BLOP1T-	460343	21.00	9,667,203.00	0.22	53.79	A	E
SAIZ-I-	1044	9,257.00	9,664,308.00	0.22	54.01	A	E
FEMR-T-	51362	188.00	9,656,056.00	0.22	54.23	A	E
RAPM-T-	29125	331.00	9,640,375.00	0.22	54.45	A	V
CELF-Y-	36622	261.00	9,558,342.00	0.22	54.67	A	E
SERQ1T-	236477	40.00	9,459,080.00	0.22	54.89	A	E
PRVF1T-	289490	32.50	9,408,425.00	0.22	55.10	A	E
CALT2T-	9382720	1.00	9,382,720.00	0.22	55.32	A	N
COZA-T-	380115	24.50	9,312,817.50	0.21	55.53	A	E
NOLD-T-	160305	57.00	9,137,385.00	0.21	55.74	A	E
TAXT1I-	1044	8,654.00	9,034,776.00	0.21	55.95	A	E
XOLR-I-	450	20,070.00	9,031,500.00	0.21	56.15	A	E
SPIR-C-	134189	67.00	8,990,663.00	0.21	56.36	A	E
PLET-T-	338973	26.50	8,982,784.50	0.21	56.57	A	E
MADI2T-	543187	16.50	8,962,585.50	0.21	56.77	A	E
LEXP-T-	170573	52.50	8,955,082.50	0.21	56.98	A	E
COTL2T-	179934	49.50	8,906,733.00	0.20	57.18	A	E
IRES-T-	3519	2,463.00	8,667,297.00	0.20	57.38	A	E
DIVN1T-	278740	31.00	8,640,940.00	0.20	57.58	A	E

Table A1 Result of the classification of drugs with high consumption value ('A' category) based on clinical important (V-Vital drugs, E-essential drugs and N-non essential drugs) demand from Central Drug Room, Out Patient Department fiscal year 2011 (cont.)

Drug code	Annual demand	Unit price (Baht)	Annual value (Baht)	% Value	Accumulate %Value	ABC	VEN
VETV-X-	4929	1,739.00	8,571,531.00	0.20	57.77	A	V
SERC1T-	990341	8.50	8,417,898.50	0.19	57.97	A	E
VYTO1T-	136194	61.50	8,375,931.00	0.19	58.16	A	E
ALPG-Y-	21733	385.00	8,367,205.00	0.19	58.35	A	E
TIEN-I-	11474	725.00	8,318,650.00	0.19	58.54	A	E
ACTO1T-	197594	42.00	8,298,948.00	0.19	58.73	A	E
AMLP1T-	2759588	3.00	8,278,764.00	0.19	58.92	A	E
BLOP2T-	254397	32.00	8,140,704.00	0.19	59.11	A	E
EPRX5I-	3221	2,513.00	8,094,373.00	0.19	59.29	A	E
AMLP2T-	1903833	4.25	8,091,290.25	0.19	59.48	A	E
TACV-T-	3172	2,541.00	8,060,052.00	0.18	59.66	A	E
ARTD-C-	194925	41.00	7,991,925.00	0.18	59.85	A	E
EPRX4I-	2055	3,887.00	7,987,785.00	0.18	60.03	A	E
PLET1T-	153264	51.50	7,893,096.00	0.18	60.21	A	E
ARAV1T-	85827	91.00	7,810,257.00	0.18	60.39	A	E
MUCT-T-	706186	11.00	7,768,046.00	0.18	60.57	A	E
EXEL2X-	44256	174.00	7,700,544.00	0.18	60.74	A	E
COTL-T-	119444	64.00	7,644,416.00	0.18	60.92	A	E
STLV1T-	145590	52.50	7,643,475.00	0.18	61.09	A	E
VYTO-T-	145249	52.50	7,625,572.50	0.17	61.27	A	E
ALUV-T-	245888	31.00	7,622,528.00	0.17	61.44	A	V
PRGF3C-	96246	78.50	7,555,311.00	0.17	61.62	A	V
LYRC1C-	86158	86.50	7,452,667.00	0.17	61.79	A	E
MYFT1C-	129026	57.00	7,354,482.00	0.17	61.96	A	V
SUTN-C-	4162	1,745.00	7,262,690.00	0.17	62.12	A	E
PARI-T-	157148	46.00	7,228,808.00	0.17	62.29	A	E
SIMU-I-	101	71,270.00	7,198,270.00	0.16	62.45	A	V
SALZ-T-	1061834	6.75	7,167,379.50	0.16	62.62	A	E
PLED1T-	298549	24.00	7,165,176.00	0.16	62.78	A	E
RECM2I-	670	10,654.00	7,138,180.00	0.16	62.95	A	E
PLED-T-	460180	15.50	7,132,790.00	0.16	63.11	A	E
DIRL-I-	1209	5,891.00	7,122,219.00	0.16	63.27	A	E
THAL-C-	10316	688.00	7,097,408.00	0.16	63.43	A	E
MEFM-T-	7095550	1.00	7,095,550.00	0.16	63.60	A	E
REMN4C-	40538	175.00	7,094,150.00	0.16	63.76	A	E
DINH1I1	3687	1,898.00	6,997,926.00	0.16	63.92	A	E
CONC1T-	792372	8.50	6,735,162.00	0.15	64.07	A	E
GEMZ2I-	583	11,454.00	6,677,682.00	0.15	64.23	A	E
VIRE-T-	146473	45.00	6,591,285.00	0.15	64.38	A	V
GEMC1I-	1181	5,560.00	6,566,360.00	0.15	64.53	A	E
DPAC-T-	421683	15.50	6,536,086.50	0.15	64.68	A	E
TRUV-T-	92065	70.00	6,444,550.00	0.15	64.83	A	V
VTBZ-T-	6442669	1.00	6,442,669.00	0.15	64.97	A	N
PIOG-T-	381687	16.50	6,297,835.50	0.14	65.12	A	E
PEGL-I-	227	27,603.00	6,265,881.00	0.14	65.26	A	V

Table A1 Result of the classification of drugs with high consumption value ('A' category) based on clinical important (V-Vital drugs, E-essential drugs and N-non essential drugs) demand from Central Drug Room, Out Patient Department fiscal year 2011 (cont.)

Drug code	Annual demand	Unit price (Baht)	Annual value (Baht)	% Value	Accumulate %Value	ABC	VEN
GLSM-W-	480023	13.00	6,240,299.00	0.14	65.41	A	N
ASPM1T-	6218859	1.00	6,218,859.00	0.14	65.55	A	E
PLAQ-T-	323229	19.00	6,141,351.00	0.14	65.69	A	E
ZYRT-T-	556785	11.00	6,124,635.00	0.14	65.83	A	E
ZEFF-T-	52743	116.00	6,118,188.00	0.14	65.97	A	V
CASD1T-	8420	720.00	6,062,400.00	0.14	66.11	A	E
VELC1I-	256	23,543.00	6,027,008.00	0.14	66.25	A	E
OLMT-T-	273825	22.00	6,024,150.00	0.14	66.38	A	E
CLEX2I-	20725	290.00	6,010,250.00	0.14	66.52	A	E
NEBD-I-	954	6,300.00	6,010,200.00	0.14	66.66	A	N
EUTP-I-	5064	1,186.00	6,005,904.00	0.14	66.80	A	E
NORV2T-	165596	36.00	5,961,456.00	0.14	66.93	A	E
REYT3C-	17264	344.75	5,951,764.00	0.14	67.07	A	V
COSP-Y-	9434	627.00	5,915,118.00	0.14	67.21	A	E
DIMR-T-	689839	8.50	5,863,631.50	0.13	67.34	A	E
DFRL-I-	26511	221.00	5,858,931.00	0.13	67.47	A	E
DORB-I-	4005	1,462.00	5,855,310.00	0.13	67.61	A	E
STOC1C-	172107	33.50	5,765,584.50	0.13	67.74	A	V
ADCR1T-	256688	22.00	5,647,136.00	0.13	67.87	A	E
MICD1T-	262449	21.50	5,642,653.50	0.13	68.00	A	E
PEGR2I-	388	14,474.00	5,615,912.00	0.13	68.13	A	V
SYBC2F1	3794	1,474.00	5,592,356.00	0.13	68.26	A	E
COCT2T-	45593	122.00	5,562,346.00	0.13	68.38	A	E
ZOLL-I-	219	25,367.00	5,555,373.00	0.13	68.51	A	E
APRO1T-	230613	24.00	5,534,712.00	0.13	68.64	A	E
ALPI-I-	737	7,490.00	5,520,130.00	0.13	68.76	A	V
MADP-T-	378179	14.50	5,483,595.50	0.13	68.89	A	E
BARA1T-	12799	418.00	5,349,982.00	0.12	69.01	A	V
SIMV-T-	5303351	1.00	5,303,351.00	0.12	69.13	A	E
LOST-T-	1171645	4.50	5,272,402.50	0.12	69.26	A	E
DALC-I2	14647	359.00	5,258,273.00	0.12	69.38	A	E
CAEL-I-	176	29,860.00	5,255,360.00	0.12	69.50	A	E
TEMD2C-	685	7,656.00	5,244,360.00	0.12	69.62	A	E
ZAND-T-	249671	21.00	5,243,091.00	0.12	69.74	A	E
TOPX3T-	116246	45.00	5,231,070.00	0.12	69.86	A	E
DAFL-T-	452147	11.50	5,199,690.50	0.12	69.98	A	E
EXFG1T-	159717	32.50	5,190,802.50	0.12	70.09	A	E

APPENDIX B
THE COMPARISON AMONG POLICIES CONSIDERED BY PAIRWISE RANKING

Table B1 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AV group 1 (No trend, normal and static demand)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
HEPS-T-	Average Inventory	3,334	3,667	2,444	1,725	5,302	(1,745)
	Time order	25	10	11	26	167	180
	Day short	27	8	24	37	1	65
	No short	6,545	1,760	3,347	4,685	1,794	823,203
	Time short	4	1	7	8	1	1
MYFT2C-	Average Inventory	5,007	7,097	3,953	3,147	9,147	(5,108)
	Time order	23	9	12	24	174	162
	Day short	15	12	33	42	3	64
	No short	4,689	2,596	8,887	9,920	10,082	2,133,247
	Time short	2	1	8	14	2	1
PEGS-I-	Average Inventory	101	132	82	65	212	(597)
	Time order	29	10	11	36	208	193
	Day short	30	11	29	100	22	143
	No short	216	44	145	611	5,676	134,648
	Time short	6	1	6	13	1	2
RAPM-T-	Average Inventory	1,893	2,455	1,536	1,109	2,732	564
	Time order	21	9	11	25	161	175
	Day short	15	10	11	69	1	55
	No short	1,193	795	390	6,639	2,009	179,880
	Time short	3	1	5	11	1	1

Table B1 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AV group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
SADN1C-	Average Inventory	38,595	48,618	32,760	24,775	57,020	(238,827)
	Time order	25	8	10	41	182	208
	Day short	23	6	20	119	4	142
	No short	78,771	9,740	27,624	280,352	50,466	51,479,099
	Time short	4	1	5	13	2	2
VIRE-T-	Average Inventory	8,571	11,109	6,565	3,301	12,208	3,789
	Time order	27	9	11	20	180	142
	Day short	43	12	24	53	2	40
	No short	28,499	4,822	9,241	16,929	3,066	942,465
	Time short	4	1	5	15	2	1
ZEFF-T-	Average Inventory	2,933	4,425	2,555	1,708	4,503	2,460
	Time order	23	9	11	20	178	141
	Day short	17	6	25	41	3	29
	No short	3,222	1,205	4,674	6,123	1,752	155,161
	Time short	4	1	7	13	2	1

Table B2 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AV group 2 (No trend, normal and lumpy demand)

Drug Code	KPI	Min/Max	M1	M4	M5	P	Q
AMBS-I-	Average Inventory	147	168	(265,850)	204	345	(618)
	Time order	17	12	11	66	57	99
	Day short	60	18	319	-	3	86
	No short	820	156	6	-	384	68,297
	Time short	2	2	5	-	2	3
PEGR2I-	Average Inventory	35	33	9,644	48	63	26
	Time order	25	12	11	132	131	143
	Day short	25	11	6	-	1	29
	No short	57	14	7	-	16	1,463
	Time short	5	1	1	-	1	1

Table B2 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AV group 2 (No trend, normal and lumpy demand) (cont.)

Drug Code	KPI	Min/Max	M1	M4	M5	P	Q
RUV-T-	Average Inventory	345	456	130,063	562	764	1,109
	Time order	20	12	11	67	64	17
	Day short	48	6	2	-	2	2
	No short	887	123	27	-	383	158
	Time short	4	1	1	-	1	2

Table B3 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AV group 4 (Not normal demand)

Drug Code	KPI	Min/Max	M5	P	Q
ALBK-I-	Average Inventory	1,209	1,479	2,357	(9,245)
	Time order	25	116	125	110
	Day short	41	-	1	97
	No short	3,024	-	230	2,180,521
	Time short	6	-	1	1
ALPI-I-	Average Inventory	5	29	156	12
	Time order	17	108	64	100
	Day short	115	1	4	58
	No short	54	3	1,458	19,479
	Time short	5	1	1	1
ALUV-T-	Average Inventory	11,844	16,495	22,723	(5,604)
	Time order	18	98	106	105
	Day short	48	-	2	60
	No short	32,477	-	6,284	2,859,895
	Time short	4	-	2	1
BARA1T-	Average Inventory	1,049	1,443	1,732	596
	Time order	24	163	166	147
	Day short	16	-	1	35
	No short	629	-	1,114	101,250
	Time short	2	-	1	1

Table B3 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AV group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
BARA-T-	Average Inventory		4,081		
	Time order	26	157	160	177
	Day short	25	-	3	69
	No short	8,637	-	5,592	3,067,953
	Time short	5	-	1	1
CELC-C-	Average Inventory	55,165	67,405	103,353	(1,205,219)
	Time order	23	177	183	208
	Day short	22	-	4	197
	No short	54,414	-	102,895	252,505,202
	Time short	4	-	2	1
GAMR1I-	Average Inventory	160	179	281	(783)
	Time order	24	141	142	168
	Day short	34	-	3	93
	No short	350	-	217	188,842
	Time short	4	-	1	1
MYFT1C-	Average Inventory	5,568	6,843	9,711	1,727
	Time order	25	145	157	128
	Day short	40	-	1	62
	No short	18,233	-	1,626	933,535
	Time short	5	-	1	1
NEUT1I-	Average Inventory	556	669	1,131	(3,270)
	Time order	24	176	182	140
	Day short	21	-	4	93
	No short	996	-	1,310	796,787
	Time short	3	-	2	1
NOSV-I-	Average Inventory	14	36	49	(83)
	Time order	18	99	79	124
	Day short	69	-	11	97
	No short	69	-	186	23,000
	Time short	4	-	6	1

Table B3 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AV group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
PEGL-I-	Average Inventory	14	22	25	(8)
	Time order	23	112	85	134
	Day short	28	-	10	57
	No short	39	-	110	4,783
	Time short	5	-	5	1
PRGF1C-	Average Inventory	14,734	14,284	20,550	(53,362)
	Time order	24	165	179	182
	Day short	41	1	3	80
	No short	33,945	232	20,624	13,212,732
	Time short	5	1	2	1
PRGF3C-	Average Inventory	4,707	5,116	6,986	(144)
	Time order	22	170	181	124
	Day short	18	-	3	64
	No short	4,756	-	2,703	978,172
	Time short	2	-	2	1
SADN2C-	Average Inventory	3,615	4,192	6,467	(6,218)
	Time order	25	169	172	168
	Day short	19	-	3	64
	No short	2,804	-	4,075	2,057,403
	Time short	4	-	2	1
SIMU-I-	Average Inventory	6	14	15	3
	Time order	15	50	25	80
	Day short	49	-	7	42
	No short	17	-	79	669
	Time short	6	-	2	2
STOC1C-	Average Inventory	9,321	10,983	13,921	5,398
	Time order	21	165	167	119
	Day short	14	-	2	41
	No short	8,339	-	4,351	1,009,082
	Time short	2	-	1	1

