PHARMACY STOCK INVENTORY SYSTEM

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ABSTRACT

A pharmacy stock inventory system (PSIS) is a computerized system designed for user to manage the stock of the drugs inventory and monitoring the stock facility. The stand alone pharmacy stock inventory system provides alert of expire drugs and minimum quantity of each drugs and also searching algorithm technique applied in this system. A research and analysis on the current system and searching technique was done to get better understanding of the system. The RAD methodology was used in this project development implements iterative development which is suitable for stand alone applications requirements that changes from time to time. Testing is done every phase of the development life cycle to make sure that the system working properly. This project was developed using Visual Basic 6.0 and Microsoft Access 2000 as a database platform. As a final result, this system was fulfilled all the research objectives. This research was successfully developed the PSIS prototype system, computerized and optimized the current system using String Search Algorithm.

ABSTRAK

Pharmacy Stock Inventory System (PSIS) ini adalah sistem berkomputer yang direkabentuk untuk memudahkan pengguna menguruskan stok inventori ubat dan memantau stok-stok ubat yang ada. PSIS ini adalah sistem tunggal yang menyediakan peringatan kepada pengguna berkenaan tarikh luput serta peringatan jika bilangan sesuatu ubat tersebut mencapai tahap minimum. Kajian dan analisa terhadap sistem semasa dan teknik carian telah dilakukan untuk mendapat pemahaman yang lebih baik tentang sistem PSIS. Metodologi *Rapid Application Development* (RAD) telah digunakan dalam pembangunan sistem ini di mana ianya adalah sesuai dengan sistem tunggal yang bercirikan aplikasi permintaan yang berubah dari semasa ke semasa. Fasa pengujian telah dijalankan pada setiap peringkat pembangunan untuk memastikan sistem ini berfungsi dengan baik. Sistem ini telah dibangunkan menggunakan Visual Basic 6.0 dan Microsoft Access 2000 sebagai pangkalan data. Sebagai hasil akhir, sistem ini telah berjaya memenuhi objektif kajian. Kajian ini berjaya membangunkan sistem prototaip PSIS, aplikasi sistem berkomputer dan mengoptimumkan sistem sedia ada menggunakan String Search Agorithm.

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LIST OF ABBREVIATIONS

CPU	-	Central Processing Unit
DBMS	-	Database Management System
GB	-	Giga Byte
HMS	-	Hospital Management System
IT	-	Information Technology
MB	-	Mega Byte
Me	-	Millennium Edition
RAD	-	Rapid Application Development
RAM	-	Random Access Memory
PSIS	-	Pharmacy Stock Inventory System
SDLC	-	Software Development Life Cycle
SQL	-	Server Query Language
VB	-	Visual Basic

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CHAPTER I

INTRODUCTION

1.1 Introduction

There are still in minimum circumstance of pharmacy shop that using the stock inventory system in over the world. Focusing in Malaysia as a case study, the pharmacist itself still didn't realize the importance and advantages using this system but more rely on manual procedure merely.

The entire pharmacist must keep accurate count of their drugs stock inventory. Therefore, it is critical to know the details of each drugs and the stock balance must be immediately updated due to any approved transaction. There is several existing pharmacy inventory system that was widely implemented around the world. For examples is Pharmatrax (Pharmacy Information & Management System). This system is used to seamlessly combine five distinct functions that are vital to a pharmacy prescription, dispensing, billing, purchasing and inventory management.

Pharmacy stock inventory system (PSIS) module deals with the automation of general workflow and administration management process of a pharmacy. The main processes of the system focus on customer's request where system able to search the most appropriate drugs and deliver it to the customers. The PSIS module is equipped with the automated alert features. It able to remind the pharmacist list of drugs that reached the minimum quantity and also support alert reminder for the expired date for each drugs.

1.2 Problem Statement

There have been various developments of inventory management system in recent years before, unfortunately there are still some problem facing on it. The process was slow, tedious, and often inaccurate, mostly because the system couldn't keep up with the hospital's dynamic inventory flows. Thus, stock-outs, overstocks, and outdated materials and their associated costs were a constant problem [8].

