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Department of Computer Science**

**BSCCS Final Year Project 2014-2015
Interim Report II**

(14CS079)

Chinese Medicine Clinic Management System

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Student Name : TSE Chun Fai

Student No. : 52575247

Programme Code : BSCCS

Supervisor : LEE, Chung Sing Victor

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Abstract

Healthcare services is one of the essential elements of our life in modern society. Healthcare services are not only include disease cure and body repair, but healthy status promotion and harmony of the systems maintenance in our bodies as well. The majority of Hongkongers may have a concept that Western Medicine relieves symptoms for short-term or immediate effect while Traditional Chinese Medicine (TCM) restores the harmony of different parts of our body and keep us healthy in the long run.

Use of information technology (IT) solutions would probably ease TCM practitioners' daily works as the attentions and needs of TCM is keep increasing. In Hong Kong, no matter what kinds of healthcare services settings, all the activities will come up with records and documentations. When the business runs for years, the management for records and documentations would become tedious and messy if they are managed manually in hardcopy. A lot of the Western Medicine practitioners have adopted some commonly use solutions like The Hong Kong Medical Association's Clinic Management System 3.0. However, only about a half of TCM practitioners have incorporated IT solution in their business.

There are some major reasons behind that they do not adopt IT solutions. First, there are not enough choice of systems in the market. Second, the existing solution is not cost effective. Third, functions and business rules implemented in some existing solutions may not be useful or may even hinder their work. Fourth, some existing solutions may require a lot of Chinese character typing work. Last but not least, there is no standard being widely used in the industry for the terminologies used at this moment and the system does not allow for customization.

Therefore, a system, which trying to solve the problems above, will be developed in this project. The system will provide some basic functions like prescription making and patient and system administration, it also provide

some advanced functions like suspected overdose alert and drug compatibility alert. It also support a certain degree of customization to solve the problem of no commonly adopted terminology standard. The system can also co-operate with the deliverable of AU-YEUNG Wing Shing's final year project (project code: 14CS078) to provide value-added function like drug reservation.

Other than the above features, the solution proposed by this project supports multiple clinics and possesses with health records sharing feature. Some doctors may work for multiple clinics. The doctor can login to the system and view their patients' consultation records entered to the system in other clinics. This allow the doctor to know the history of their patients and provide a better treatment.

Furthermore, this solution can also help forming the standard for the terminologies used in the TCM industry. All the user can contribute their customized item to the system. The set of items with higher using frequency, which set of items would probably become the standard.

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1. Introduction

1.1. Background Information

Healthcare services is essential in the modern society. Healthcare services are not only including those treating our diseases and repairing our body, they also include those keeping our body in a healthy status and maintaining the systems in our bodies work well. The majority of Hongkongers may have a concept that Western Medicine is for relieving symptoms while Traditional Chinese Medicine (TCM) is for restoring the harmony of different parts of our body and keeping us healthy in the long run.

Nowadays, staying healthy is one of the hot topics in the city. In addition to the aging problem in Hong Kong, more and more concerns about diseases associated with old age and weakened systems in bodies are being emphasized on. It is claimed in one of the World Health Organization's Commission on Intellectual Property Rights, Innovation and Public Health Studies that spreading TCM to all the places on the Earth is beneficial for people's health (Jia, n.d.). From this, we can see the status of TCM keep rising all over the world. Thus, the attention on TCM and the needs of TCM are growing.

1.2. Existing Problems

No matter what kind of healthcare services settings, TCM or Modern Western Medicine, it is all about consultation, medication, treatments and procedures. These activities need to be recorded and keep track by documentation. As the population in Hong Kong keeps growing (Census and Statistics Department, 2014), the demand of healthcare services will greatly increases. As the amount of patient increases, the number of records produced will also increase exponentially. Unfortunately, for clinics, these records are in written form, which means all these records are in hardcopies. When their businesses just start up, it might be still able to keep and manage few hundreds piles of health records. When their clinics run for years, it may be

difficult for clinics to find and manage thousands decks of patient profiles. It may also be a problem for storing such a huge amount of hardcopy paper records in a clinic as the size for clinics is usually small and rental fee is high.