Table B3 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AV group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
TRCL-T-	Average Inventory	4,121	4,538	6,595	(25,750)
	Time order	24	139	148	117
	Day short	22	-	3	86
	No short	6,851	-	8,540	6,064,503
	Time short	3	-	2	1
VALC-T-	Average Inventory	810	911	1,122	(1,775)
	Time order	24	143	146	154
	Day short	17	-	3	89
	No short	1,007	-	506	474,427
	Time short	3	-	3	3
VETV-X-	Average Inventory	253	392	620	(224)
	Time order	20	74	79	102
	Day short	64	1	2	64
	No short	1,149	11	794	83,779
	Time short	4	1	1	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
ACTE1T-	Average Inventory	4,372	5,581	3,519	2,876	6,822	(28,580)
	Time order	16	8	11	43	180	208
	Day short	4	4	16	134	3	176
	No short	690	690	3,126	72,356	3,668	6,059,091
	Time short	1	1	6	12	2	1
ACTO1T-	Average Inventory	13,138	16,629	11,151	8,672	15,880	1,028
	Time order	19	9	11	22	104	176
	Day short	14	11	32	22	8	46
	No short	10,651	7,646	14,913	13,665	57,268	1,771,462
	Time short	2	1	8	9	4	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
ACTO2T-	Average Inventory	11,218	13,976	10,571	8,438	21,053	(20,763)
	Time order	18	9	10	30	208	204
	Day short	7	8	11	14	1	71
	No short	4,574	4,676	5,361	6,930	214	5,378,921
	Time short	1	2	2	3	1	3
ADCR1T-	Average Inventory	15,438	20,236	13,988	7,996	24,242	8,031
	Time order	18	8	11	18	104	137
	Day short	10	10	17	20	4	31
	No short	7,882	7,882	12,648	10,183	37,893	1,278,055
	Time short	1	1	3	8	3	1
ALPG-Y-	Average Inventory	1,212	1,434	1,070	685	2,158	45
	Time order	18	9	10	20	208	159
	Day short	10	11	15	23	-	54
	No short	746	753	966	1,466	-	188,967
	Time short	1	2	5	6	-	1
AMLP2T-	Average Inventory	95,683	118,546	87,870	48,126	123,724	(23,121)
	Time order	17	8	10	19	104	150
	Day short	6	6	11	25	8	59
	No short	30,625	30,625	38,098	91,052	681,930	21,247,313
	Time short	1	1	2	9	4	1
APRO1T-	Average Inventory	12,262	14,997	10,758	6,475	20,473	6,459
	Time order	17	9	10	16	104	127
	Day short	10	10	18	23	6	34
	No short	6,453	6,453	9,107	9,429	47,493	1,200,819
	Time short	1	1	4	6	4	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
ARAV1T-	Average Inventory	5,071	6,502	3,473	3,156	6,054	1,430
	Time order	18	9	12	23	104	152
	Day short	9	9	41	47	8	47
	No short	1,306	1,306	9,615	12,059	22,330	537,219
	Time short	1	1	8	11	5	1
ARCX1T-	Average Inventory	25,377	33,016	23,105	19,145	49,672	(68,025)
	Time order	17	8	11	31	208	203
	Day short	8	9	13	31	1	73
	No short	10,273	10,887	13,274	32,143	5,849	16,286,301
	Time short	1	2	3	8	1	6
ARCX2T-	Average Inventory	22,280	29,257	20,978	18,690	38,149	(30,968)
	Time order	17	8	10	29	208	203
	Day short	10	10	15	20	1	84
	No short	7,014	7,014	18,431	19,699	1,400	8,084,737
	Time short	1	1	3	8	1	3
	Average Inventory	3,939	4,831	3,286	2,555	5,477	(3,920)
ARIP-T-	Time order	17	9	11	24	104	170
	Day short	13	13	16	32	9	65
	No short	2,817	2,817	3,688	4,876	28,666	1,469,922
	Time short	1	1	4	10	5	1
ARMD-T-	Average Inventory	4,497	5,997	3,661	3,234	8,800	(7,800)
	Time order	17	9	11	31	208	202
	Day short	8	9	30	110	-	65
	No short	2,652	2,666	6,199	30,018	-	2,218,422
	Time short	1	2	9	10	-	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
ASPM1T-	Average Inventory	341,045	411,298	322,762	207,685	579,473	294,338
	Time order	18	9	10	23	104	101
	Day short	8	8	14	20	7	33
	No short	142,510	142,510	207,287	306,279	1,529,658	26,878,792
	Time short	1	1	4	9	5	1
AZTP-T-	Average Inventory	26,149	31,531	21,532	14,846	33,064	(17,068)
	Time order	17	9	11	23	104	160
	Day short	8	8	18	32	8	64
	No short	9,408	9,408	19,002	39,138	170,751	7,772,663
	Time short	1	1	5	10	4	1
BLOP1T-	Average Inventory	23,122	29,677	20,213	12,414	29,996	(10,487)
	Time order	17	8	11	23	104	160
	Day short	11	11	21	35	9	64
	No short	11,452	11,452	19,999	32,830	156,759	6,016,770
	Time short	1	1	4	12	3	1
BLOP2T-	Average Inventory	13,411	15,855	11,287	6,150	16,529	(357)
	Time order	17	9	11	19	104	149
	Day short	10	11	11	26	9	57
	No short	5,937	6,783	7,000	13,652	76,806	2,332,627
	Time short	1	2	3	12	5	1
BONV-T-	Average Inventory	1,055	1,301	824	721	1,658	(7,499)
	Time order	17	9	12	44	208	208
	Day short	12	12	17	143	3	123
	No short	616	616	1,069	12,049	1,121	1,643,945
	Time short	1	1	5	12	3	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
CELB-C-	Average Inventory	44,336	58,944	43,607	35,030	85,941	(425,448)
	Time order	19	9	11	37	208	208
	Day short	8	8	16	142	-	201
	No short	21,023	21,023	32,580	418,326	-	89,128,347
	Time short	1	1	5	11	-	2
CELF-Y-	Average Inventory	1,893	2,506	1,805	915	2,666	(904)
	Time order	18	9	10	22	104	162
	Day short	5	5	7	29	10	64
	No short	298	298	710	2,200	14,758	526,370
	Time short	1	1	2	8	3	1
CEVT-T-	Average Inventory	507	596	315	313	803	(1,471)
	Time order	20	10	12	30	208	184
	Day short	17	10	53	56	-	138
	No short	338	161	1,127	1,367	-	343,360
	Time short	4	3	10	11	-	3
COSP-Y-	Average Inventory	494	590	407	288	810	271
	Time order	17	9	11	16	104	129
	Day short	11	11	19	25	6	34
	No short	213	213	510	486	1,161	44,657
	Time short	1	1	6	7	6	1
COTL2T-	Average Inventory	9,228			3,036,457	13,602	(4,891)
	Time order	18			9	104	155
	Day short	7			33	10	64
	No short	4,037			13,731	76,211	2,759,070
	Time short	1			5	2	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
COTL-T-	Average Inventory	6,629	9,849	6,110	3,684	8,823	1,563
	Time order	18	8	11	22	104	159
	Day short	8	8	22	50	8	45
	No short	3,275	3,275	8,854	16,259	34,141	856,191
	Time short	1	1	7	13	5	1
DAFL-T-	Average Inventory	23,115	29,257	21,719	13,822	41,510	13,289
	Time order	17	9	10	17	104	123
	Day short	9	9	12	22	8	33
	No short	14,237	14,237	16,112	24,067	116,963	2,684,295
	Time short	1	1	2	8	4	1
DFRL-I-	Average Inventory	1,976	2,374	1,649	1,022	2,905	1,135
	Time order	20	10	11	23	104	144
	Day short	17	10	10	75	4	30
	No short	1,875	910	1,030	6,532	1,986	116,127
	Time short	2	1	3	14	4	1
DIMR-T-	Average Inventory	33,784	44,227	31,107	17,548	62,443	16,571
	Time order	21	9	11	17	104	130
	Day short	11	10	23	18	8	40
	No short	14,372	11,821	40,591	26,785	166,354	4,300,664
	Time short	2	1	5	6	4	1
DIRL-I-	Average Inventory	100	130	74	69	124	44
	Time order	19	9	12	24	104	169
	Day short	14	12	29	41	5	34
	No short	72	62	144	208	192	7,488
	Time short	3	1	7	10	3	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
DIVN1T-	Average Inventory	14,398	19,366	13,518	7,415	19,251	(2,175)
	Time order	17	8	10	21	104	161
	Day short	8	8	16	18	9	56
	No short	5,865	5,865	13,189	13,592	99,965	2,940,726
	Time short	1	1	4	6	4	1
DIVN-T-	Average Inventory	23,425	31,941	22,151	12,404	35,176	(10,315)
	Time order	18	8	11	24	208	172
	Day short	9	9	18	23	3	64
	No short	12,087	12,087	17,979	20,988	23,767	5,799,831
	Time short	1	1	6	12	2	1
DPAC-T-	Average Inventory	21,607	29,439	19,636	11,844	36,780	10,005
	Time order	18	8	11	19	104	140
	Day short	8	8	22	24	7	38
	No short	4,501	4,501	21,005	29,450	78,613	2,350,834
	Time short	1	1	6	6	5	1
ENAN-I-	Average Inventory	112	111	66	45	165	(43)
	Time order	18	9	11	25	208	171
	Day short	10	10	27	57	1	65
	No short	43	43	105	235	28	23,261
	Time short	1	1	7	11	1	1
EPRX-I-	Average Inventory	1,003	1,337	904	573	1,559	(8,461)
	Time order	18	9	11	41	208	208
	Day short	10	10	10	144	4	186
	No short	317	317	380	14,901	739	1,781,746
	Time short	1	1	3	14	2	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
FEMR-T-	Average Inventory	3,940	4,362	2,796	2,307	4,634	(898)
	Time order	20	9	12	26	104	186
	Day short	12	14	27	51	7	55
	No short	2,422	2,797	4,685	7,235	18,331	688,029
	Time short	1	2	6	10	4	1
HEMX3I-	Average Inventory	1,283	1,612	1,171	1,083	2,365	(2,400)
	Time order	17	8	10	30	208	204
	Day short	6	6	8	14	-	64
	No short	437	437	300	719	-	672,199
	Time short	1	1	2	5	-	1
HEMX4I-	Average Inventory	261	285	177	180	322	(129)
	Time order	18	10	12	25	104	157
	Day short	12	11	16	52	7	65
	No short	205	189	200	616	1,263	67,276
	Time short	2	1	5	10	6	1
INTX1I0	Average Inventory	14,771	21,088	13,677	9,895	32,806	(19,993)
	Time order	18	8	11	41	208	95
	Day short	7	8	20	140	-	65
	No short	6,754	7,487	13,822	177,253	-	8,253,322
	Time short	1	2	5	13	-	1
LIPR1T-	Average Inventory	114,418	138,819	110,596	19,685,356	159,656	(2,142,057)
	Time order	18	9	10	66	208	208
	Day short	7	7	11	184	2	201
	No short	54,465	54,465	58,522	1,309,000,936	60,917	448,173,265
	Time short	1	1	2	19	2	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
LIPR2T-	Average Inventory	46,827	60,150	44,384	59,019	72,034	(591,987)
	Time order	17	9	10	48	208	208
	Day short	10	10	12	144	4	188
	No short	22,509	22,509	28,448	2,300,798	75,685	124,247,950
	Time short	1	1	2	13	2	1
LIPR3T-	Average Inventory	18,484	21,850	16,069	14,564	34,052	(61,107)
	Time order	17	9	11	32	208	199
	Day short	7	8	17	45	-	99
	No short	6,514	6,698	14,313	39,189	-	14,620,835
	Time short	1	2	5	9	-	1
MADI1T-	Average Inventory	53,851	69,190	51,205	24,750	71,525	(42,748)
	Time order	17	8	10	22	104	165
	Day short	9	10	12	22	9	65
	No short	19,452	20,442	27,642	47,872	376,428	17,976,798
	Time short	1	2	4	9	3	2
MADP-T-	Average Inventory	22,826	23,534	14,803	9,117	33,641	12,409
	Time order	18	10	12	17	104	126
	Day short	16	15	37	44	6	33
	No short	22,502	20,907	39,328	32,251	73,448	1,779,770
	Time short	2	3	9	14	6	1
MEFM-T-	Average Inventory	382,855	491,469	375,503	204,877	478,848	165,633
	Time order	18	9	10	20	104	148
	Day short	8	8	10	15	9	39
	No short	127,919	127,919	215,894	192,325	2,221,045	38,885,287
	Time short	1	1	2	6	4	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
MICC2F-	Average Inventory	300	425	257	253	550	(1,825)
	Time order	18	8	12	33	208	208
	Day short	11	11	28	108	-	202
	No short	148	148	411	2,828	-	382,763
	Time short	1	1	8	12	-	1
NASN-F1	Average Inventory	823	964	717	569	1,088	(1,100)
	Time order	17	9	11	25	104	167
	Day short	10	13	13	43	9	64
	No short	260	329	482	1,796	5,952	365,956
	Time short	1	3	4	10	4	1
NERT1C-	Average Inventory	39,374	53,412	38,073	28,891	78,767	(417,530)
	Time order	22	9	11	37	208	208
	Day short	17	9	15	126	-	196
	No short	31,094	17,284	32,998	348,620	-	87,491,872
	Time short	3	1	5	12	-	1
NERT3C-	Average Inventory	32,859	44,735	27,507	26,581	46,351	(36,840)
	Time order	19	9	11	23	104	169
	Day short	10	7	24	46	10	65
	No short	12,083	9,312	37,383	73,681	263,561	13,308,330
	Time short	2	1	6	11	3	1
NEXM1T-	Average Inventory	23,507	28,690	21,734	18,002	46,275	(88,356)
	Time order	17	9	10	34	208	205
	Day short	10	10	13	115	1	98
	No short	13,037	13,037	13,346	137,052	1,226	20,643,715
	Time short	1	1	3	11	1	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
NEXM2T-	Average Inventory	14,474	17,171	11,965	10,149	27,663	(42,110)
	Time order	18	10	11	29	208	195
	Day short	12	13	14	63	-	78
	No short	6,944	7,263	7,950	57,332	-	10,450,040
	Time short	1	2	3	7	-	1
NOLD-T-	Average Inventory	8,298	10,181	6,749	3,898	10,963	(2,402)
	Time order	17	9	11	22	104	155
	Day short	7	8	16	40	9	64
	No short	3,447	3,470	7,079	13,733	50,535	1,909,778
	Time short	1	2	5	12	4	1
NORV1T-	Average Inventory	26,460	32,087	23,585	17,595	32,168	(9,868)
	Time order	18	9	10	24	104	177
	Day short	10	10	17	21	7	64
	No short	13,975	13,975	24,124	23,633	112,792	5,914,282
	Time short	1	1	4	9	5	1
NORV2T-	Average Inventory	9,380	11,760	8,000	4,282	15,251	4,213
	Time order	17	9	11	18	104	136
	Day short	4	4	17	26	6	36
	No short	1,435	1,435	8,468	9,006	32,031	992,054
	Time short	1	1	5	10	6	1
PARI1T-	Average Inventory	30,836	47,270	30,411	22,984	59,894	(429,104)
	Time order	19	9	11	42	208	205
	Day short	10	10	24	124	4	171
	No short	10,827	10,827	41,007	626,929	24,320	90,789,742
	Time short	1	1	6	14	3	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
PARI-T-	Average Inventory	8,978	11,644	7,394	4,173	14,181	(70)
	Time order	19	9	11	20	104	155
	Day short	9	9	27	27	7	49
	No short	4,699	4,699	12,189	13,294	92,812	1,881,577
	Time short	1	1	9	12	3	1
PLAQ-T-	Average Inventory	24,815	30,500	18,225	12,490	27,212	14,766
	Time order	19	9	11	21	104	149
	Day short	12	10	20	32	5	28
	No short	12,800	12,139	20,583	38,438	72,576	1,176,834
	Time short	2	1	5	10	4	1
PLAV-T-	Average Inventory	58,024	68,667	54,644	5,041,036	81,248	(1,176,608)
	Time order	18	9	10	70	208	208
	Day short	9	9	11	181	2	202
	No short	24,821	24,821	31,723	1,539,341,683	25,645	246,146,801
	Time short	1	1	3	19	2	1
PLED1T-	Average Inventory	18,258	26,549	18,728	11,553	23,485	8,801
	Time order	19	8	11	21	104	163
	Day short	6	8	15	18	7	34
	No short	5,725	7,299	14,893	16,085	70,005	1,584,457
	Time short	1	2	3	6	5	1
PLED-T-	Average Inventory	33,391	38,421	27,787	15,060	35,751	9,793
	Time order	19	9	11	21	104	162
	Day short	10	10	13	21	6	38
	No short	14,271	15,240	12,542	17,898	124,620	3,040,813
	Time short	2	2	4	10	6	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
PLET-T-	Average Inventory	18,309	23,960	17,715	11,452	24,949	(2,483)
	Time order	17	9	10	22	104	166
	Day short	6	6	12	32	9	56
	No short	5,541	5,541	9,489	30,172	119,202	3,647,640
	Time short	1	1	2	11	3	1
PROS-T-	Average Inventory	11,168	16,441	10,341	7,455	14,137	(1,884)
	Time order	19	8	11	26	104	194
	Day short	6	6	22	38	6	56
	No short	2,660	2,660	14,835	21,835	38,661	1,974,092
	Time short	1	1	6	9	6	1
PRTX-W-	Average Inventory	17,480	24,357	16,633	10,255	29,446	(159,950)
	Time order	17	9	10	41	208	203
	Day short	9	9	11	154	2	161
	No short	7,896	7,896	6,855	211,718	7,149	34,202,812
	Time short	1	1	3	12	1	1
PRVF2T-	Average Inventory	14,909	19,437	14,489	11,222	27,497	(21,744)
	Time order	18	8	10	28	208	192
	Day short	8	8	11	56	-	65
	No short	5,960	5,960	8,596	37,169	-	6,413,575
	Time short	1	1	3	10	-	1
RECM-I-	Average Inventory	828	1,010	689	524	1,603	(3,937)
	Time order	18	9	11	37	208	206
	Day short	10	10	14	40	2	118
	No short	291	291	679	1,598	567	877,737
	Time short	1	1	5	10	2	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
REMC-I-	Average Inventory	35	44	12,761	10,039	64	(24)
	Time order	18	10	11	9	208	199
	Day short	8	9	5	70	-	111
	No short	19	19	7	130	-	7,395
	Time short	1	2	1	6	-	2
SALZ-T-	Average Inventory	55,065	70,024	46,719	24,126	91,083	(2,865)
	Time order	17	9	11	20	104	151
	Day short	4	5	18	38	5	57
	No short	8,623	9,334	47,002	94,015	173,264	9,551,772
	Time short	1	2	5	13	3	1
SERE3F-	Average Inventory	504	577	409	366	961	(1,078)
	Time order	17	9	10	29	208	180
	Day short	11	11	19	94	-	65
	No short	209	209	437	3,416	-	306,882
	Time short	1	1	5	9	-	1
SERT2F-	Average Inventory	487	605	433	306	648	(269)
	Time order	18	9	11	22	104	165
	Day short	9	9	17	23	11	65
	No short	218	218	351	511	2,971	135,550
	Time short	1	1	6	5	3	1
SIGL2T-	Average Inventory	13,552	16,247	9,958	7,473	18,748	(19,250)
	Time order	17	9	11	24	104	169
	Day short	6	9	28	43	9	65
	No short	4,581	5,600	18,770	19,364	100,930	6,321,834
	Time short	1	2	9	7	3	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
SIMV-T-	Average Inventory	283,084	351,616	254,065	169,021	457,118	200,188
	Time order	18	9	11	17	104	125
	Day short	8	8	15	23	5	28
	No short	100,055	100,055	211,730	223,438	821,630	18,758,958
	Time short	1	1	5	9	5	1
SPIR-C-	Average Inventory	6,878	8,584	6,293	4,400	9,684	(1,273)
	Time order	17	9	10	22	104	158
	Day short	11	12	17	40	7	64
	No short	4,340	4,731	4,368	13,463	45,070	1,499,594
	Time short	1	2	5	11	4	1
SUPL1T-	Average Inventory	24,217	32,440	23,013	19,591	51,809	(15,704)
	Time order	17	8	11	31	208	136
	Day short	7	7	14	18	-	65
	No short	9,487	9,487	16,835	22,129	-	8,124,150
	Time short	1	1	6	5	-	1
SYBC2F1	Average Inventory	234	243	167	107	607	156
	Time order	16	9	10	18	208	125
	Day short	8	11	20	38	-	27
	No short	77	95	182	332	-	12,645
	Time short	1	2	5	11	-	1
TACV1T-	Average Inventory	682	805	466	458	1,161	(3,419)
	Time order	16	9	11	46	208	205
	Day short	5	5	24	179	3	144
	No short	83	83	704	88,180	2,025	751,401
	Time short	1	1	6	14	2	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
TAXL1I0	Average Inventory	9,700	10,475	6,385	54,972	15,237	(16,277)
	Time order	16	9	11	55	208	104
	Day short	9	10	28	164	-	96
	No short	4,248	5,105	7,747	25,544,205	-	4,887,089
	Time short	1	2	7	13	-	1
TOPX3T-	Average Inventory	5,254	7,791	4,804	2,486	9,885	5,653
	Time order	17	9	12	17	104	117
	Day short	11	11	20	51	4	21
	No short	1,462	1,462	7,941	11,853	12,663	175,017
	Time short	1	1	6	15	2	1
VYTO1T-	Average Inventory	7,336	8,328	5,977	3,005	9,786	(1,419)
	Time order	17	9	11	20	104	149
	Day short	5	6	12	35	9	65
	No short	2,670	2,937	3,040	8,606	45,324	1,547,665
	Time short	1	2	3	12	3	1
XALT-Y-	Average Inventory	892	1,200	819	631	1,466	(879)
	Time order	17	8	11	24	104	162
	Day short	7	7	10	40	11	65
	No short	213	213	436	1,638	7,499	363,020
	Time short	1	1	3	11	5	1
XATX-T-	Average Inventory	29,891	36,816	25,874	24,142	58,454	(76,156)
	Time order	17	9	11	30	208	192
	Day short	10	13	17	34	-	67
	No short	18,011	23,169	18,420	47,449	-	19,775,235
	Time short	1	2	4	7	-	1