Before, if the pharmacy department wanted to know the expired date of the certain drugs the pharmacist itself must go and check on the paper, so this is take a lot of time. There are still in minimum quantity of system that able to give an alert message or reminder for the expired date for each drug in the stock. With the pharmacy system, we had access to real-time and accurate information [8].

With the PSIS, the accurate information could be retrieved. This system took away a lot of manual tasks, and it fulfilled main goal of getting rid of as much paper as we possibly could. Plus, the windows based system is user-friendly; the point-and-click graphic display is easy to navigate. Sometimes pharmacist didn't realize the inaccurate distribution of expenses and the inventory level is not known. Besides that, pharmacist also always do the common mistake which is they will make the multiple orders for the same product.

i. A lot of manual task.

ii. No alert message to remind for the critical quantity of each drug.

iii. No alert message to remind for the expired date of each drug.

iv. No automated process in manipulating data such as add, insert, delete and searching.

1.3 Objectives

i. To develop a prototype of pharmacy stock inventory system.

ii. To computerized the manual task in term of pharmacy stock inventory

iii. To apply string match searching algorithm technique in order to search the appropriate drugs based on the description of drugs.

1.4 Scopes

i. The system was developed in Windows environment, which is familiar to various classifications of users, with or without IT background.

ii. This is a stand alone system.

iii. The system was designed to track record of the stock of the pharmacy inventory.

iv. The size of sample data of drugs is 2359.

v. The user of this system is pharmacist.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

The use of computers in pharmacy has expanded rapidly over the last 10 years [7]. They have changed both institutional and community practice dramatically. Computers have automated many of the traditional technical functions of pharmacists, enabling them to increase their clinical activities. The working conditions of the community pharmacist have also undergone unprecedented changes as a result of computerization. For example, prescription refills, which may account for three quarters or more of a drug store's. As the 1990s begin, it is difficult to find many drug stores which do not have some sort of computer [7]. Many, in fact, have several. Computerization has even extended beyond the pharmacy department into the remainder of the store. Inventory management, point-of-sale information and virtually any other function within a drug store which lends itself to automation has been computerized [7].

Generally, Pharmacy Management System is a system that consists of data entry, retrieval and stock monitoring facility, tracking drug dispensing pattern, generation of reports and statistics and others. Pharmacy Management System focuses on pharmacy store operation and how it manages the inventory flow with suppliers (external) and departments' dispensary (internal). The system covers typical operations like receiving medication from suppliers, processing departments' medication requests, distributing medication to departments, returning expired medication to suppliers.

The system also maintains an inventory book on stock in/out details and provides monthly inventory report and statistics on medication consumption. Pharmacy inventory management keeps track of patient, doctor, drug and prescription records. It will print receipts of indent, invoice, stock details, bills and others. Pharmacy inventory management deals with all medical items. Activities include enquiry, purchase order, online approval, maintenance of drug inventory, online request for stock from various sub-stores, online stock transfer, maintenance of stock at different sub-stores, return of items nearing expiry, physical stock verification and adjustment and many other activities.

Pharmacy Management System is a drug stock inventory system that consists of data entry, retrieval and monitoring stock facility, alert of expire drugs and minimum quantity of each drugs. String searching technique also applied in this system. This technique is referring by drugs name, drug code and description of the drugs. Besides that, the system also provides two types of alert method which are quantity and expire date of the drugs. This system always checking the date to remind the pharmacist if the certain drug was expires and will be triggered to remind the pharmacist if the certain of the drugs reached the minimal quantity. This system gives an alert message so that pharmacist able to control and monitor the drugs stock very well.

2.2 Pioneering Research

The three basic methods of inventory control are the visual, periodic and perpetual systems [9]. The visual system is simply that, a visual inspection of what is on the shelf. It may include a comparison with a listing of how many units should be carried. When the stock falls below the level and order is placed. The visual system is simple, inexpensive and requires no special training. However, visual systems are imprecise and tend to focus on impeding stock-outs rather than excess inventory [9].

Furthermore, visual systems do not consider the monetary investment in inventory. In this system, stock on hand is counted at periodic intervals and compared it the desired inventory levels. Items that fall below the desired level are then orders. Because on evaluation of inventory levels is made on a more formal basis, this system tends to be more precise than the visual system [9].