In this situation, information technology can help. For Modern Western Medicine, there are plenty of solutions for clinical management and the majority of clinics and hospitals have adopt these solutions. For government Western Medicine clinics and hospitals, they all use the Hospital Authority (HA) in-house developed Clinical Management System (Hospital Authority, 2014). For private clinics, they adopted some popular solutions like The Hong Kong Medical Association's CMS 3.0 (Food and Health Bureau, 2014). For Hospital Authority running TCM clinics, most of them are using the in-house developed system, Chinese Medicine Information System (Health, Welfare and Food Bureau, & Hospital Authority, 2007; Hospital Authority, 2011). However, for private Traditional Chinese Medicine clinics, most of them have not adopted any of the solutions mentioned above. There are less than a half of practitioners in Hong Kong are using IT facilities for their work and only a half of them are satisfied with the currently adopted system (eHealth Consortium Limited, 2010).

1.3. Motivation

There are some major reasons to explain why TCM practitioners have not adopted IT solutions.

First, there may not have enough systems, which can be chosen, in the market (eHealth Consortium Limited, 2009). This may increase the difficulties to find the best solution. For example, considering a clinic which only provides consultation services. Those integrated clinical and sales systems may not fit their business. Thus, the clinic would probably refuse to adopt the solutions.

Second, the cost of many existing solutions is expensive (eHealth Consortium Limited, 2010). Like the case mentioned above, the sales management part is

not necessary for the clinic. This means that clinics are paying extra for functions which they do not need. If the cost of the system outweighs the profit or even the benefits they get, this would make the TCM practitioners hesitate to adopt those solutions.

Third, there is no standard being widely used in the TCM industry for the terminologies used at this moment (Food and Health Bureau, 2014) and practices for different doctors may vary (eHealth Consortium Limited, 2010). This would cause inconvenience to users if the system being used does not provide flexibility to do a certain degree of customization.

Fourth, as told by some existing system users, functions and business rules implemented in existing systems may not be useful or may even hinder their work. For example, if the doctor prescribes an herb with dosage larger than the suggested dosage stated in the system, the system will block the doctor from exercising their professional judgment for prescribing the recipe. This would lead to change of treatment and use a suboptimal recipe for the patient.

Fifth, some senior doctors may not be able to type Chinese characters in an acceptable speed or even cannot type Chinese. If the system requires users to type a lot for making prescription and entering history, this would discourage the doctors to use the solution.

Therefore, a system which incorporates more knowledge of the business domain and can be run under acceptable cost is needed.

1.4. Project Objectives and Scope

In Hong Kong, there are different scales of business regarding TCM clinics, from single doctor clinics for consultations only to clinics run by healthcare corporates with multiple doctors on duty at a time and dispensary with self-owned supply chain. In order to fit as much types of business as the system can, the system will only handle clinical and medication records part. For

sales and dispensary part, it will be the deliverable of AU-YEUNG Wing Shing's final year project (Project Code: 14CS078). When combining the two systems together, it can form an integrated clinic information system.

In this project, a system that can help users with their daily jobs will be developed. The system should be possess with some basic functions including patient administration, consultation record management and documents generation functions. In order to keep the system can running at low cost, the tools chosen would be freeware. In order to solve the problem raised by no widely adopted standard for terminology used in the industry, the system should allow a certain degree of customization to fit different users. Furthermore, this system would not stop the user from exercising professional decision. Once suspected decision errors and abnormal situations happens, the system will remind or warn the user instead of stops the action like the case mentioned in Section 1.3 point four. Concerning the Chinese typing ability of users, this system would minimize the chance of using word-typing input.

In the development process, opinions and suggestions from potential users will be received so as to optimize the system for practical use.

Concerns of Internet security will not be addressed in this project and adoption of basic existing measure remain, i.e. anti-virus and firewall software.