Table B4 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
ZAND-T-	Average Inventory	12,766	17,353	9,668	7,580	22,598	10,355
	Time order	16	8	11	15	104	119
	Day short	11	11	34	24	8	28
	No short	3,431	3,431	24,579	14,866	61,051	819,403
	Time short	1	1	8	7	4	1
ZOLL-I-	Average Inventory	13	18	12	9	1,390	(105)
	Time order	18	9	10	20	208	101
	Day short	6	6	25	52	2	53
	No short	5	5	17	41	4,043	105,745
	Time short	1	1	7	10	1	1
ZOMT-I-	Average Inventory	77	84	57	51	142	(240)
	Time order	18	10	11	30	208	187
	Day short	10	12	24	32	1	124
	No short	30	36	72	95	8	56,637
	Time short	1	3	7	8	1	1
ZYRT-T-	Average Inventory	30,271	34,501	25,673	15,270	51,642	9,997
	Time order	17	9	11	18	104	133
	Day short	10	10	11	31	7	42
	No short	12,828	12,828	7,344	34,273	153,517	4,257,939
	Time short	1	1	2	12	5	1

Table B5 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 2 (No trend, normal and lumpy demand)

Drug Code	KPI	Min/Max	M1	M4	M5	P	Q
ALMT-I-	Average Inventory	22	26	7,328	31	43	(29)
	Time order	17	10	11	138	208	168
	Day short	12	11	3	-	1	68
	No short	8	7	3	-	17	9,434
	Time short	2	1	1	-	1	3
CAEL-I-	Average Inventory	18	21	5,859	25	40	13
	Time order	21	10	11	78	208	109
	Day short	15	12	7	-	-	36
	No short	10	9	5	-	-	1,640
	Time short	2	2	1	-	-	1
DINH1I1	Average Inventory	214	268	77,513	359	359	128
	Time order	17	10	10	107	104	128
	Day short	11	14	4	-	4	55
	No short	88	97	36	-	792	18,488
	Time short	1	2	1	-	2	2
ENBL-I-	Average Inventory	125	139	40,960	110	139	(25)
	Time order	19	10	11	100	104	186
	Day short	12	9	4	-	4	71
	No short	54	47	21	-	228	17,895
	Time short	2	1	1	-	2	2
EPRX4I-	Average Inventory	150	184	56,321	151	190	72
	Time order	19	10	10	99	104	160
	Day short	6	4	3	-	4	37
	No short	50	32	16	-	652	10,019
	Time short	2	1	1	-	2	1

Table B5 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 2 (No trend, normal and lumpy demand) (cont.)

Drug Code	KPI	Min/Max	M1	M4	M5	P	Q
EPRX5I-	Average Inventory	192	254	79,420	211	291	(29)
	Time order	20	10	10	100	104	159
	Day short	19	11	5	3	8	55
	No short	175	109	44	115	1,443	42,415
	Time short	4	1	1	3	4	1
ERBI-I-	Average Inventory	67	85	24,841	100	165	(202)
	Time order	19	9	11	135	208	167
	Day short	26	5	6	-	-	66
	No short	75	5	11	-	-	55,531
	Time short	4	1	1	-	-	1
EUTP-I-	Average Inventory	515	490	144,592	524	594	199
	Time order	19	11	11	98	104	151
	Day short	12	12	5	-	5	36
	No short	350	385	85	-	2,599	40,678
	Time short	2	2	1	-	1	1
FORE-I-	Average Inventory	43	51	15,503	62	70	(21)
	Time order	18	10	10	151	208	179
	Day short	10	10	5	-	-	62
	No short	16	16	8	-	-	9,356
	Time short	1	1	1	-	-	2
GLIV-T-	Average Inventory	4,034	4,904	1,424,289	4,678	6,933	(55,818)
	Time order	17	10	10	151	208	208
	Day short	8	8	4	-	4	199
	No short	1,633	1,633	654	-	11,526	11,690,979
	Time short	1	1	1	-	2	1

Table B5 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 2 (No trend, normal and lumpy demand) (cont.)

Drug Code	KPI	Min/Max	M1	M4	M5	P	Q
IRES-T-	Average Inventory	290	317	97,248	275	373	154
	Time order	17	10	10	87	104	154
	Day short	9	11	2	-	4	42
	No short	81	97	17	-	435	10,258
	Time short	1	2	1	-	2	3
NEXV-T-	Average Inventory	838	863	273,667	1,173	1,443	(3,083)
	Time order	19	11	10	119	208	184
	Day short	6	13	6	-	1	159
	No short	250	397	154	-	70	676,805
	Time short	1	3	1	-	1	3
REMN4C-	Average Inventory	2,502	2,605	836,898	2,946	3,740	765
	Time order	17	11	11	104	104	137
	Day short	7	19	4	-	4	50
	No short	1,004	2,044	424	-	7,658	263,339
	Time short	1	5	1	-	1	1
SPRY1T-	Average Inventory	264	331	107,172	348	2,658	234
	Time order	20	10	10	109	208	108
	Day short	13	11	4	-	2	53
	No short	164	155	54	-	4,688	176,039
	Time short	3	1	1	-	1	1
STLV1T-	Average Inventory	8,986	9,551	3,008,745	8,641	14,087	2,757
	Time order	17	10	10	57	104	145
	Day short	9	10	4	-	5	49
	No short	4,925	5,135	1,726	-	35,920	967,421
	Time short	1	2	1	-	3	1

Table B5 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 2 (No trend, normal and lumpy demand) (cont.)

Drug Code	KPI	Min/Max	M1	M4	M5	P	Q
SUTN-C-	Average Inventory	469	526	156,805	680	971	223
	Time order	19	10	10	99	208	155
	Day short	12	14	4	-	-	61
	No short	172	186	54	-	-	26,000
	Time short	1	2	1	-	-	2
TACV-T-	Average Inventory	187	226	68,294	198	382	(130)
	Time order	18	11	10	85	104	133
	Day short	10	10	5	2	7	63
	No short	64	64	35	26	1,366	73,473
	Time short	1	1	1	-	3	1
TASN-C-	Average Inventory	1,093	1,239	393,463	1,385	2,185	(1,179)
	Time order	17	10	10	77	208	141
	Day short	11	17	5	1	-	65
	No short	380	734	204	23	-	440,597
	Time short	1	3	1	-	-	1
TAXT1I-	Average Inventory	43	51	15,645	55	687	(170)
	Time order	17	10	10	93	104	116
	Day short	10	11	6	-	3	53
	No short	27	27	9	-	5,804	114,500
	Time short	1	2	1	-	3	1
TAXT2I-	Average Inventory	37	42	12,664	49	73	(85)
	Time order	16	9	10	170	208	177
	Day short	10	10	6	-	2	68
	No short	15	15	7	-	9	23,470
	Time short	1	1	1	-	2	1

Table B5 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 2 (No trend, normal and lumpy demand) (cont.)

Drug Code	KPI	Min/Max	M1	M4	M5	P	Q
TEMD2C-	Average Inventory	80	98	29,639	121	162	77
	Time order	20	10	10	105	208	138
	Day short	11	9	5	-	-	16
	No short	48	56	13	-	-	605
	Time short	2	2	1	-	-	-
THAL-C-	Average Inventory	1,463	1,393	424,566	1,191	1,346	156
	Time order	22	11	10	97	104	184
	Day short	18	10	2	-	3	84
	No short	1,507	743	74	-	903	77,487
	Time short	3	1	1	-	3	2
VELC1I-	Average Inventory	34	44	13,114	48	291	89
	Time order	22	10	11	47	208	91
	Day short	15	13	3	-	2	48
	No short	25	17	4	-	440	6,498
	Time short	2	1	1	-	2	1
XOLR-I-	Average Inventory	26	28	9,085	25	42	(17)
	Time order	18	11	10	94	104	146
	Day short	12	12	2	-	9	66
	No short	10	10	1	-	179	8,783
	Time short	1	1	1	-	5	1

Table B6 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 3 (Trend and normal demand)

Drug Code	KPI	Min/Max	M6	P	Q
AMLP1T-	Average Inventory	141,465	117,457	176,841	(9,331)
	Time order	16	13	104	151
	Day short	10	11	8	57
	No short	49,287	59,060	961,263	25,587,389
	Time short	1	1	5	1
CADX-T-	Average Inventory	36,275	29,119	62,346	(61,858)
	Time order	16	13	208	182
	Day short	10	8	2	64
	No short	12,976	10,671	5,997	18,140,218
	Time short	1	1	1	1
COZA-T-	Average Inventory	27,620	32,921	28,914	1,253
	Time order	19	12	104	187
	Day short	13	11	6	48
	No short	17,783	18,158	80,631	3,306,928
	Time short	2	1	6	1
CRES1T-	Average Inventory	84,405	81,321	139,617	(1,449,977)
	Time order	18	12	208	208
	Day short	7	9	2	193
	No short	26,882	25,282	71,109	303,836,482
	Time short	1	1	2	1
EZET-T-	Average Inventory	34,976	28,201	54,587	(211,286)
	Time order	16	13	208	206
	Day short	7	11	2	122
	No short	12,890	13,890	2,599	46,757,639
	Time short	1	1	2	1
MADI2T-	Average Inventory	27,509	25,256	35,629	(7,143)
	Time order	17	13	104	155
	Day short	9	8	8	64
	No short	9,749	6,648	192,045	6,139,751
	Time short	1	1	4	1

Table B6 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 3 (Trend and normal demand) (cont.)

Drug Code	KPI	Min/Max	M6	P	Q
OLMT-T-	Average Inventory	13,575	11,717	24,161	5,187
	Time order	17	15	104	128
	Day short	6	3	7	43
	No short	5,194	779	61,577	1,888,826
	Time short	1	1	5	1
PRVF1T-	Average Inventory	14,839	11,734	18,907	(7,841)
	Time order	17	15	104	151
	Day short	10	-	9	64
	No short	6,307	-	94,622	4,107,860
	Time short	1	-	3	1
SERC1T-	Average Inventory	49,381	43,874	66,799	(2,865)
	Time order	17	13	104	151
	Day short	4	5	11	57
	No short	9,796	13,264	362,119	9,551,772
	Time short	1	1	3	1
SERQ1T-	Average Inventory	12,034	9,326	14,321	(4,137)
	Time order	16	14	104	149
	Day short	9	-	7	64
	No short	5,544	-	60,922	2,729,643
	Time short	1	-	5	1
ULTR-T-	Average Inventory	34,578	29,171	42,426	(43,390)
	Time order	16	14	104	167
	Day short	8	9	8	65
	No short	6,212	13,437	197,284	14,241,101
	Time short	1	1	4	1
VYTO-T-	Average Inventory	7,690	6,134	1,466	852
	Time order	17	15	104	141
	Day short	10	-	11	54
	No short	3,389	-	7,499	1,154,127
	Time short	1	-	5	1

Table B6 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 3 (Trend and normal demand) (cont.)

Drug Code	KPI	Min/Max	M6	P	Q
XELD2T-	Average Inventory	5,506	4,460	15,084	(18,400)
	Time order	17	13	208	177
	Day short	9	-	2	65
	No short	3,048	-	14,614	5,101,977
	Time short	1	-	1	1
ZOLO-T-	Average Inventory	16,889	20,688	29,083	(23,121)
	Time order	19	13	208	206
	Day short	7	7	-	162
	No short	5,945	8,213	-	5,244,250
	Time short	1	1	-	2

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand)

Drug Code	KPI	Min/Max	M5	P	Q
ACLS-I-	Average Inventory	42	57	89	(80)
	Time order	16	131	182	147
	Day short	8	-	1	64
	No short	11	-	2	24,808
	Time short	1	-	1	1
ALMT1I-	Average Inventory	57	91	137	(129)
	Time order	18	97	208	107
	Day short	8	-	1	64
	No short	31	-	15	23,350
	Time short	1	-	1	1

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
ARIP1T-	Average Inventory	3,456	3,831	4,116	(3,078)
	Time order	16	134	104	160
	Day short	8	-	8	64
	No short	1,303	-	20,489	1,164,724
	Time short	1	-	5	1
ARTD-C-	Average Inventory	30,862	42,521	58,285	(170,053)
	Time order	24	156	208	208
	Day short	31	-	3	173
	No short	83,817	-	5,946	36,150,024
	Time short	4	-	2	1
AVAT-I-	Average Inventory	46	64	91	(99)
	Time order	16	143	208	159
	Day short	8	-	-	72
	No short	28	-	-	27,891
	Time short	1	-	-	1
AVOD-C-	Average Inventory	15,560	22,852	32,967	(25,736)
	Time order	16	102	208	120
	Day short	8	-	-	64
	No short	4,794	-	-	8,609,345
	Time short	1	-	-	1
CAMP2I-	Average Inventory	34	41	54	(41)
	Time order	16	118	104	133
	Day short	11	-	10	65
	No short	24	-	355	15,517
	Time short	1	-	4	1
CASD1T-	Average Inventory	522	827	1,013	156
	Time order	18	105	104	120
	Day short	11	-	6	53
	No short	295	-	2,409	79,292
	Time short	2	-	2	1

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
CASD-T-	Average Inventory	2,689	3,602	4,734	(4,354)
	Time order	17	151	208	169
	Day short	7	-	1	66
	No short	925	-	87	1,293,768
	Time short	1	-	1	1
CLEX2I-	Average Inventory	1,190	1,475	1,491	570
	Time order	15	109	71	115
	Day short	10	-	9	39
	No short	669	-	7,363	94,470
	Time short	1	-	5	2
COCT2T-	Average Inventory	2,566	3,556	4,642	661
	Time order	16	121	104	117
	Day short	12	-	10	49
	No short	1,447	-	19,365	427,619
	Time short	1	-	4	1
CONC1T-	Average Inventory	39,687	55,089	63,752	3,757
	Time order	17	137	104	128
	Day short	9	-	7	54
	No short	16,714	-	186,155	6,714,828
	Time short	2	-	5	1
CRES2T-	Average Inventory	18,284	24,266	33,465	(69,166)
	Time order	17	183	208	185
	Day short	10	-	-	99
	No short	9,791	-	-	16,448,814
	Time short	1	-	-	1
DALC-I2	Average Inventory	762	1,304	1,682	(211)
	Time order	17	119	208	96
	Day short	13	-	-	64
	No short	287	-	-	217,357
	Time short	1	-	-	1

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
DORB-I-	Average Inventory	341	451	482	228
	Time order	21	70	104	88
	Day short	11	-	6	44
	No short	157	-	908	18,284
	Time short	3	-	4	2
EBIX-T-	Average Inventory	8,981	11,465	15,741	(15,514)
	Time order	16	159	208	171
	Day short	10	-	2	64
	No short	3,711	-	6,340	4,528,251
	Time short	1	-	2	1
ELOX-I-	Average Inventory	58	80	122	(214)
	Time order	16	146	208	138
	Day short	9	-	-	100
	No short	29	-	-	53,928
	Time short	1	-	-	1
ENAN1I-	Average Inventory	34	28	40	(12)
	Time order	16	98	104	145
	Day short	2	-	10	64
	No short	4	-	146	7,805
	Time short	1	-	3	1
ENBL1I-	Average Inventory	116	151	174	(725)
	Time order	19	151	208	194
	Day short	7	-	-	169
	No short	42	-	-	155,574
	Time short	1	-	-	3
EXEL2X-	Average Inventory	2,812	2,520	4,017	(293)
	Time order	17	84	104	135
	Day short	5	-	7	64
	No short	488	-	13,476	555,775
	Time short	1	-	6	1