The perpetual system is the most elaborate and more accurate method of inventory control [9]. Under the perpetual system, inventory is monitored at all times, and it is possible to determine the number of units in stock of any time at any time. However, it is the most labor intensive and most expensive. The use of computer systems makes the perpetual system available to most pharmacy managers. In reality, most pharmacies employ a combination of all three systems in the operational procedures of pharmacy. A visual system may be employed to place routine orders, with a periodic system in place to monitor the entire inventory. Certain items such as controlled substances, expensive items, or items of a critical nature may be controlled using a perpetual system. When combined with purchase history reports from the wholesaler, the pharmacy manager has a wealth of data available to control inventory [9].

2.3 Existing Systems

There are many existing of pharmacy inventory systems in the worldwide nowadays. Pharmacy operations, as one might assume, lend themselves particularly well to inventory control techniques due to the need of the supplier (the pharmacy) to meet the patients' demand for medications. The need for the demand to be met must be balanced against the standard inventory costs (e.g. holding cost, reorder cost, etc.). When determining a medicinal inventory policy, one must consider that the demand for drugs can be either deterministic or stochastic. There is a multitude of literature relating stochastic processes (as applied to inventory theory) to drug distribution. This discussion is not intended to encompass all of the work that has been done in this field. [6]

Inventory control of drugs is basically a special case of perishable inventory control theory (which is itself a special case of general inventory control theory). There are a large number of articles describing stochastic inventory systems. Many of the authors note that the majority of the literature on inventory models describes demand as deterministic, though stochastic demand is actually more appropriate in many cases. [6]

2.3.1 Tipton County Memorial Hospital

Hospital Management System's (HMS) integrated pharmacy solution provides online access to all vital pharmacy functions such as medication administration records and med labels, patient profiles and medication charges. One of the pharmacy modules of this integrated system is faster order entry. The system allows the pharmacy department to input medication orders by mnemonic code, brand or generic description. It supports default values, such as dose, frequency, route of administration and standard comments.

Second module is tailored reports. The system includes a flexible tool that can create unlimited reports, including customized monitoring of workload statistics and drug usage. Convenient integration is the last of the pharmacy module. The Pharmacy solution links with HMS's Laboratory solution to display key lab values that affect a patient's medication profile. It also integrates with HMS's Materials Management solution to provide accurate, perpetual inventory control.

2.3.2 Pharmatrax (Pharmacy Information & Management System)

This system is used to seamlessly combine five distinct functions that are vital to a pharmacy - prescription, dispensing, billing, purchasing and inventory management. This system contains item entry, purchase order and item maintenance for easy mark-up on the items. The sales modules are divided into different types of patients such for in-patient, out-patients and walk-in patients. Every sales transaction is automatically deducted from the stock quantity for automatic inventory generated report.

Other module is generating report. The reports contains such as Sales Report, Stock Allotment, Stock Movement Status, Monthly consumption report as to fast moving or slow moving, Inventory, Delivery Report and Stock card for easy item assessment. This system also alerts user for any expiring medicines and medicines that needs re-order.

2.3.3 Pharmaceutical Management System

The existing system focuses on pharmacy store operation and how it manages the inventory flow with suppliers (external) and departments' dispensary (internal). The system covers typical operations like receiving medication from suppliers, processing departments' medication requests, distributing medication to departments, returning expired medication to suppliers. The system also maintains an inventory book on stock in/out details and provides monthly inventory report and statistics on medication consumption. Pharmacy System keeps track of patient, doctor, drug and prescription records. It will print receipts of indent, invoice, stock details, bills and others.

Pharmacy System deals with all medical items. Activities include enquiry, purchase order, online approval, maintenance of drug inventory, online request for stock from various sub-stores, online stock transfer, maintenance of stock at different sub-stores, return of items nearing expiry, physical stock verification and adjustment and many other activities.

First the records of the medication will be received from suppliers and adds to the store of the inventory and then the approval form department's medication must be requested and then updates both store and department inventory. Enquires the store inventory and automated perpetual inventory control.

The issues the request to suppliers and the whole records quantity accepted by them and automatically the amount from store inventory will be deducted. After all the process was completed, all the detail listing of stock in and out activities for a given time period, by medication, medication type, and supplier.