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
EXFG1T-	Average Inventory	9,214	11,319	14,683	2,380
	Time order	16	82	104	99
	Day short	11	2	8	55
	No short	4,786	4,606	35,796	1,328,875
	Time short	1	2	4	1
EXJA-T-	Average Inventory	1,522	1,525	2,740	(2,225)
	Time order	18	98	208	169
	Day short	9	1	-	65
	No short	416	212	-	686,978
	Time short	2	1	-	2
FOSP-T-	Average Inventory	2,462	3,518	4,281	(4,993)
	Time order	16	148	208	143
	Day short	10	-	1	72
	No short	1,026	-	9	1,414,594
	Time short	1	-	1	3
GEMC1I-	Average Inventory	137	303	197	(102)
	Time order	21	110	208	88
	Day short	23	-	-	56
	No short	104	-	-	16,781
	Time short	4	-	-	1
GEMZ2I-	Average Inventory	56	48	49	21
	Time order	16	103	104	147
	Day short	10	3	5	40
	No short	33	22	27	2,350
	Time short	1	3	5	2
HARN1T-	Average Inventory	24,049	33,725	46,474	(76,351)
	Time order	16	146	208	141
	Day short	6	-	2	85
	No short	5,477	-	5,993	19,637,400
	Time short	1	-	2	3

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
HECT-I-	Average Inventory	14	24	35	(113)
	Time order	24	120	208	169
	Day short	55	-	2	123
	No short	75	-	11	25,711
	Time short	5	-	1	1
INVZ-I-	Average Inventory	310	407	640	(608)
	Time order	16	98	208	126
	Day short	12	1	-	65
	No short	204	7	-	188,794
	Time short	1	1	-	1
JANU-T-	Average Inventory	16,641	22,191	28,015	(36,309)
	Time order	15	155	208	130
	Day short	9	-	-	64
	No short	4,057	-	-	10,296,761
	Time short	2	-	-	1
KEPP2T-	Average Inventory	11,453	10,393	15,721	(14,973)
	Time order	16	98	104	142
	Day short	13	1	9	64
	No short	6,583	13	89,122	5,168,121
	Time short	2	1	4	1
HARN1T-	Average Inventory	24,049	33,725	46,474	(76,351)
	Time order	16	146	208	141
	Day short	6	-	2	85
	No short	5,477	-	5,993	19,637,400
	Time short	1	-	2	3
LANO-I-	Average Inventory	863	724	1,121	(1,499)
	Time order	17	98	104	157
	Day short	8	-	10	65
	No short	278	-	6,745	444,231
	Time short	1	-	2	1

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
LEXP-T-	Average Inventory	9,107	7,869	11,527	(2,474)
	Time order	17	98	104	152
	Day short	10	-	10	64
	No short	4,596	-	57,261	2,038,666
	Time short	1	-	4	1
LOST-T-	Average Inventory	67,066	83,361	107,365	56,605
	Time order	15	73	104	84
	Day short	13	1	6	29
	No short	34,453	14,077	174,344	3,397,728
	Time short	1	1	6	1
LUCT-I-	Average Inventory	13	18	29	42
	Time order	18	113	208	22
	Day short	13	-	2	2
	No short	9	-	10	16
	Time short	1	-	2	2
LYRC1C-	Average Inventory	4,455	5,524	7,759	(812)
	Time order	16	98	104	131
	Day short	7	-	8	64
	No short	1,184	-	24,593	1,040,700
	Time short	1	-	4	1
LUCT-I-	Average Inventory	13	18	29	42
	Time order	18	113	208	22
	Day short	13	-	2	2
	No short	9	-	10	16
	Time short	1	-	2	2
LYRC1C-	Average Inventory	4,455	5,524	7,759	(812)
	Time order	16	98	104	131
	Day short	7	-	8	64
	No short	1,184	-	24,593	1,040,700
	Time short	1	-	4	1

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
LYRC-C-	Average Inventory	23,380	31,306	42,805	(98,739)
	Time order	16	168	208	167
	Day short	8	-	2	98
	No short	13,775	-	2,997	23,507,806
	Time short	1	-	2	1
MATR2I-	Average Inventory	17	25	36	(32)
	Time order	15	121	208	124
	Day short	10	-	1	65
	No short	9	-	2	10,218
	Time short	1	-	1	1
MAXM-I-	Average Inventory	867	1,066	1,439	(2,279)
	Time order	18	99	104	111
	Day short	14	4	9	100
	No short	516	725	6,351	615,057
	Time short	1	4	3	2
MERN2I-	Average Inventory	963	1,275	1,758	(4,962)
	Time order	16	82	104	106
	Day short	12	3	8	95
	No short	614	989	4,505	1,189,313
	Time short	1	3	6	1
MICD1T-	Average Inventory	13,820	12,939	21,824	7,257
	Time order	16	66	104	119
	Day short	10	1	7	38
	No short	4,745	879	66,287	1,361,403
	Time short	1	1	5	1
MUCT-T-	Average Inventory	40,230	42,580	54,950	426
	Time order	14	100	104	116
	Day short	10	-	6	62
	No short	7,276	-	77,985	6,493,428
	Time short	1	-	4	1

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
NCLO-T-	Average Inventory	3,079	3,063	4,886	(3,708)
	Time order	17	85	104	139
	Day short	12	-	9	64
	No short	1,476	-	24,604	1,406,611
	Time short	1	-	3	1
OXAL-I-	Average Inventory	70	63	150	(260)
	Time order	16	86	104	121
	Day short	14	2	13	68
	No short	45	57	1,199	71,640
	Time short	1	2	1	1
PIOG-T-	Average Inventory	16,393	14,741	23,257	16,637
	Time order	17	40	104	93
	Day short	10	-	-	-
	No short	5,511	-	-	-
	Time short	1	-	-	-
PLET1T-	Average Inventory	7,470	8,388	12,620	(3,249)
	Time order	16	97	104	128
	Day short	9	-	8	63
	No short	2,063	-	45,887	2,092,262
	Time short	1	-	4	1
RECM2I-	Average Inventory	39	60	62	14
	Time order	19	100	104	140
	Day short	6	-	10	47
	No short	19	-	217	5,659
	Time short	1	-	4	1
SAIZ-I-	Average Inventory	65	66	104	27,782
	Time order	17	93	104	142
	Day short	8	-	7	37
	No short	21	-	348	4,983,468
	Time short	2	-	3	1

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
SERM1T-	Average Inventory	33,936	27,955	41,241	(47,588)
	Time order	16	98	104	150
	Day short	8	1	8	64
	No short	8,344	589	217,723	15,256,207
	Time short	2	1	4	1
SUPR1I-	Average Inventory	764	772	2,160	(2,239)
	Time order	18	60	208	101
	Day short	12	-	1	65
	No short	341	-	22	658,291
	Time short	1	-	1	1
TAZC-I-	Average Inventory	1,708	1,606	2,854	(6,281)
	Time order	16	96	208	108
	Day short	12	4	-	82
	No short	1,122	1,046	-	1,570,743
	Time short	1	4	-	1
TELF2T-	Average Inventory	22,535	24,410	24,563	11,934
	Time order	17	103	104	153
	Day short	8	-	-	44
	No short	3,922	-	-	874,675
	Time short	1	-	-	1
TIEN-I-	Average Inventory	1,038	822	975	(878)
	Time order	19	85	104	112
	Day short	10	3	6	93
	No short	622	1,269	1,894	290,635
	Time short	2	3	5	2
TYGC-I-	Average Inventory	432	555	729	(412)
	Time order	17	95	208	102
	Day short	5	-	1	83
	No short	110	-	7	167,771
	Time short	1	-	1	2

Table B7 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking average inventory in drug category AE group 4 (Not normal demand) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
VFEN2T-	Average Inventory	594	846	1,311	(1,387)
	Time order	16	131	208	159
	Day short	6	-	1	64
	No short	135	-	388	395,349
	Time short	1	-	1	1
VIAT-W-	Average Inventory	143,202	161,623	246,465	(3,028,167)
	Time order	23	155	208	208
	Day short	30	-	4	199
	No short	375,674	-	222,547	633,853,668
	Time short	4	-	2	1
VISL-Y-	Average Inventory	1,965	2,708	3,830	(4,231)
	Time order	17	172	208	177
	Day short	10	-	-	65
	No short	842	-	-	1,183,399
	Time short	1	-	-	1

Table B8 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AN group 1 (No trend, normal and static demand)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
CALT2T-	Average Inventory	460,368	618,838	447,379	224,325	894,158	(234,031)
	Time order	17	8	11	21	186	160
	Day short	9	9	11	22	3	64
	No short	212,268	212,268	187,128	363,495	82,953	127,227,464
	Time short	1	1	4	9	2	1

Table B8 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AN group 1 (No trend, normal and static demand) (cont.)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
GLSM-W-	Average Inventory	22,500	30,226	18,833	15,441	56,567	73,863
	Time order	18	9	11	25	61	28
	Day short	10	10	27	60	9	4
	No short	12,546	12,546	28,722	72,955	285,877	51,696
	Time short	1	1	8	10	6	1

Table B9 The results of comparison among Current Min/Max Inventory Policy, Developed Inventory Policies and Inventory Policies from Theory; P-System and Q-System considered by Pairwise Ranking in drug category AN group 4 (No normal demand)

Drug Code	KPI	Min/Max	M5	P	Q
NEBD-I-	Average Inventory	69	15,132	66	57
	Time order	17	9	52	124
	Day short	10	70	13	21
	No short	45	251	584	1,228
	Time short	1	8	5	2
VTBZ-T-	Average Inventory	526,277	105,806,544	643,816	251,482
	Time order	19	9	185	161
	Day short	7	96	-	41
	No short	159,003	2,294,057	-	18,602,365
	Time short	1	9	-	3

APPENDIX C
TOTAL INVENTORY COSTS
FROM DIFFERENT INVENTORY POLICIES

Table B10 The total inventory costs of high consumption value and vital drugs (AV) with no trend, normally distributed and static demand (drug group 1)

Drug Code	KPI	Min/Max	M1	M2	M3	P	Q
HEPS-T-	HC	776,887.24	854,436.63	569,349.48	401,959.95	1,235,407.25	406,656.35
	OC	144.38	57.75	63.53	150.15	964.43	1,039.50
	SC	1,525,089.85	410,047.38	779,869.64	1,091,635.29	418,002.00	191,806,299.00
	TC	2,302,121.47	**1,264,541.76**	1,349,282.65	1,493,745.39	1,654,373.67	192,213,994.85
MYFT2C-	HC	530,787.58	752,320.16	419,033.90	333,609.56	969,632.72	541,428.95
	OC	132.83	51.98	69.30	138.60	1,004.85	935.55
	SC	497,006.44	275,162.22	942,050.62	1,051,507.28	1,068,692.00	226,124,220.13
	TC	1,027,926.85	**1,027,534.36**	1,361,153.82	1,385,255.44	2,039,329.57	226,666,584.63
PEGS-I-	HC	1,130,483.65	1,488,798.06	920,239.55	727,871.82	2,378,943.49	6,707,075.74
	OC	167.48	57.75	63.53	207.90	1,201.20	1,114.58
	SC	2,423,653.51	493,904.99	1,633,383.04	6,867,898.98	63,815,268.00	1,513,852,693.32
	TC	3,554,304.64	**1,982,760.80**	2,553,686.12	7,595,978.70	66,195,412.69	1,520,560,883.63
RAPM-T-	HC	626,440.67	812,707.61	508,449.10	367,234.57	904,425.03	186,568.09
	OC	121.28	51.98	63.53	144.38	929.78	1,010.63
	SC	394,727.43	262,982.81	128,970.84	2,197,429.56	664,979.00	59,540,122.02
	TC	1,021,289.38	1,075,742.40	**637,483.47**	2,564,808.51	1,570,333.81	59,727,700.74
SADN1C-	HC	1,736,784.45	2,187,792.45	1,474,199.55	1,114,891.20	2,565,891.60	10,747,236.65
	OC	144.38	46.20	57.75	236.78	1,051.05	1,201.20
	SC	3,544,710.75	438,315.30	1,243,081.80	12,615,840.00	2,270,970.00	2,316,559,439.43
	TC	5,281,639.58	**2,626,153.95**	2,717,339.10	13,730,967.98	4,837,912.65	2,327,307,877.28
VIRE-T-	HC	385,714.80	499,920.75	295,403.40	148,528.35	549,347.51	170,525.87
	OC	155.93	51.98	63.53	115.50	1,039.50	820.05
	SC	1,282,445.10	217,009.80	415,857.15	761,793.75	137,970.00	42,410,917.10
	TC	1,668,315.83	716,982.53	711,324.08	910,437.60	**688,357.01**	42,582,263.02
ZEFF-T-	HC	340,201.32	513,242.00	296,369.56	198,169.76	522,398.51	285,339.43
	OC	132.83	51.98	63.53	115.50	1,027.95	814.28
	SC	373,799.56	139,820.60	542,199.08	710,229.72	203,232.00	17,998,706.88
	TC	714,133.71	**653,114.58**	838,632.17	908,514.98	726,658.46	18,284,860.59

Table B11 The total inventory costs of high consumption value and vital drugs (AV) with no trend, normally distributed and lumpy demand (drug group 2)

Drug Code	KPI	Min/Max	M1	M4	M5	P	Q
AMBS-I-	HC	1,302,035.34	1,489,002.44	2,355,696,850.00	1,810,390.91	3,058,648.42	5,475,114.15
	OC	98.18	69.30	63.53	381.15	329.18	571.73
	SC	7,262,741.43	1,379,037.43	53,166.00	-	3,402,624.00	605,183,462.60
	TC	8,564,874.95	2,868,109.17	2,355,750,079.53	**1,810,772.06**	6,461,601.59	610,659,148.47
PEGR2I-	HC	502,103.06	480,971.02	139,585,519.12	698,572.55	917,333.03	372,290.15
	OC	144.38	69.30	63.53	762.30	756.53	825.83
	SC	829,794.42	200,754.38	99,436.38	-	231,584.00	21,175,405.10
	TC	1,332,041.86	**681,794.70**	139,685,019.03	699,334.85	1,149,673.56	21,548,521.08
TRUV-T-	HC	24,171.00	31,951.50	9,104,421.90	39,343.47	53,488.67	77,608.23
	OC	115.50	69.30	63.53	386.93	369.60	98.18
	SC	62,057.10	8,619.10	1,899.10	-	26,810.00	11,060.21
	TC	86,343.60	40,639.90	9,106,384.53	**39,730.39**	80,668.27	88,766.61

Table B12 The total inventory costs of high consumption value and vital drugs (AV) with not normally distributed demand (drug group 4)

Drug Code	KPI	Min/Max	M5	P	Q
ALBK-I-	HC	1,496,469.64	1,831,385.34	2,918,576.11	11,445,648.82
	OC	144.38	669.90	721.88	635.25
	SC	3,743,575.82	-	284,740.00	2,699,484,875.90
	TC	5,240,189.84	**1,832,055.24**	3,204,037.99	2,710,931,159.97
ALPI-I-	HC	35,277.90	214,699.39	1,172,095.41	91,539.25
	OC	98.18	623.70	369.60	577.50
	SC	407,231.30	22,470.00	10,920,420.00	145,895,797.57
	TC	442,607.38	**237,793.09**	12,092,885.01	145,987,914.31
ALUV-T-	HC	367,176.71	511,342.00	704,427.91	173,710.03
	OC	103.95	565.95	612.15	606.38
	SC	1,006,772.43	-	194,804.00	88,656,736.48
	TC	1,374,053.09	**511,907.95**	899,844.06	88,831,052.88
BARA1T-	HC	438,398.40	603,046.33	723,890.00	249,279.05
	OC	138.60	941.33	958.65	848.93
	SC	263,055.76	-	465,652.00	42,322,549.17
	TC	701,592.76	**603,987.66**	1,190,500.65	42,572,677.15
BARA-T-	HC	1,259,313.30	1,150,932.64	1,774,422.26	3,335,403.57
	OC	150.15	906.68	924.00	1,022.18
	SC	2,435,574.78	-	1,576,944.00	865,162,642.40
	TC	3,695,038.23	**1,151,839.32**	3,352,290.26	868,499,068.15

Table B12 The total inventory costs of high consumption value and vital drugs (AV) with not normally distributed demand (drug group 4) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
CELC-C-	HC	3,475,406.34	4,246,491.02	6,511,216.09	75,928,807.55
	OC	132.83	1,022.18	1,056.83	1,201.20
	SC	3,428,112.87	-	6,482,385.00	15,907,827,698.82
	TC	6,903,652.04	**4,247,513.19**	12,994,657.92	15,983,757,707.57
GAMR1I-	HC	1,948,180.04	2,181,117.26	3,413,804.05	9,527,168.51
	OC	138.60	814.28	820.05	970.20
	SC	4,253,339.86	-	2,640,239.00	2,297,641,603.63
	TC	6,201,658.50	**2,181,931.53**	6,054,863.10	2,307,169,742.33
MYFT1C-	HC	317,389.68	390,025.41	553,545.82	98,418.43
	OC	144.38	837.38	906.68	739.20
	SC	1,039,280.43	-	92,682.00	53,211,494.05
	TC	1,356,814.49	**390,862.78**	647,134.49	53,310,651.68
NEUT1I-	HC	951,795.08	1,145,423.30	1,935,640.38	5,595,428.99
	OC	138.60	1,016.40	1,051.05	808.50
	SC	1,704,857.51	-	2,241,410.00	1,363,302,828.42
	TC	2,656,791.19	**1,146,439.70**	4,178,101.43	1,368,899,065.91
NOSV-I-	HC	362,277.51	939,328.10	1,265,881.39	2,165,354.70
	OC	103.95	571.73	456.23	716.10
	SC	1,798,644.12	-	4,837,302.00	598,154,185.55
	TC	2,161,025.58	**939,899.82**	6,103,639.62	600,320,256.35
PEGL-I-	HC	378,713.16	616,653.82	694,961.66	224,266.12
	OC	132.83	646.80	490.88	773.85
	SC	1,070,996.40	-	3,036,330.00	132,015,582.30
	TC	1,449,842.39	**617,300.62**	3,731,782.53	132,240,622.27
PRGF1C-	HC	1,989,026.55	1,928,363.98	2,774,198.97	7,203,899.18
	OC	138.60	952.88	1,033.73	1,051.05
	SC	4,582,584.45	31,320.00	2,784,240.00	1,783,718,775.00
	TC	6,571,749.60	**1,960,636.86**	5,559,472.70	1,790,923,725.24
PRGF3C-	HC	369,512.85	401,574.44	548,436.31	11,307.45
	OC	127.05	981.75	1,045.28	716.10
	SC	373,369.55	-	212,185.50	76,786,523.64
	TC	743,009.45	**402,556.19**	761,667.08	76,798,547.19
SADN2C-	HC	650,698.20	754,486.15	1,163,986.79	1,119,281.98
	OC	144.38	975.98	993.30	970.20
	SC	504,631.80	-	733,500.00	370,332,584.59
	TC	1,155,474.38	**755,462.13**	1,898,480.09	371,452,836.77

Table B12 The total inventory costs of high consumption value and vital drugs (AV) with not normally distributed demand (drug group 4) (cont.)

Drug Code	KPI	Min/Max	M5	P	Q
SIMU-I-	HC	394,123.10	990,992.38	1,055,431.53	242,672.55
	OC	86.63	288.75	144.38	462.00
	SC	1,204,463.00	-	5,630,330.00	47,654,025.72
	TC	1,598,672.73	**991,281.13**	6,685,905.90	47,897,160.27
STOC1C-	HC	312,266.57	367,941.50	466,367.44	180,827.96
	OC	121.28	952.88	964.43	687.23
	SC	279,370.24	-	145,758.50	33,804,261.89
	TC	591,758.08	**368,894.38**	613,090.37	33,985,777.07
TRCL-T-	HC	7,529,688.18	8,290,659.75	12,049,335.99	47,045,492.04
	OC	138.60	802.73	854.70	675.68
	SC	12,516,630.84	-	15,602,580.00	11,079,846,449.30
	TC	20,046,457.62	**8,291,462.48**	27,652,770.69	11,126,892,617.02
VALC-T-	HC	992,741.24	1,116,746.41	1,375,777.31	2,176,756.14
	OC	138.60	825.83	843.15	889.35
	SC	1,234,618.78	-	620,356.00	581,647,534.13
	TC	2,227,498.62	**1,117,572.23**	1,996,976.46	583,825,179.62
VETV-X-	HC	439,358.35	681,758.50	1,077,714.79	389,778.07
	OC	115.50	427.35	456.23	589.05
	SC	1,998,354.46	19,129.00	1,380,766.00	145,691,334.34
	TC	2,437,828.31	**701,314.85**	2,458,937.01	146,081,701.47

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
ACTE1T-	HC	1,744,499.26	2,226,632.28	1,404,116.91	1,147,654.54	2,721,808.09	11,403,355.09
	OC	92.40	46.20	63.53	248.33	1,039.50	1,201.20
	SC	275,334.94	275,334.94	1,247,131.50	28,870,101.92	1,463,532.00	2,417,577,309.00
	TC	**2,019,926.60**	2,502,013.41	2,651,311.93	30,018,004.78	4,186,379.59	2,428,981,865.29
ACTO1T-	HC	551,811.08	698,417.20	468,339.78	364,210.04	666,975.07	43,192.08
	OC	109.73	51.98	63.53	127.05	600.60	1,016.40
	SC	447,360.74	321,120.37	626,329.38	573,935.94	2,405,256.00	74,401,404.00
	TC	999,281.55	1,019,589.55	1,094,732.69	**938,273.03**	3,072,831.67	74,445,612.48
ACTO2T-	HC	925,474.22	1,153,043.58	872,129.86	696,148.95	1,736,900.13	1,712,946.71
	OC	103.95	51.98	57.75	173.25	1,201.20	1,178.10
	SC	377,351.99	385,763.98	442,298.21	571,751.24	17,655.00	443,760,982.50
	TC	1,302,930.16	1,538,859.54	1,314,485.83	1,268,073.44	1,755,756.33	445,475,107.31

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1) (cont.)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
ADCR1T-	HC	339,635.68	445,192.23	307,745.59	175,909.06	533,322.95	176,689.79
	OC	103.95	46.20	63.53	103.95	600.60	791.18
	SC	173,393.47	173,393.47	278,265.40	224,023.76	833,646.00	28,117,210.00
	TC	513,133.10	618,631.89	586,074.51	**400,036.77**	1,367,569.55	28,294,690.96
ALPG-Y-	HC	466,684.82	552,078.88	411,849.89	263,552.16	831,021.58	17,201.58
	OC	103.95	51.98	57.75	115.50	1,201.20	918.23
	SC	287,200.03	289,885.05	371,818.81	564,465.83	-	72,752,295.00
	TC	**753,988.80**	842,015.91	783,726.45	828,133.49	832,222.78	72,770,414.80
AMLP2T-	HC	406,652.58	503,819.81	373,447.99	204,536.74	525,826.51	98,265.59
	OC	98.18	46.20	57.75	109.73	600.60	866.25
	SC	130,157.01	130,157.01	161,916.11	386,971.07	2,898,202.50	90,301,080.25
	TC	536,907.77	634,023.02	**535,421.85**	591,617.54	3,424,629.61	90,400,212.09
APRO1T-	HC	294,283.30	359,927.57	258,185.80	155,409.16	491,361.65	155,020.59
	OC	98.18	51.98	57.75	92.40	600.60	733.43
	SC	154,879.79	154,879.79	218,578.89	226,307.20	1,139,832.00	28,819,656.00
	TC	449,261.27	514,859.34	476,822.43	**381,808.76**	1,631,794.25	28,975,410.02
ARAV1T-	HC	461,440.98	591,712.59	316,029.73	287,182.20	550,870.89	130,112.15
	OC	103.95	51.98	69.30	132.83	600.60	877.80
	SC	118,825.88	118,825.88	874,977.22	1,097,370.71	2,032,030.00	48,886,929.00
	TC	**580,370.81**	710,590.45	1,191,076.25	1,384,685.74	2,583,501.49	49,017,918.95
ARCX1T-	HC	1,015,060.71	1,320,631.12	924,203.00	765,784.44	1,986,878.47	2,721,014.16
	OC	98.18	46.20	63.53	179.03	1,201.20	1,172.33
	SC	410,925.26	435,490.53	530,970.08	1,285,703.95	233,960.00	651,452,040.00
	TC	**1,426,084.15**	1,756,167.85	1,455,236.60	2,051,667.41	2,222,039.67	654,174,226.49
ARCX2T-	HC	891,212.17	1,170,298.30	839,100.37	747,610.33	1,525,979.90	1,238,733.01
	OC	98.18	46.20	57.75	167.48	1,201.20	1,172.33
	SC	280,558.13	280,558.13	737,259.66	787,952.11	56,000.00	323,389,480.00
	TC	**1,171,868.48**	1,450,902.64	1,576,417.78	1,535,729.92	1,583,181.10	324,629,385.34
ARIP-T-	HC	598,767.92	734,301.95	499,434.81	388,320.06	832,522.18	595,777.45
	OC	98.18	51.98	63.53	138.60	600.60	981.75
	SC	428,160.73	428,160.73	560,572.45	741,198.52	4,357,232.00	223,428,144.00
	TC	**1,027,026.83**	1,162,514.66	1,060,070.79	1,129,657.18	5,190,354.78	224,024,903.20
ARMD-T-	HC	966,856.74	1,289,446.27	787,103.05	695,218.65	1,891,920.79	1,677,099.78
	OC	98.18	51.98	63.53	179.03	1,201.20	1,166.55
	SC	570,216.55	573,263.10	1,332,719.58	6,453,766.01	-	476,960,730.00
	TC	**1,537,171.46**	1,862,761.35	2,119,886.15	7,149,163.68	1,893,121.99	478,638,996.33

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1) (cont.)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
ASPM1T-	HC	341,044.91	411,298.04	322,762.50	207,684.92	579,473.44	294,337.75
	OC	103.95	51.98	57.75	132.83	600.60	583.28
	SC	142,510.27	142,510.27	207,286.57	306,278.63	1,529,658.00	26,878,792.00
	TC	**483,659.13**	553,860.28	530,106.81	514,096.38	2,109,732.04	27,173,713.02
AZTP-T-	HC	522,982.48	630,629.28	430,645.48	296,925.33	661,274.83	341,352.82
	OC	98.18	51.98	63.53	132.83	600.60	924.00
	SC	188,161.35	188,161.35	380,049.30	782,763.86	3,415,020.00	155,453,260.00
	TC	**711,242.01**	818,842.61	810,758.30	1,079,822.02	4,076,895.43	155,795,536.82
BLOP1T-	HC	485,561.22	623,221.86	424,477.72	260,690.75	629,916.20	220,235.54
	OC	98.18	46.20	63.53	132.83	600.60	924.00
	SC	240,485.18	240,485.18	419,985.64	689,437.85	3,291,939.00	126,352,170.00
	TC	**726,144.58**	863,753.24	844,526.89	950,261.43	3,922,455.80	126,573,329.54
BLOP2T-	HC	429,144.14	507,359.85	361,180.06	196,807.02	528,943.92	11,409.61
	OC	98.18	51.98	63.53	109.73	600.60	860.48
	SC	189,986.78	217,061.55	223,995.78	436,860.84	2,457,792.00	74,644,064.00
	TC	619,229.09	724,473.38	**585,239.36**	633,777.59	2,987,336.52	74,656,334.08
BONV-T-	HC	1,940,746.12	2,392,616.13	1,515,951.15	1,325,784.48	3,049,132.39	13,791,012.96
	OC	98.18	51.98	69.30	254.10	1,201.20	1,201.20
	SC	1,133,613.47	1,133,613.47	1,966,048.89	22,158,550.08	2,061,519.00	3,023,214,855.00
	TC	**3,074,457.76**	3,526,281.57	3,482,069.34	23,484,588.65	5,111,852.59	3,037,007,069.16
CELB-C-	HC	1,307,900.77	1,738,834.11	1,286,419.32	1,033,389.43	2,535,250.75	12,550,720.09
	OC	109.73	51.98	63.53	213.68	1,201.20	1,201.20
	SC	620,165.08	620,165.08	961,101.95	12,340,625.72	-	2,629,286,236.50
	TC	**1,928,175.57**	2,359,051.16	2,247,584.79	13,374,228.83	2,536,451.95	2,641,838,157.79
CELF-Y-	HC	494,137.49	654,106.17	471,163.63	238,786.45	695,804.77	235,819.12
	OC	103.95	51.98	57.75	127.05	600.60	935.55
	SC	77,754.27	77,754.27	185,415.08	574,124.14	3,851,838.00	137,382,570.00
	TC	**571,995.71**	731,912.42	656,636.45	813,037.64	4,548,243.37	137,619,324.67
CEVT-T-	HC	924,426.24	1,087,177.69	573,802.42	569,702.31	1,463,834.11	2,681,824.89
	OC	115.50	57.75	69.30	173.25	1,201.20	1,062.60
	SC	616,561.87	292,882.40	2,053,977.98	2,492,038.16	-	625,945,280.00
	TC	1,541,103.62	**1,380,117.85**	2,627,849.69	3,061,913.72	1,465,035.31	628,628,167.49
COSP-Y-	HC	309,552.35	370,094.78	254,959.74	180,458.92	508,086.00	169,920.00
	OC	98.18	51.98	63.53	92.40	600.60	744.98
	SC	133,339.83	133,339.83	319,583.43	304,880.66	727,947.00	27,999,939.00
	TC	**442,990.36**	503,486.59	574,606.70	485,431.98	1,236,633.60	28,170,603.98

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1) (cont.)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
COTL2T-	HC	356,117.52	494,147.66	309,720.42	300,933.10	673,284.55	242,105.92
	OC	109.73	51.98	63.53	155.93	600.60	895.13
	SC	784,052.19	210,149.19	373,479.86	1,031,407.20	3,772,444.50	136,573,965.00
	TC	1,140,279.43	704,348.82	**683,263.80**	1,332,496.22	4,446,329.65	136,816,966.05
COTL-T-	HC	424,238.47	630,353.71	391,011.69	235,756.11	564,682.11	100,026.18
	OC	103.95	46.20	63.53	127.05	600.60	918.23
	SC	209,600.00	209,600.00	566,674.29	1,040,584.20	2,185,024.00	54,796,224.00
	TC	**633,942.42**	839,999.91	957,749.51	1,276,467.37	2,750,306.71	54,897,168.41
DAFL-T-	HC	265,823.25	336,451.90	249,765.30	158,957.87	477,367.37	152,829.17
	OC	98.18	51.98	57.75	98.18	600.60	710.33
	SC	163,726.45	163,726.45	185,289.75	276,765.76	1,345,074.50	30,869,392.50
	TC	**429,647.88**	500,230.33	435,112.79	435,821.80	1,823,042.47	31,022,931.99
DFRL-I-	HC	436,591.66	524,658.04	364,470.99	225,930.18	642,083.25	250,752.52
	OC	115.50	57.75	63.53	132.83	600.60	831.60
	SC	414,421.41	201,133.21	227,664.89	1,443,659.90	438,906.00	25,664,067.00
	TC	851,128.57	725,849.00	**592,199.40**	1,669,722.90	1,081,589.85	25,915,651.12
DIMR-T-	HC	287,161.03	375,928.62	264,413.26	149,155.39	530,768.67	140,854.15
	OC	121.28	51.98	63.53	98.18	600.60	750.75
	SC	122,165.64	100,476.07	345,021.24	227,671.48	1,414,009.00	36,555,644.00
	TC	409,447.94	476,456.67	609,498.03	**376,925.05**	1,945,378.27	36,697,248.90
DIRL-I-	HC	587,524.49	766,901.40	438,162.25	408,495.08	730,399.44	258,471.15
	OC	109.73	51.98	69.30	138.60	600.60	975.98
	SC	426,086.36	367,850.45	850,276.04	1,228,248.27	1,131,072.00	44,111,808.00
	TC	**1,013,720.57**	1,134,803.83	1,288,507.59	1,636,881.95	1,862,072.04	44,371,255.12
DIVN1T-	HC	446,324.21	600,330.94	419,056.29	229,858.95	596,771.80	67,415.80
	OC	98.18	46.20	57.75	121.28	600.60	929.78
	SC	181,816.14	181,816.14	408,851.51	421,361.27	3,098,915.00	91,162,506.00
	TC	**628,238.52**	782,193.27	827,965.55	651,341.49	3,696,287.40	91,230,851.58
DIVN-T-	HC	527,058.05	718,668.36	498,396.00	279,100.99	791,453.86	232,097.73
	OC	103.95	46.20	63.53	138.60	1,201.20	993.30
	SC	271,960.96	271,960.96	404,518.35	472,226.50	534,757.50	130,496,197.50
	TC	799,122.96	990,675.52	902,977.88	**751,466.09**	1,327,412.56	130,729,288.53
DPAC-T-	HC	334,900.97	456,301.72	304,351.16	183,582.93	570,083.99	155,078.61
	OC	103.95	46.20	63.53	109.73	600.60	808.50
	SC	69,769.85	69,769.85	325,572.44	456,467.64	1,218,501.50	36,437,927.00
	TC	**404,774.77**	526,117.77	629,987.12	640,160.29	1,789,186.09	36,593,814.11

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1) (cont.)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
ENAN-I-	HC	785,099.39	780,454.32	465,364.67	317,163.95	1,152,604.33	300,218.83
	OC	103.95	51.98	63.53	144.38	1,201.20	987.53
	SC	304,074.48	304,074.48	736,384.41	1,646,829.01	196,168.00	162,966,566.00
	TC	1,089,277.82	**1,084,580.77**	1,201,812.61	1,964,137.34	1,349,973.53	163,267,772.36
EPRX-I-	HC	1,634,388.83	2,179,675.19	1,474,271.69	934,590.04	2,540,975.02	13,791,305.22
	OC	103.95	51.98	63.53	236.78	1,201.20	1,201.20
	SC	515,911.63	515,911.63	619,575.83	24,289,346.90	1,204,570.00	2,904,245,980.00
	TC	2,150,404.42	2,695,638.80	**2,093,911.05**	25,224,173.71	3,746,746.22	2,918,038,486.42
FEMR-T-	HC	740,681.33	820,140.43	525,585.54	433,782.56	871,219.89	168,877.07
	OC	115.50	51.98	69.30	150.15	600.60	1,074.15
	SC	455,415.36	525,806.71	880,725.61	1,360,091.84	3,446,228.00	129,349,452.00
	TC	**1,196,212.19**	1,345,999.12	1,406,380.45	1,794,024.55	4,318,048.49	129,519,403.22
HEMX3I-	HC	1,046,808.00	1,315,696.77	955,353.23	883,765.35	1,929,504.23	1,958,337.53
	OC	98.18	46.20	57.75	173.25	1,201.20	1,178.10
	SC	356,629.28	356,629.28	244,984.62	586,744.10	-	548,514,384.00
	TC	1,403,535.46	1,672,372.25	**1,200,395.60**	1,470,682.70	1,930,705.43	550,473,899.63
HEMX4I-	HC	591,055.13	644,872.14	399,924.71	406,560.54	729,305.60	292,858.65
	OC	103.95	57.75	69.30	144.38	600.60	906.68
	SC	464,148.55	427,737.28	452,065.32	1,392,451.07	2,856,906.00	152,178,312.00
	TC	1,055,307.63	1,072,667.16	**852,059.33**	1,799,155.99	3,586,812.20	152,472,077.33
INTX1I0	HC	797,613.97	1,138,737.60	738,557.16	534,325.75	1,771,514.70	1,079,638.79
	OC	103.95	46.20	63.53	236.78	1,201.20	548.63
	SC	364,735.58	404,283.16	746,369.77	9,571,685.54	-	445,679,388.00
	TC	**1,162,453.51**	1,543,066.96	1,484,990.46	10,106,248.06	1,772,715.90	446,759,575.42
LIPR1T-	HC	4,576,732.93	5,552,742.91	4,423,855.70	787,414,241.29	6,386,233.68	85,682,294.35
	OC	103.95	51.98	57.75	381.15	1,201.20	1,201.20
	SC	2,178,613.48	2,178,613.48	2,340,868.20	360,037,424.75	2,436,680.00	17,926,930,600.00
	TC	**6,755,450.36**	7,731,408.36	6,764,781.65	147,452,047.19	8,824,114.88	18,012,614,095.55
LIPR2T-	HC	2,458,432.69	3,157,896.66	2,330,140.06	3,098,479.48	3,781,802.83	31,079,292.63
	OC	98.18	51.98	57.75	277.20	1,201.20	1,201.20
	SC	1,181,704.72	1,181,704.72	1,493,524.92	120,791,917.91	3,973,462.50	6,523,017,375.00
	TC	**3,640,235.59**	4,339,653.36	3,823,722.73	123,890,674.59	7,756,466.53	6,554,097,868.83
LIPR3T-	HC	1,136,740.11	1,343,799.82	988,241.92	895,680.59	2,094,193.00	3,758,094.92
	OC	98.18	51.98	63.53	184.80	1,201.20	1,149.23
	SC	400,611.96	411,928.91	880,280.18	2,410,120.35	-	899,181,352.50
	TC	**1,537,450.24**	1,755,780.71	1,868,585.63	3,305,985.74	2,095,394.20	902,940,596.64