2.3.4 Hospital 2000 Pharmacy Information System (PhIS)

The Hospital 2000 Inventory module, coupled with the Purchasing module, provides a complete Materials Management Solution for hospitals. Completely integrated with the Hospital 2000 system, Inventory automatically records and manages in real time all changes in stock levels throughout the hospital. Whenever an item is sold, dispensed within the hospital or has its stock level adjusted, its movement is immediately recorded and simultaneously visible to Inventory users. As items are charged to a patient's account, they are automatically deducted from the inventory of the providing store.

Replenishment between stores occurs either automatically or semi-automatically, as set up per item per store. When an item reaches a defined minimum level, a purchase request is automatically available for processing in the Purchasing module. All inventory movements are posted to the General Ledger.

Inventory workflows are further enhanced with the addition of peripheral devices such as hand held stock check devices and full barcode printing and reading functionality. In addition to automating the routine workflow of a pharmacy, the Hospital 2000 PhIS provides tools for the enterprise-wide management of medication administration, critical in the reduction of risk in the medication administration process.

First module is Traditional and online ordering. This is support for either direct online ordering by physicians or centralized order data entry by pharmacists using handwritten orders transmitted to the pharmacy using the Hospital 2000 document imaging feature. Online Inventory stock level access also support in this system. Integration to the Hospital 2000 Inventory system provides accurate real-time pharmacy stock levels. The dosage recommendations is available that suggests appropriate dosages and frequencies upon medication selection.

2.4 The Comparison of Existing System

The comparison between current systems used does have their own features. The comparisons of existing systems are showed in the **Table 2.1.**

Table 2.1: The Comparison of Existing Systems

System	Package	Alert Expire Date	Ordering	Bar Coding
Tipton County Memorial Hospital	Integrated	No	No	No
Pharmatrax	Alone	Yes	No	No
Pharmaceutical Management System	Alone	No	No	No

Cont Table 2.1: The Comparison of Existing Systems

System	Package	Alert Expire Date	Ordering	Bar Coding
Hospital 2000 Pharmacy Information System (PhIS)	Integrated	No	Automatic	Yes

2.5 Advantage and Disadvantages of Current System

The current system used does have some advantage and disadvantages. The list of the advantage and disadvantages is shown in the **Table 2.2.**

Table 2.2: Advantage and Disadvantages of Current System

Advantage	Disadvantages
Use directed counting, where the portable unit displays each item to be counted, or with bar coding where the user simply scans the bar code for each item and then enters the quantity.	Unable to detect and no automatic validation and warning for the expired date and minimum quantity for each drugs in the stock
	Not apply searching technique for which can find drugs that suitable with the disease

2.6 Problem Solving Techniques

There are many steps and activities involved in building software product. Problem solving techniques is a technologies used to solve the problem encounter in the system development. String Match Searching Algorithm is a very important subject in the wider domain of text processing. String Match Searching Algorithm are basic components used in implementations of practical software's existing under most operating systems. Moreover, they emphasize programming methods that serve as paradigms in other fields of computer science (system or software design). Finally, they also play an important role in theoretical computer science by providing challenging problems [10].

Although data are memorized in various ways, text remains the main form to exchange information. This is particularly evident in literature or linguistics where data are composed of huge corpus and dictionaries. There are three examples of string searching algorithm that widely used for this approach such as Karp-Rabin Algorithm, Tuned Boyer-Moore Algorithm and String Match Searching Algorithm.

2.6.1 Karp-Rabin Algorithm

The Karp Rabin Algorithm has two modes of operation, Preprocessing Phase and Search phase. Preprocessing phase involves initial calculations and hashing of pattern to search. The algorithm then enters the Search phase, wherein it hashes the "pattern-sized" substrings obtained from the text and compares the hash values with the hash value of the pattern derived in the preprocessing phase. A match indicates the presence of the pattern in the text. Hashing provides a simple method to avoid a quadratic number of character comparisons in most practical situations. Instead of checking at each position of the text if the pattern occurs, it seems to be more efficient to check only if the content of the window "looks like" the pattern. In order to check the resemblance between these two words and hashing function is used [10].