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1) (cont.)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
MADI1T-	HC	525,046.97	674,605.85	499,247.22	241,313.23	697,367.54	416,796.92
	OC	98.18	46.20	57.75	127.05	600.60	952.88
	SC	189,656.64	199,308.79	269,505.39	466,747.27	3,670,173.00	175,273,780.50
	TC	714,801.78	873,960.83	768,810.36	708,187.55	4,368,141.14	175,691,530.29
MADP-T-	HC	330,981.14	341,249.13	214,637.16	132,200.96	487,795.75	179,936.33
	OC	103.95	57.75	69.30	98.18	600.60	727.65
	SC	326,282.99	303,150.24	570,252.90	467,646.44	1,064,996.00	25,806,665.00
	TC	657,368.09	644,457.12	784,959.37	**599,945.58**	1,553,392.35	25,987,328.98
MEFM-T-	HC	382,855.33	491,469.05	375,502.72	204,876.56	478,848.45	165,633.21
	OC	103.95	51.98	57.75	115.50	600.60	854.70
	SC	127,919.01	127,919.01	215,894.24	192,324.67	2,221,045.00	38,885,287.00
	TC	510,878.29	619,440.04	591,454.71	**397,316.73**	2,700,494.05	39,051,774.91
MICC2F-	HC	1,007,013.78	1,427,144.63	861,724.06	848,472.94	1,847,924.10	6,125,834.33
	OC	103.95	46.20	69.30	190.58	1,201.20	1,201.20
	SC	497,759.18	497,759.18	1,378,743.88	9,493,037.87	-	1,284,935,391.00
	TC	**1,504,876.90**	1,924,950.00	2,240,537.24	10,341,701.39	1,849,125.30	1,291,062,426.53
NASN-F1	HC	667,476.04	781,915.92	581,553.80	461,819.02	882,527.10	891,711.96
	OC	98.18	51.98	63.53	144.38	600.60	964.43
	SC	211,230.24	267,118.72	391,058.16	1,456,541.80	4,827,072.00	296,790,316.00
	TC	**878,804.45**	1,049,086.61	972,675.48	1,918,505.19	5,710,199.70	297,682,992.39
NERT1C-	HC	1,319,039.38	1,789,296.04	1,275,454.36	967,848.29	2,638,709.57	13,987,254.68
	OC	127.05	51.98	63.53	213.68	1,201.20	1,201.20
	SC	1,041,660.17	579,006.56	1,105,428.21	11,678,763.96	-	2,930,977,712.00
	TC	**2,360,826.60**	2,368,354.58	2,380,946.10	12,646,825.92	2,639,910.77	2,944,966,167.88
NERT3C-	HC	542,168.43	738,120.54	453,861.71	438,579.03	764,789.68	607,859.53
	OC	109.73	51.98	63.53	132.83	600.60	975.98
	SC	199,373.39	153,649.95	616,813.49	1,215,733.25	4,348,756.50	219,587,445.00
	TC	**741,651.55**	891,822.46	1,070,738.73	1,654,445.11	5,114,146.78	220,196,280.50
NEXM1T-	HC	1,245,887.73	1,520,553.91	1,151,927.78	954,098.78	2,452,551.67	4,682,885.50
	OC	98.18	51.98	57.75	196.35	1,201.20	1,183.88
	SC	690,955.45	690,955.45	707,323.09	7,263,736.49	64,978.00	1,094,116,895.00
	TC	1,936,941.36	2,211,561.34	**1,859,308.63**	8,218,031.63	2,518,730.87	1,098,800,964.37
NEXM2T-	HC	1,020,392.71	1,210,587.23	843,553.14	715,530.57	1,950,206.42	2,968,750.95
	OC	103.95	57.75	63.53	167.48	1,201.20	1,126.13
	SC	489,566.82	512,071.15	560,488.33	4,041,872.51	-	736,727,820.00
	TC	1,510,063.49	1,722,716.12	**1,404,104.99**	4,757,570.55	1,951,407.62	739,697,697.08

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1) (cont.)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
NOLD-T-	HC	472,998.81	580,315.91	384,667.59	222,178.81	624,870.55	136,910.73
	OC	98.18	51.98	63.53	127.05	600.60	895.13
	SC	196,451.51	197,792.03	403,499.53	782,753.50	2,880,495.00	108,857,346.00
	TC	**669,548.50**	778,159.91	788,230.65	1,005,059.37	3,505,966.15	108,995,151.85
NORV1T-	HC	595,339.27	721,963.54	530,651.42	395,896.26	723,785.28	222,028.71
	OC	103.95	51.98	57.75	138.60	600.60	1,022.18
	SC	314,431.09	314,431.09	542,795.15	531,735.65	2,537,820.00	133,071,345.00
	TC	**909,874.31**	1,036,446.61	1,073,504.32	927,770.52	3,262,205.88	133,294,395.88
NORV2T-	HC	337,690.13	423,370.62	288,016.40	154,151.24	549,033.59	151,683.85
	OC	98.18	51.98	63.53	103.95	600.60	785.40
	SC	51,657.17	51,657.17	304,836.13	324,224.83	1,153,116.00	35,713,944.00
	TC	**389,445.47**	475,079.77	592,916.05	478,480.02	1,702,750.19	35,866,413.25
PARI1T-	HC	1,665,158.80	2,552,556.92	1,642,195.85	1,241,116.56	3,234,269.02	23,171,633.83
	OC	109.73	51.98	63.53	242.55	1,201.20	1,183.88
	SC	584,641.28	584,641.28	2,214,359.48	33,854,185.89	1,313,280.00	4,902,646,068.00
	TC	**2,249,909.80**	3,137,250.18	3,856,618.85	35,095,545.00	4,548,750.22	4,925,818,885.70
PARI-T-	HC	412,981.88	535,618.89	340,120.91	191,973.44	652,308.17	3,212.74
	OC	109.73	51.98	63.53	115.50	600.60	895.13
	SC	216,144.24	216,144.24	560,681.45	611,528.75	4,269,352.00	86,552,542.00
	TC	**629,235.85**	751,815.10	900,865.89	803,617.69	4,922,260.77	86,556,649.86
PLAQ-T-	HC	471,481.08	579,497.44	346,274.47	237,308.32	517,023.64	280,556.09
	OC	109.73	51.98	63.53	121.28	600.60	860.48
	SC	243,196.12	230,648.56	391,085.62	730,328.29	1,378,944.00	22,359,846.00
	TC	**714,786.93**	810,197.97	737,423.61	967,757.89	1,896,568.24	22,641,262.57
PLAV-T-	HC	5,135,093.88	6,077,021.20	4,835,978.24	446,131,705.85	7,190,451.39	104,129,788.10
	OC	103.95	51.98	57.75	404.25	1,201.20	1,201.20
	SC	2,196,694.68	2,196,694.68	2,807,478.03	231,738,917.85	2,269,582.50	21,783,991,888.50
	TC	**7,331,892.51**	8,273,767.86	7,643,514.01	677,871,027.96	9,461,235.09	21,888,122,877.80
PLED1T-	HC	438,202.62	637,184.52	449,480.46	277,276.19	563,648.04	211,222.62
	OC	109.73	46.20	63.53	121.28	600.60	941.33
	SC	137,392.20	175,184.41	357,427.63	386,035.12	1,680,120.00	38,026,968.00
	TC	**575,704.55**	812,415.13	806,971.62	663,432.58	2,244,368.64	38,239,131.95
PLED-T-	HC	517,560.75	595,521.00	430,696.95	233,435.11	554,138.65	151,797.36
	OC	109.73	51.98	63.53	121.28	600.60	935.55
	SC	221,196.81	236,216.31	194,397.10	277,416.09	1,931,610.00	47,132,601.50
	TC	738,867.29	831,789.28	625,157.57	**510,972.47**	2,486,349.25	47,285,334.41

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1) (cont.)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
PLET-T-	HC	485,200.77	634,935.21	469,453.31	303,485.36	661,139.50	65,794.56
	OC	98.18	51.98	57.75	127.05	600.60	958.65
	SC	146,849.27	146,849.27	251,460.98	799,548.65	3,158,853.00	96,662,460.00
	TC	**632,148.22**	781,836.46	720,972.04	1,103,161.06	3,820,593.10	96,729,213.21
PROS-T-	HC	636,588.40	937,120.98	589,464.18	424,955.69	805,820.73	107,409.00
	OC	109.73	46.20	63.53	150.15	600.60	1,120.35
	SC	151,644.14	151,644.14	845,580.04	1,244,578.59	2,203,677.00	112,523,244.00
	TC	**788,342.27**	1,088,811.32	1,435,107.75	1,669,684.43	3,010,098.33	112,631,773.35
PRTX-W-	HC	1,590,676.29	2,216,528.41	1,513,630.46	933,238.63	2,679,617.35	14,555,453.05
	OC	98.18	51.98	57.75	236.78	1,201.20	1,172.33
	SC	718,539.71	718,539.71	623,819.59	19,266,346.84	650,559.00	3,112,455,892.00
	TC	2,309,314.17	2,935,120.10	**2,137,507.80**	20,199,822.24	3,331,377.55	3,127,012,517.37
PRVF2T-	HC	782,746.15	1,020,455.51	760,688.02	589,153.13	1,443,606.32	1,141,575.57
	OC	103.95	46.20	57.75	161.70	1,201.20	1,108.80
	SC	312,885.56	312,885.56	451,275.28	1,951,353.60	-	336,712,687.50
	TC	**1,095,735.66**	1,333,387.26	1,212,021.04	2,540,668.43	1,444,807.52	337,855,371.87
RECM-I-	HC	1,353,733.68	1,650,056.23	1,125,405.37	856,031.27	2,619,849.27	6,433,519.27
	OC	103.95	51.98	63.53	213.68	1,201.20	1,189.65
	SC	475,947.89	475,947.89	1,109,161.79	2,610,987.73	926,478.00	1,434,222,258.00
	TC	**1,829,785.52**	2,126,056.09	2,234,630.69	3,467,232.67	3,547,528.47	1,440,656,966.92
REMC-I-	HC	1,054,014.58	1,341,340.06	387,455,957.95	304,799,904.98	1,956,452.25	724,063.12
	OC	103.95	57.75	63.53	51.98	1,201.20	1,149.23
	SC	565,123.59	583,713.18	200,767.59	3,937,275.55	-	224,534,385.00
	TC	**1,619,242.12**	1,925,111.00	387,656,789.06	308,737,232.51	1,957,653.45	225,259,597.34
SALZ-T-	HC	371,687.48	472,660.05	315,355.98	162,852.37	614,811.61	19,338.75
	OC	98.18	51.98	63.53	115.50	600.60	872.03
	SC	58,206.15	63,006.29	317,266.26	634,602.60	1,169,532.00	64,474,461.00
	TC	**429,991.81**	535,718.32	632,685.77	797,570.46	1,784,944.21	64,494,671.78
SERE3F-	HC	920,453.77	1,053,829.77	746,387.66	668,028.27	1,756,367.66	1,969,208.78
	OC	98.18	51.98	57.75	167.48	1,201.20	1,039.50
	SC	381,055.98	381,055.98	797,881.02	6,240,852.90	-	560,673,414.00
	TC	**1,301,607.93**	1,434,937.73	1,544,326.42	6,909,048.65	1,757,568.86	562,643,662.28
SERT2F-	HC	514,916.91	639,289.61	457,785.11	323,907.18	684,728.65	284,439.21
	OC	103.95	51.98	63.53	127.05	600.60	952.88
	SC	230,754.60	230,754.60	370,943.63	540,296.99	3,140,347.00	143,276,350.00
	TC	**745,775.46**	870,096.19	828,792.26	864,331.21	3,825,676.25	143,561,742.08

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1) (cont.)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
SIGL2T-	HC	677,582.90	812,326.46	497,893.32	373,656.52	937,386.84	962,506.46
	OC	98.18	51.98	63.53	138.60	600.60	975.98
	SC	229,058.33	280,016.67	938,498.81	968,189.97	5,046,500.00	316,091,700.00
	TC	**906,739.41**	1,092,395.10	1,436,455.66	1,341,985.08	5,984,487.44	317,055,182.43
SIMV-T-	HC	283,084.20	351,615.94	254,065.14	169,021.30	457,117.97	200,187.81
	OC	103.95	51.98	63.53	98.18	600.60	721.88
	SC	100,055.39	100,055.39	211,730.19	223,437.60	821,630.00	18,758,958.00
	TC	**383,243.54**	451,723.30	465,858.85	392,557.07	1,279,348.57	18,959,867.68
SPIR-C-	HC	460,821.45	575,107.11	421,636.93	294,799.26	648,840.50	85,260.55
	OC	98.18	51.98	57.75	127.05	600.60	912.45
	SC	290,748.57	316,981.14	292,642.23	902,052.07	3,019,690.00	100,472,798.00
	TC	751,668.20	892,140.23	**714,336.91**	1,196,978.38	3,669,131.10	100,558,971.00
SUPL1T-	HC	665,980.88	892,086.79	632,845.23	538,755.95	1,424,742.11	431,861.05
	OC	98.18	46.20	63.53	179.03	1,201.20	785.40
	SC	260,893.13	260,893.13	462,952.00	608,541.29	-	223,414,125.00
	TC	**926,972.19**	1,153,026.12	1,095,860.76	1,147,476.27	1,425,943.31	223,846,771.45
SYBC2F1	HC	345,519.23	358,866.00	246,538.54	157,053.96	895,127.05	229,880.53
	OC	92.40	51.98	57.75	103.95	1,201.20	721.88
	SC	113,682.25	140,398.50	267,557.32	489,929.19	-	18,638,730.00
	TC	**459,293.88**	499,316.47	514,153.61	647,087.10	896,328.25	18,869,332.40
TACV1T-	HC	2,104,447.16	2,483,695.43	1,437,010.42	1,413,622.04	3,582,993.66	10,552,111.89
	OC	92.40	51.98	63.53	265.65	1,201.20	1,183.88
	SC	255,717.18	255,717.18	2,171,221.43	272,123,813.73	6,249,150.00	2,318,823,486.00
	TC	**2,360,256.75**	2,739,464.58	3,608,295.37	273,537,701.43	9,833,344.86	2,329,376,781.76
TAXL1I0	HC	1,697,564.73	1,833,188.29	1,117,368.49	9,620,021.52	2,666,552.03	2,848,557.06
	OC	92.40	51.98	63.53	317.63	1,201.20	600.60
	SC	743,400.00	893,375.00	1,355,675.00	470,235,818.65	-	855,240,575.00
	TC	**2,441,057.13**	2,726,615.26	2,473,107.02	479,856,157.80	2,667,753.23	858,089,732.66
TOPX3T-	HC	236,440.29	350,601.35	216,162.97	111,847.79	444,832.75	254,363.25
	OC	98.18	51.98	69.30	98.18	600.60	675.68
	SC	65,770.58	65,770.58	357,365.49	533,399.68	569,835.00	7,875,765.00
	TC	**302,309.05**	416,423.91	573,597.76	645,345.64	1,015,268.35	8,130,803.93
VYTO1T-	HC	451,146.46	512,145.19	367,601.42	184,778.58	601,866.07	87,266.15
	OC	98.18	51.98	63.53	115.50	600.60	860.48
	SC	164,175.53	180,628.06	186,960.55	529,290.28	2,787,426.00	95,181,397.50
	TC	615,420.17	692,825.23	**554,625.50**	714,184.35	3,389,892.67	95,269,524.12

Table B13 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and static demand (drug group1) (cont.)

Drug Code	Cost	Min/Max	M1	M2	M3	P	Q
XALT-Y-	HC	503,803.82	678,009.57	462,658.86	356,442.58	828,503.56	496,556.60
	OC	98.18	46.20	63.53	138.60	600.60	935.55
	SC	120,276.61	120,276.61	246,118.67	925,317.41	4,236,935.00	205,106,300.00
	TC	**624,178.60**	798,332.38	708,841.06	1,281,898.59	5,066,039.16	205,603,792.15
XATX-T-	HC	956,520.18	1,178,107.47	827,954.72	772,555.54	1,870,534.28	2,437,003.48
	OC	98.18	51.98	63.53	173.25	1,201.20	1,108.80
	SC	576,363.55	741,399.09	589,435.71	1,518,378.16	-	632,807,520.00
	TC	1,532,981.90	1,919,558.54	**1,417,453.95**	2,291,106.95	1,871,735.48	635,245,632.28
ZAND-T-	HC	268,095.81	364,409.52	203,028.65	159,187.29	474,564.13	217,450.58
	OC	92.40	46.20	63.53	86.63	600.60	687.23
	SC	72,053.05	72,053.05	516,154.92	312,188.07	1,282,071.00	17,207,463.00
	TC	**340,241.25**	436,508.76	719,247.10	471,461.98	1,757,235.73	17,425,600.80
ZOLL-I-	HC	335,510.12	468,669.50	295,607.98	219,216.62	35,249,813.28	2,666,326.58
	OC	103.95	51.98	57.75	115.50	1,201.20	583.28
	SC	119,358.41	119,358.41	420,214.85	1,035,434.73	02,558,781.00	2,682,433,415.00
	TC	**454,972.48**	588,079.88	715,880.58	1,254,766.86		2,685,100,324.86
ZOMT-I-	HC	1,059,576.59	1,150,809.52	781,177.64	695,873.49	1,944,314.52	3,288,122.03
	OC	103.95	57.75	63.53	173.25	1,201.20	1,079.93
	SC	404,696.93	487,195.79	982,119.31	1,302,402.63	109,720.00	776,776,455.00
	TC	**1,464,377.47**	1,638,063.06	1,763,360.48	1,998,449.37	2,055,235.72	780,065,656.96
ZYRT-T-	HC	332,983.33	379,512.10	282,405.27	167,967.80	568,058.21	109,966.58
	OC	98.18	51.98	63.53	103.95	600.60	768.08
	SC	141,103.14	141,103.14	80,788.73	377,005.89	1,688,687.00	46,837,329.00
	TC	474,184.64	520,667.21	**363,257.53**	545,077.64	2,257,345.81	46,948,063.65

Table B14 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and lumpy demand (drug group 2)

Drug Code	Cost	Min/Max	M1	M4	M5	P	Q
ALMT-I-	HC	971,139.86	1,165,948.06	326,484,791.94	323,557.86	1,922,131.02	1,288,384.15
	OC	98.18	57.75	63.53	796.95	1,201.20	970.20
	SC	349,523.98	308,417.99	130,209.99	-	757,384.00	420,303,568.00
	TC	1,320,762.02	1,474,423.80	326,615,065.46	**324,354.81**	2,680,716.22	421,592,922.35
CAEL-I-	HC	524,447.08	629,734.26	174,951,893.56	748,796.92	1,198,114.64	386,179.81
	OC	121.28	57.75	63.53	450.45	1,201.20	629.48
	SC	286,134.17	256,274.17	157,997.09	-	-	48,970,400.00
	TC	810,702.53	886,066.18	175,109,954.18	**749,247.37**	1,199,315.84	49,357,209.28

Table B14 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and lumpy demand (drug group 2) (cont.)

Drug Code	Cost	Min/Max	M1	M4	M5	P	Q
DINH1I1	HC	405,391.87	507,857.87	147,120,141.15	680,563.70	680,591.92	243,824.89
	OC	98.18	57.75	57.75	617.93	600.60	739.20
	SC	166,795.33	183,648.65	68,099.33	-	1,503,216.00	35,090,224.00
	TC	**572,285.38**	691,564.28	147,188,298.23	681,181.63	2,184,408.52	35,334,788.09
ENBL-I-	HC	903,399.71	1,001,838.57	295,405,042.36	789,839.58	1,003,710.26	177,919.00
	OC	109.73	57.75	63.53	577.50	600.60	1,074.15
	SC	389,699.16	335,483.58	147,971.58	-	1,644,336.00	129,058,740.00
	TC	1,293,208.59	1,337,379.90	295,553,077.47	**790,417.08**	2,648,646.86	129,237,733.15
EPRX4I-	HC	584,152.42	713,456.40	218,921,620.02	586,838.84	736,967.76	280,552.13
	OC	109.73	57.75	57.75	571.73	600.60	924.00
	SC	192,975.81	123,696.90	61,504.90	-	2,534,324.00	38,943,853.00
	TC	777,237.95	837,211.06	218,983,182.67	**587,410.57**	3,271,892.36	39,225,329.13
EPRX5I-	HC	481,753.87	637,394.63	199,582,309.97	530,593.07	730,321.09	72,864.98
	OC	115.50	57.75	57.75	577.50	600.60	918.23
	SC	440,375.12	274,067.03	110,722.03	288,995.00	3,626,259.00	106,588,895.00
	TC	922,244.49	911,519.41	199,693,089.75	**820,165.57**	4,357,180.69	106,662,678.20
ERBI-I-	HC	1,053,129.02	1,345,540.67	393,307,579.45	1,587,929.53	2,609,717.78	3,196,144.83
	OC	109.73	51.98	63.53	779.63	1,201.20	964.43
	SC	1,180,160.34	81,294.58	176,292.58	-	-	879,222,323.00
	TC	2,233,399.08	**1,426,887.23**	393,483,935.56	1,588,709.16	2,610,918.98	882,419,432.26
EUTP-I-	HC	610,642.75	580,560.59	171,486,075.69	621,984.39	704,103.80	236,275.03
	OC	109.73	63.53	63.53	565.95	600.60	872.03
	SC	415,511.47	457,021.47	101,015.73	-	3,082,414.00	48,244,108.00
	TC	1,026,263.95	1,037,645.59	171,587,154.95	**622,550.34**	3,787,118.40	48,481,255.06
FORE-I-	HC	921,801.95	1,082,697.04	329,400,219.89	1,307,321.60	1,485,561.78	447,203.60
	OC	103.95	57.75	57.75	872.03	1,201.20	1,033.73
	SC	334,798.02	334,798.02	164,822.02	-	-	198,786,932.00
	TC	**1,256,703.92**	1,417,552.81	329,565,099.67	1,308,193.62	1,486,762.98	199,235,169.33
GLIV-T-	HC	4,300,275.98	5,228,075.65	1,518,291,926.31	4,987,046.48	7,390,863.63	59,501,926.79
	OC	98.18	57.75	57.75	872.03	1,201.20	1,201.20
	SC	1,741,099.41	1,741,099.41	697,485.41	-	12,286,716.00	12,462,583,614.00
	TC	6,041,473.56	6,969,232.81	1,518,989,469.46	**4,987,918.51**	19,678,780.83	12,522,086,741.99
IRES-T-	HC	715,251.01	780,476.65	239,521,047.49	677,494.86	917,626.59	379,714.46
	OC	98.18	57.75	57.75	502.43	600.60	889.35
	SC	200,607.10	238,656.21	42,975.10	-	1,071,405.00	25,265,454.00
	TC	915,956.29	1,019,190.61	239,564,080.34	**677,997.29**	1,989,632.19	25,646,057.81

Table B14 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and lumpy demand (drug group 2) (cont.)

Drug Code	Cost	Min/Max	M1	M4	M5	P	Q
NEXV-T-	HC	1,452,740.62	1,495,747.51	474,265,461.81	2,032,198.41	2,500,511.70	5,342,399.53
	OC	109.73	63.53	57.75	687.23	1,201.20	1,062.60
	SC	433,731.96	687,713.88	267,363.96	-	121,310.00	1,172,903,065.00
	TC	**1,886,582.31**	2,183,524.91	474,532,883.52	2,032,885.63	2,623,022.90	1,178,246,527.13
REMN4C-	HC	437,803.39	455,805.38	146,457,208.33	515,606.10	654,505.02	133,858.25
	OC	98.18	63.53	63.53	600.60	600.60	791.18
	SC	175,631.06	357,705.30	74,131.06	-	1,340,150.00	46,084,325.00
	TC	613,532.63	813,574.21	146,531,402.92	**516,206.70**	1,995,255.62	46,218,974.43
SPRY1T-	HC	761,089.01	955,304.95	309,297,430.00	1,004,147.63	7,671,692.24	676,332.03
	OC	115.50	57.75	57.75	629.48	1,201.20	623.70
	SC	474,586.67	447,757.56	156,271.56	-	13,529,568.00	508,048,554.00
	TC	1,235,791.18	1,403,120.25	309,453,759.31	**1,004,777.10**	21,202,461.44	508,725,509.73
STLV1T-	HC	471,741.13	501,412.12	157,959,118.27	453,636.52	739,578.80	144,756.06
	OC	98.18	57.75	57.75	329.18	600.60	837.38
	SC	258,558.46	269,579.42	90,610.96	-	1,885,800.00	50,789,602.50
	TC	730,397.77	771,049.29	158,049,786.98	**453,965.70**	2,625,979.40	50,935,195.94
SUTN-C-	HC	817,789.16	917,474.08	273,625,140.48	1,186,397.84	1,693,526.67	389,560.81
	OC	109.73	57.75	57.75	571.73	1,201.20	895.13
	SC	300,889.70	324,324.41	94,979.70	-	-	45,370,000.00
	TC	**1,118,788.59**	1,241,856.23	273,720,177.93	1,186,969.56	1,694,727.87	45,760,455.94
TACV-T-	HC	475,631.72	575,099.69	173,535,760.89	503,430.05	969,823.11	331,132.42
	OC	103.95	63.53	57.75	490.88	600.60	768.08
	SC	163,203.53	163,203.53	89,514.53	66,066.00	3,471,006.00	186,694,893.00
	TC	638,939.20	738,366.74	173,625,333.17	**569,986.93**	4,441,429.71	187,026,793.50
TASN-C-	HC	1,859,033.77	2,107,398.42	669,281,251.50	2,356,223.09	3,716,392.00	2,004,762.79
	OC	98.18	57.75	57.75	444.68	1,201.20	814.28
	SC	646,096.50	1,247,683.50	346,720.50	39,123.00	-	749,455,497.00
	TC	2,505,228.45	3,355,139.67	669,628,029.75	**2,395,790.76**	3,717,593.20	751,461,074.06
TAXT1I-	HC	372,791.35	438,964.81	135,395,412.57	471,829.11	5,941,985.46	1,467,867.46
	OC	98.18	57.75	57.75	537.08	600.60	669.90
	SC	231,471.24	237,938.47	75,699.24	-	50,227,816.00	990,883,000.00
	TC	604,360.76	676,961.04	135,471,169.56	**472,366.18**	56,170,402.06	992,351,537.36
TAXT2I-	HC	1,155,227.86	1,318,851.35	395,767,189.46	1,516,861.40	2,289,470.68	2,646,401.42
	OC	92.40	51.98	57.75	981.75	1,201.20	1,022.18
	SC	469,105.54	469,105.54	219,089.54	-	281,268.00	733,484,440.00
	TC	1,624,425.80	1,788,008.86	395,986,336.75	**1,517,843.15**	2,571,939.88	736,131,863.59

Table B14 The total inventory costs of high consumption value and essential drugs (AE) with no trend, normally distributed and lumpy demand (drug group 2) (cont.)

Drug Code	Cost	Min/Max	M1	M4	M5	P	Q
TEMD2C-	HC	609,926.77	747,713.80	226,912,902.86	926,726.66	1,243,129.26	585,702.32
	OC	115.50	57.75	57.75	606.38	1,201.20	796.95
	SC	369,825.71	431,073.71	100,696.85	-	-	4,631,880.00
	TC	979,867.98	1,178,845.26	227,013,657.46	**927,333.03**	1,244,330.46	5,218,379.27
THAL-C-	HC	1,006,510.84	958,100.15	292,101,431.19	819,379.77	926,285.01	107,321.42
	OC	127.05	63.53	57.75	560.18	600.60	1,062.60
	SC	1,036,794.83	510,947.61	50,675.61	-	621,264.00	53,311,056.00
	TC	2,043,432.73	1,469,111.28	292,152,164.55	**819,939.95**	1,548,149.61	53,419,440.02
VELC1I-	HC	801,882.82	1,042,472.93	308,747,292.96	1,134,548.38	6,855,518.84	2,090,370.58
	OC	127.05	57.75	63.53	271.43	1,201.20	525.53
	SC	597,730.61	404,808.81	98,749.81	-	10,358,920.00	152,982,414.00
	TC	1,399,740.48	1,447,339.49	308,846,106.29	**1,134,819.81**	17,215,640.04	155,073,310.10
XOLR-I-	HC	522,253.75	562,063.83	182,340,204.96	507,301.28	852,158.76	340,901.91
	OC	103.95	63.53	57.75	542.85	600.60	843.15
	SC	198,671.65	198,671.65	18,041.65	-	3,592,530.00	176,274,810.00
	TC	721,029.35	760,799.00	182,358,304.36	**507,844.13**	4,445,289.36	176,616,555.06

Table B15 The total inventory costs of high consumption value and essential drugs (AE) with trend and normally distributed demand (drug group 3)

Drug Code	Cost	Min/Max	M6	P	Q
AMLP1T-	HC	424,395.10	352,369.81	530,522.10	27,993.30
	OC	92.40	75.08	600.60	872.03
	SC	147,860.25	177,180.00	2,883,789.00	76,762,167.00
	TC	572,347.75	**529,624.88**	3,414,911.70	76,791,032.33
CADX-T-	HC	925,018.73	742,531.01	1,589,821.78	1,577,377.90
	OC	92.40	75.08	1,201.20	1,051.05
	SC	330,887.22	272,110.50	152,923.50	462,575,559.00
	TC	1,255,998.35	**1,014,716.58**	1,743,946.48	464,153,987.95
COZA-T-	HC	676,686.92	806,564.57	708,404.84	30,697.21
	OC	109.73	69.30	600.60	1,079.93
	SC	435,684.75	444,871.00	1,975,459.50	81,019,736.00
	TC	**1,112,481.40**	1,251,504.87	2,684,464.94	81,051,513.14

Table B15 The total inventory costs of high consumption value and essential drugs (AE) with trend and normally distributed demand (drug group 3) (cont.)

Drug Code	Cost	Min/Max	M6	P	Q
CRES1T-	HC	4,009,215.08	3,862,763.90	6,631,800.00	68,873,915.00
	OC	103.95	69.30	1,201.20	1,201.20
	SC	1,276,892.31	1,200,895.00	3,377,677.50	14,432,232,895.00
	TC	5,286,211.33	**5,063,728.20**	10,010,678.70	14,501,108,011.20
EZET-T-	HC	1,713,827.53	1,381,835.84	2,674,769.56	10,353,029.71
	OC	92.40	75.08	1,201.20	1,189.65
	SC	631,593.58	680,610.00	127,351.00	2,291,124,311.00
	TC	2,345,513.51	**2,062,520.92**	2,803,321.76	2,301,478,530.36
MADI2T-	HC	453,892.99	416,719.43	587,880.16	117,863.21
	OC	98.18	75.08	600.60	895.13
	SC	160,863.29	109,692.00	3,168,742.50	101,305,891.50
	TC	614,854.45	**526,486.51**	3,757,223.26	101,424,649.84
OLMT-T-	HC	298,652.70	257,774.60	531,536.21	114,124.00
	OC	98.18	86.63	600.60	739.20
	SC	114,275.78	17,138.00	1,354,694.00	41,554,172.00
	TC	413,026.66	**274,999.23**	1,886,830.81	41,669,035.20
PRVF1T-	HC	482,265.99	381,364.08	614,473.30	254,827.06
	OC	98.18	86.63	600.60	872.03
	SC	204,968.59	-	3,075,215.00	133,505,450.00
	TC	687,332.76	**381,450.71**	3,690,288.90	133,761,149.08
SERC1T-	HC	419,739.18	372,926.37	567,795.69	24,352.50
	OC	98.18	75.08	600.60	872.03
	SC	83,270.16	112,744.00	3,078,011.50	81,190,062.00
	TC	503,107.52	**485,745.44**	3,646,407.79	81,215,286.53
SERQ1T-	HC	481,376.43	373,049.32	572,840.38	165,492.63
	OC	92.40	80.85	600.60	860.48
	SC	221,773.81	-	2,436,880.00	109,185,720.00
	TC	703,242.65	**373,130.17**	3,010,320.98	109,352,073.11
ULTR-T-	HC	656,983.86	554,257.07	806,091.18	824,405.82
	OC	92.40	80.85	600.60	964.43
	SC	118,021.50	255,303.00	3,748,396.00	270,580,919.00
	TC	**775,097.77**	809,640.92	4,555,087.78	271,406,289.24
VYTO-T-	HC	403,720.91	322,060.03	76,984.84	44,733.01
	OC	98.18	86.63	600.60	814.28
	SC	177,921.70	-	393,697.50	60,591,667.50
	TC	581,740.78	**322,146.65**	471,282.94	60,637,214.79

Table B15 The total inventory costs of high consumption value and essential drugs (AE) with trend and normally distributed demand (drug group 3) (cont.)

Drug Code	Cost	Min/Max	M6	P	Q
XELD2T-	HC	941,602.13	762,607.06	2,579,416.36	3,146,467.91
	OC	98.18	75.08	1,201.20	1,022.18
	SC	521,241.49	-	2,498,994.00	872,438,067.00
	TC	1,462,941.80	**762,682.14**	5,079,611.56	875,585,557.08
ZOLO-T-	HC	793,777.20	972,313.34	1,366,901.22	1,086,686.55
	OC	109.73	75.08	1,201.20	1,189.65
	SC	279,422.34	386,011.00	-	246,479,750.00
	TC	**1,073,309.27**	1,358,399.41	1,368,102.42	247,567,626.20

Table B16 The total inventory costs of high consumption value and essential drugs (AE) with not normally distributed demand (drug group 4)

Drug Code	Cost	Min/Max	M5	P	Q
ACLS-I-	HC	713,347.24	968,566.44	1,525,129.57	1,361,962.83
	OC	92.40	756.53	1,051.05	848.93
	SC	194,718.32	-	34,256.00	424,911,424.00
	TC	**908,157.96**	969,322.97	1,560,436.62	426,274,235.76
ALMT1I-	HC	587,254.23	936,228.80	1,414,957.09	1,323,316.75
	OC	103.95	560.18	1,201.20	617.93
	SC	316,051.32	-	154,410.00	240,364,900.00
	TC	**903,409.50**	936,788.97	1,570,568.29	241,688,834.67
ARIP1T-	HC	701,601.72	777,725.64	835,568.40	624,759.21
	OC	92.40	773.85	600.60	924.00
	SC	264,543.68	-	4,159,267.00	236,438,972.00
	TC	966,237.81	**778,499.49**	4,995,436.00	237,064,655.21
ARTD-C-	HC	1,265,326.40	1,743,356.06	2,389,700.11	6,972,176.53
	OC	138.60	900.90	1,201.20	1,201.20
	SC	3,436,499.88	-	243,786.00	1,482,150,984.00
	TC	4,701,964.88	**1,744,256.96**	2,634,687.31	1,489,124,361.73
AVAT-I-	HC	1,000,648.16	1,385,611.77	1,956,156.82	2,131,771.64
	OC	92.40	825.83	1,201.20	918.23
	SC	607,206.90	-	-	602,529,273.00
	TC	1,607,947.46	**1,386,437.60**	1,957,358.02	604,661,962.86
AVOD-C-	HC	910,278.68	1,336,869.18	1,928,563.06	1,505,581.75
	OC	92.40	589.05	1,201.20	693.00
	SC	280,427.27	-	-	503,646,682.50
	TC	**1,190,798.35**	1,337,458.23	1,929,764.26	505,152,957.25

Table B16 The total inventory costs of high consumption value and essential drugs (AE) with not normally distributed demand (drug group 4) (cont.)