To be helpful for the string matching problem an hashing function *hash* should have the following properties:

i. Efficiently computable

ii. Highly discriminating for strings

iii. hash($y[j+1 .. j+m]$) must be easily computable from hash($y[j .. j+m-1]$) and $y[j+m]$:

iv. hash($y[j+1 .. j+m]$)= rehash($y[j]$, $y[j+m]$, hash($y[j .. j+m-1]$).

For a word w of length m let hash(w) be defined as follows:
hash($w[0 .. m-1]$)=($w[0]*2^{m-1}+ w[1]*2^{m-2}+\cdots+ w[m-1]*2^0$) mod q
where q is a large number.Then, rehash(a,b,h)= (($h-a*2^{m-1}$)*2+b) mod q

The preprocessing phase of the Karp-Rabin algorithm consists in computing hash(x). It can be done in constant space and $\boldsymbol{O}$ (m) time.

During searching phase, it is enough to compare hash(x) with hash(y $[j .. j+m-1]$) for $0 \leqslant j < n-m$. If an equality is found, it is still necessary to check the equality $x=y$ $[j .. j+m-1]$ character by character.

The time complexity of the searching phase of the Karp-Rabin algorithm is $\boldsymbol{O}(mn)$ (when searching for a^m in a^n for instance). Its expected number of text character comparisons is $\boldsymbol{O}(n+m)$.

2.6.2 Tuned Boyer-Moore Algorithm

The Tuned Boyer-Moore is an implementation of a simplified version of the Boyer-Moore algorithm which is very fast in practice. The most costly part of a string-matching algorithm is to check whether the character of the pattern match the character of the window. To avoid doing this part too often, it is possible to unrolled several shifts before actually comparing the characters.

The algorithm used the bad-character shift function to find x [m-1] in y and keep on shifting until finding it, doing blindly three shifts in a row. This required to save the value of *bmBc*[*x* [*m*-1]] in a variable *shift* and then to set *bmBc*[*x* [*m*-1]] to 0. This required also to add *m* occurrences of *x* [*m*-1] at the end of *y*. When *x* [*m*-1] is found the *m*-1 other characters of the window are checked and a shift of length *shift* is applied [10].

The comparisons between pattern and text characters during each attempt can be done in any order. This algorithm has a quadratic worst-case time complexity but a very good practical behavior [10].

2.6.3 String Match Searching Algorithm

String Match Searching Algorithm is an important class of string algorithms that try to find a place where one or several strings (also called patterns) are found within a larger string or text.

Let Σ be an alphabet (finite set). Formally, both the pattern and searched text are concatenation of elements of Σ. The Σ may be usual human alphabet (A-Z). Other applications may use *binary alphabet* (Σ = {0, 1}) or *DNA alphabet* (Σ = {A, C, G, T}) in bioinformatics.

2.6.3.1 The Matching Rules

There are six (6) basic rules that regular expressions apply in order.

i. Starting before the first character, try to match the pattern on everything to the right, then subtracting characters right to left. If no match then repeat starting after the first character, and so on. **Figure 2.1** is the example of it which will match “ar” in “Cart” that will show how the algorithm works.

Cart // Does "Cart" match? ... NO
Cart // Does "Car" match? ... NO
Cart // Does "Ca" match? ... NO
Cart // Does "C" match? ... NO
Cart // Does "" match? ... NO
Cart // Does "art" match? ... NO
Cart // Does "ar" match? ... YES

Figure 2.1: Sample How the Algorithm Works

ii. The whole pattern is regarded as a set of alternatives separated by vertical bars (|).

iii. Any specific alternative matches if every assertion or quantified atom in the alternatives matches sequentially according to Rules iv and v.

iv. If an assertion does not match according to the following table, backtrack to Rule iii and try a higher-pecking-order item with different choices.

Table 2.3: Assertion and Description of the String

Assertion	Description
^	Matches at the beginning of the string.
$	Matches at the end of the string.
\b	Matches a word boundary (between \w and \W), when not inside [].
\B	Matches a non-word boundary.

v. A quantified atom matches only if the atom itself matches some number of times allowed its following quantifier. Multiple matches must be adjacent within the string. If no match can be found at a