Drug Code	Cost	Min/Max	M5	P	Q
CAMP2I-	HC	517,581.28	629,924.59	833,664.13	629,180.48
	OC	92.40	681.45	600.60	768.08
	SC	372,404.61	-	5,453,510.00	238,372,154.00
	TC	890,078.30	**630,606.04**	6,287,774.73	239,002,102.55
CASD1T-	HC	375,767.21	595,299.41	729,518.47	112,295.89
	OC	103.95	606.38	600.60	693.00
	SC	212,421.30	-	1,734,480.00	57,090,240.00
	TC	**588,292.46**	595,905.78	2,464,599.07	57,203,228.89
CASD-T-	HC	881,952.22	1,181,342.78	1,552,671.96	1,428,052.36
	OC	98.18	872.03	1,201.20	975.98
	SC	303,351.72	-	28,536.00	424,355,904.00
	TC	1,185,402.11	**1,182,214.81**	1,582,409.16	425,784,932.34
CLEX2I-	HC	345,115.40	427,804.74	432,319.23	165,349.95
	OC	86.63	629.48	410.03	664.13
	SC	193,938.98	-	2,135,270.00	27,396,300.00
	TC	539,141.01	**428,434.22**	2,567,999.26	27,562,314.08
COCT2T-	HC	313,060.48	433,873.75	566,364.86	80,620.40
	OC	92.40	698.78	600.60	675.68
	SC	176,525.52	-	2,362,530.00	52,169,518.00
	TC	489,678.40	**434,572.53**	2,929,495.46	52,250,814.08
CONC1T-	HC	337,339.42	468,252.75	541,889.60	31,931.17
	OC	98.18	791.18	600.60	739.20
	SC	142,067.62	-	1,582,317.50	57,076,038.00
	TC	479,505.22	**469,043.92**	2,124,807.70	57,108,708.37
CRES2T-	HC	1,197,575.34	1,589,443.28	2,191,954.05	4,530,403.09
	OC	98.18	1,056.83	1,201.20	1,068.38
	SC	641,309.17	-	-	1,077,397,317.00
	TC	1,838,982.68	**1,590,500.11**	2,193,155.25	1,081,928,788.46
DALC-I2	HC	273,700.15	468,269.63	603,736.66	75,663.11
	OC	98.18	687.23	1,201.20	554.40
	SC	102,923.31	-	-	78,031,163.00
	TC	**376,721.63**	468,956.85	604,937.86	78,107,380.51
DORB-I-	HC	498,908.14	659,305.77	705,159.67	332,790.37
	OC	121.28	404.25	600.60	508.20
	SC	228,856.16	-	1,327,496.00	26,731,208.00
	TC	727,885.58	**659,710.02**	2,033,256.27	27,064,506.57

Table B16 The total inventory costs of high consumption value and essential drugs (AE) with not normally distributed demand (drug group 4) (cont.)

Drug Code	Cost	Min/Max	M5	P	Q
EBIX-T-	HC	916,061.51	1,169,463.83	1,605,575.66	1,582,422.14
	OC	92.40	918.23	1,201.20	987.53
	SC	378,496.50	-	646,680.00	461,881,602.00
	TC	1,294,650.41	**1,170,382.05**	2,253,456.86	463,465,011.67
ELOX-I-	HC	890,489.81	1,234,772.65	1,872,473.44	3,290,408.10
	OC	92.40	843.15	1,201.20	796.95
	SC	442,342.56	-	-	828,441,936.00
	TC	1,332,924.77	**1,235,615.80**	1,873,674.64	831,733,141.05
ENAN1I-	HC	670,651.51	562,133.72	789,381.10	234,875.17
	OC	92.40	565.95	600.60	837.38
	SC	86,241.58	-	2,886,420.00	154,304,850.00
	TC	756,985.50	**562,699.67**	3,676,401.70	154,540,562.54
ENBL1I-	HC	1,667,843.37	2,169,541.31	2,495,689.55	10,411,556.67
	OC	109.73	872.03	1,201.20	1,120.35
	SC	598,637.62	-	-	2,234,353,788.00
	TC	2,266,590.72	**2,170,413.33**	2,496,890.75	2,244,766,465.02
EXEL2X-	HC	489,317.24	438,426.14	698,996.30	50,946.20
	OC	98.18	485.10	600.60	779.63
	SC	84,970.00	-	2,344,824.00	96,704,850.00
	TC	574,385.41	**438,911.24**	3,044,420.90	96,756,575.83
EXFG1T-	HC	299,468.95	367,879.79	477,202.01	77,351.09
	OC	92.40	473.55	600.60	571.73
	SC	155,556.42	149,695.00	1,163,370.00	43,188,437.50
	TC	**455,117.78**	518,048.34	1,641,172.61	43,266,360.31
EXJA-T-	HC	900,915.40	903,025.38	1,621,881.72	1,317,324.63
	OC	103.95	565.95	1,201.20	975.98
	SC	246,130.76	125,504.00	-	406,690,976.00
	TC	1,147,150.11	**1,029,095.33**	1,623,082.92	408,009,276.61
FOSP-T-	HC	876,568.53	1,252,505.90	1,524,092.21	1,777,657.89
	OC	92.40	854.70	1,201.20	825.83
	SC	365,418.92	-	3,204.00	503,595,464.00
	TC	**1,242,079.84**	1,253,360.60	1,528,497.41	505,373,947.72
GEMC1I-	HC	763,286.11	1,683,708.35	1,093,838.35	568,838.72
	OC	121.28	635.25	1,201.20	508.20
	SC	579,180.69	-	-	93,302,804.80
	TC	1,342,588.08	1,684,343.60	**1,095,039.55**	93,872,151.72

Table B16 The total inventory costs of high consumption value and essential drugs (AE) with not normally distributed demand (drug group 4) (cont.)

Drug Code	Cost	Min/Max	M5	P	Q
GEMZ2I-	HC	637,307.24	546,516.27	565,517.96	243,430.38
	OC	92.40	594.83	600.60	848.93
	SC	374,128.03	251,988.00	309,258.00	26,915,754.60
	TC	1,011,527.67	**799,099.09**	875,376.56	27,160,033.91
HARN1T-	HC	961,948.22	1,348,983.64	1,858,967.85	3,054,029.86
	OC	92.40	843.15	1,201.20	814.28
	SC	219,091.12	-	239,720.00	785,496,000.00
	TC	**1,181,131.74**	1,349,826.79	2,099,889.05	788,550,844.13
HECT-I-	HC	1,227,284.30	2,173,829.04	3,142,538.47	10,090,374.20
	OC	138.60	693.00	1,201.20	975.98
	SC	6,754,971.34	-	984,291.00	2,300,645,991.00
	TC	7,982,394.24	**2,174,522.04**	4,128,030.67	2,310,737,341.18
INVZ-I-	HC	511,943.31	671,658.88	1,055,502.63	1,003,002.63
	OC	92.40	565.95	1,201.20	727.65
	SC	337,002.03	11,550.00	-	311,510,100.00
	TC	849,037.74	**683,774.83**	1,056,703.83	312,513,830.28
JANU-T-	HC	973,514.36	1,298,151.27	1,638,865.74	2,124,084.06
	OC	86.63	895.13	1,201.20	750.75
	SC	237,361.27	-	-	602,360,518.50
	TC	**1,210,962.26**	1,299,046.40	1,640,066.94	604,485,353.31
KEPP2T-	HC	566,930.14	514,450.22	778,197.79	741,139.82
	OC	92.40	565.95	600.60	820.05
	SC	325,876.68	643.50	4,411,539.00	255,821,989.50
	TC	892,899.22	**515,659.67**	5,190,337.39	256,563,949.37
LANO-I-	HC	710,742.74	596,622.24	924,094.32	1,235,172.06
	OC	98.18	565.95	600.60	906.68
	SC	229,420.94	-	5,557,880.00	366,046,344.00
	TC	940,261.86	**597,188.19**	6,482,574.92	367,282,422.73
LEXP-T-	HC	478,108.25	413,140.09	605,144.14	129,882.49
	OC	98.18	565.95	600.60	877.80
	SC	241,278.54	-	3,006,202.50	107,029,965.00
	TC	719,484.96	**413,706.04**	3,611,947.24	107,160,725.29
LOST-T-	HC	301,798.87	375,125.59	483,144.46	254,722.05
	OC	86.63	421.58	600.60	485.10
	SC	155,036.55	63,346.50	784,548.00	15,289,776.00
	TC	456,922.05	**438,893.66**	1,268,293.06	15,544,983.15

Table B16 The total inventory costs of high consumption value and essential drugs (AE) with not normally distributed demand (drug group 4) (cont.)

Drug Code	Cost	Min/Max	M5	P	Q
LUCT-I-	HC	801,815.18	1,154,034.93	1,803,866.84	2,630,376.74
	OC	103.95	652.58	1,201.20	127.05
	SC	557,524.68	-	626,780.00	1,002,848.00
	TC	1,359,443.81	**1,154,687.51**	2,431,848.04	3,633,351.79
LYRC1C-	HC	385,325.54	477,826.00	671,182.89	70,207.79
	OC	92.40	565.95	600.60	756.53
	SC	102,451.04	-	2,127,294.50	90,020,550.00
	TC	487,868.98	**478,391.95**	2,799,077.99	90,091,514.31
LYRC-C-	HC	1,356,041.99	1,815,727.98	2,482,678.07	5,726,845.63
	OC	92.40	970.20	1,201.20	964.43
	SC	798,965.02	-	173,826.00	1,363,452,748.00
	TC	2,155,099.40	**1,816,698.18**	2,657,705.27	1,369,180,558.05
MATR2I-	HC	1,189,454.88	1,735,433.89	2,503,880.47	2,212,362.21
	OC	86.63	698.78	1,201.20	716.10
	SC	588,732.64	-	138,314.00	706,646,226.00
	TC	1,778,274.15	**1,736,132.67**	2,643,395.67	708,859,304.31
MAXM-I-	HC	562,684.85	691,814.43	933,755.74	1,479,102.05
	OC	103.95	571.73	600.60	641.03
	SC	334,727.46	470,525.00	4,121,799.00	399,171,993.00
	TC	**897,516.26**	1,162,911.16	5,056,155.34	400,651,736.08
MERN2I-	HC	1,420,145.81	1,879,971.57	2,591,306.11	7,313,769.37
	OC	92.40	473.55	600.60	612.15
	SC	905,341.59	1,457,786.00	6,640,370.00	1,753,047,362.00
	TC	**2,325,579.80**	3,338,231.12	9,232,276.71	1,760,361,743.52
MICD1T-	HC	297,129.54	278,196.79	469,223.61	156,022.62
	OC	92.40	381.15	600.60	687.23
	SC	102,025.79	18,898.50	1,425,170.50	29,270,164.50
	TC	399,247.73	**297,476.44**	1,894,994.71	29,426,874.34
MUCT-T-	HC	442,530.89	468,376.70	604,451.37	4,684.74
	OC	80.85	577.50	600.60	669.90
	SC	80,030.56	-	857,835.00	71,427,708.00
	TC	522,642.30	**468,954.20**	1,462,886.97	71,433,062.64
NCLO-T-	HC	492,719.17	490,038.37	781,760.00	593,283.06
	OC	98.18	490.88	600.60	802.73
	SC	236,100.12	-	3,936,640.00	225,057,760.00
	TC	728,917.46	**490,529.24**	4,719,000.60	225,651,845.79

Table B16 The total inventory costs of high consumption value and essential drugs (AE) with not normally distributed demand (drug group 4) (cont.)

Drug Code	Cost	Min/Max	M5	P	Q
OXAL-I-	HC	698,536.09	626,333.86	1,490,337.18	2,589,860.00
	OC	92.40	496.65	600.60	698.78
	SC	445,941.88	567,777.00	11,943,239.00	713,606,040.00
	TC	**1,144,570.36**	1,194,607.51	13,434,176.78	716,196,598.78
PIOG-T-	HC	270,480.87	243,224.93	383,740.03	274,509.95
	OC	98.18	231.00	600.60	537.08
	SC	90,934.31	-	-	-
	TC	361,513.36	**243,455.93**	384,340.63	275,047.02
PLET1T-	HC	384,681.12	431,995.27	649,927.04	167,310.93
	OC	92.40	560.18	600.60	739.20
	SC	106,268.66	-	2,363,180.50	107,751,493.00
	TC	491,042.18	**432,555.45**	3,013,708.14	107,919,543.13
RECM2I-	HC	420,744.70	643,821.22	661,924.35	143,905.46
	OC	109.73	577.50	600.60	808.50
	SC	200,135.39	-	2,311,918.00	60,290,986.00
	TC	**620,989.82**	644,398.72	2,974,442.95	60,435,699.96
SAIZ-I-	HC	600,003.18	612,007.15	960,779.16	257,176,113.74
	OC	98.18	537.08	600.60	820.05
	SC	192,804.40	-	3,221,436.00	46,131,963,276.00
	TC	792,905.75	**612,544.22**	4,182,815.76	46,389,140,209.79
SERM1T-	HC	746,591.37	615,012.02	907,303.68	1,046,936.11
	OC	92.40	565.95	600.60	866.25
	SC	183,557.45	12,958.00	4,789,906.00	335,636,554.00
	TC	930,241.22	**628,535.97**	5,697,810.28	336,684,356.36
SUPR1I-	HC	573,122.35	578,893.75	1,620,168.66	1,679,124.40
	OC	103.95	346.50	1,201.20	583.28
	SC	255,668.75	-	16,500.00	493,718,250.00
	TC	828,895.05	**579,240.25**	1,637,869.86	495,397,957.68
TAZC-I-	HC	1,154,700.78	1,085,895.42	1,929,080.82	4,246,130.66
	OC	92.40	554.40	1,201.20	623.70
	SC	758,155.13	707,096.00	-	1,061,822,268.00
	TC	1,912,948.30	**1,793,545.82**	1,930,282.02	1,066,069,022.36
TELF2T-	HC	540,842.24	585,843.36	589,501.78	286,424.96
	OC	98.18	594.83	600.60	883.58
	SC	94,127.54	-	-	20,992,200.00
	TC	635,067.95	**586,438.19**	590,102.38	21,279,508.53

Table B16 The total inventory costs of high consumption value and essential drugs (AE) with not normally distributed demand (drug group 4) (cont.)

Drug Code	Cost	Min/Max	M5	P	Q
TIEN-I-	HC	752,841.34	596,201.62	706,927.03	636,813.64
	OC	109.73	490.88	600.60	646.80
	SC	451,171.76	920,025.00	1,373,150.00	210,710,375.00
	TC	**1,204,122.83**	1,516,717.49	2,080,677.63	211,347,835.44
TYGC-I-	HC	1,144,659.35	1,470,696.97	1,933,784.00	1,092,059.79
	OC	98.18	548.63	1,201.20	589.05
	SC	290,831.72	-	18,557.00	444,760,921.00
	TC	**1,435,589.25**	1,471,245.60	1,953,542.20	445,853,569.84
VFEN2T-	HC	1,085,658.76	1,544,814.30	2,395,249.45	2,534,293.77
	OC	92.40	756.53	1,201.20	918.23
	SC	245,998.99	-	708,876.00	722,302,623.00
	TC	**1,331,750.15**	1,545,570.82	3,105,326.65	724,837,834.99
VIAT-W-	HC	6,014,471.60	6,788,180.07	10,351,523.57	127,183,009.58
	OC	132.83	895.13	1,201.20	1,201.20
	SC	15,778,297.77	-	9,346,974.00	26,621,854,056.00
	TC	21,792,902.19	**6,789,075.20**	19,699,698.77	26,749,038,266.78
VISL-Y-	HC	844,943.83	1,164,274.11	1,646,743.64	1,819,364.98
	OC	98.18	993.30	1,201.20	1,022.18
	SC	362,011.98	-	-	508,861,570.00
	TC	1,207,053.98	**1,165,267.41**	1,647,944.84	510,681,957.15

Table B17 The total inventory costs of high consumption value and non-essential drugs (AN) with no trend, normally distributed and static demand (drug group1)

Drug Cost	Cost	Min/Max	M1	M2	M3	P	Q
CALT2T-	HC	460,368.43	618,838.30	447,378.78	224,324.59	894,158.32	234,031.33
	OC	98.18	46.20	63.53	121.28	1,074.15	924.00
	SC	212,267.73	212,267.73	187,127.52	363,495.45	82,953.00	127,227,464.00
	TC	672,734.33	831,152.23	634,569.83	**587,941.32**	978,185.47	127,462,419.33
GLSM-W-	HC	292,495.89	392,938.45	244,833.67	200,739.49	735,370.58	960,221.96
	OC	103.95	51.98	63.53	144.38	352.28	161.70
	SC	163,098.12	163,098.12	373,389.93	948,418.00	3,716,401.00	672,048.00
	TC	**455,697.96**	556,088.54	618,287.13	1,149,301.87	4,452,123.85	1,632,431.66

Table B18 The total inventory costs of high consumption value and non-essential drugs (AN) with not normally distributed demand (drug group4)

Drug Cost	Cost	Min/Max	M5	P	Q
NEBD-I-	HC	432,856.62	613,442.71	416,161.72	356,899.52
	OC	98.18	750.75	300.30	716.10
	SC	282,202.01	-	3,679,200.00	7,736,400.00
	TC	715,156.81	**614,193.46**	4,095,662.02	8,094,015.62
VTBZ-T-	HC	526,276.89	592,944.74	3,718,037.54	251,481.71
	OC	109.73	1,027.95	1,068.38	929.78
	SC	159,003.08	-		18,602,365.00
	TC	685,389.69	**593,972.69**	3,719,105.92	18,854,776.48

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