2. Literature Review

In Hong Kong, information technology solutions has been used for daily operation in healthcare sector for a period of time. Just take the example of Hospital Authority, they use their in-house developed Clinical Management Systems since 1995 (Hospital Authority, 2014). It has been run for nearly 20 years. There may be some features or designs that can be learnt for this project. In the market, there are also some solutions for Traditional Chinese Medicine practitioners. However, it is not popular among the industry. From them, we can know what is unfavorable by the users. Thus, a solution that can be applied to various situations can be developed. The following are some related solutions that have been studied.

2.1. HA Clinical Management System

Hospital Authority's Clinical Management System (HA CMS) is an important system in the HA. It is used by nearly all the HA clinicians providing healthcare services (Hospital Authority, 2011). It provides a system for clinicians to access and create patient records within or outside itself (Solomon, 2008).

HA CMS in phase III development to enhance its function and features providing in the existing system in order to help the HA to provide services with high quality, less errors and high efficiency (Hospital Authority, 2011). In this sophisticated system, it provides drug allergy checking function (Hospital Authority, 2013) and this might also be useful in Chinese Medicine setting. However, some clinicians may find that the system's user interface keep changing frequently and they cannot adapt to the updated system easily. Thus, it may lead to errors due to clicking the wrong buttons.

2.2. HA Chinese Medicine Information

System

Hospital Authority's Chinese Medicine Information System (CMIS) is the information technology solution adopted by Chinese Medicine Centers for Training and Research (CMCTRs) (Hospital Authority, 2011). According to Leung et al. (2012), it is an integrated system in-house developed by HA for helping clinicians with their daily tasks and sharing data among clinics. Furthermore, it also serves for data collection for researches and studies.

CMIS has implemented functions facilitate all aspects in the daily workflow. For instance, herb-herb interaction and dosage checking functions have been implemented in order to increase the quality and safety of services provided by reducing human errors due to carelessness. What is more, CMIS seems to be the first system developed for Hong Kong TCM industry enforcing a terminology standard. Besides, advanced functions like monitoring the suspected outbreak of infectious diseases also provided in the system which can help in administration-level staff's work. In order to keep the services quality improving, Key Performance Indicators also implemented in CMIS. As this system is centralized, it can launch policies or standards like International Classification of Diseases 11th Revision (ICD-11) which is going to be release by 2017 (World Health Organization, 2014) with ease. It may be the most comprehensive and useful system that suits corporate level healthcare services providers.

However, there is quite a few number of clinics are in such a large scale. Most of TCM clinics are small to medium enterprise level. Those surveillance and performance monitoring function may not be useful to those common clinics and these functions may requires a large amount of resources, thus increase the cost. From a LegCo document, over five million of Hong Kong dollars were used for the implementation of CMIS in five CMCTRs (Health, Welfare and Food Bureau, & Hospital Authority, 2007), i.e. over one million per clinic. This huge amount of budget seems not affordable by those common clinics.

2.3. KT Chinese Medical Integration System

KT Chinese Medical Integration System (in Chinese: 國泰中醫整合系統) is a system developed in Taiwan. This system is being used by some clinics in Hong Kong. According to the website (國泰電腦有限公司, &國圓科技股份有限公司, n.d.), it is an all-in-one system which can support a whole workflow in clinics, including consultation, drug dispense, point-of-sales and clinicians roster scheduling. It supports various well-known database systems with different performance, from MySQL to Oracle and Informix. This system can also connect with peripheral systems like queue number calling system which can make the clinic look modern and give their client more confidence on their services.

This system may be suitable to some large clinics in Hong Kong as it possesses with a queuing system and also has the ability to cooperate with other peripheral systems. However, as this system is developed based on Taiwan's TCM industry, some of the functions implemented in the system may not be useful in Hong Kong or even tailor-made for Taiwanese.

2.4. Clinic Management System by ONE-POS

The TCM clinic management system developed by ONE-POS is called 中醫診所管理系統. It is a Hong Kong local developed system. It provides users with patient administration, health record management and point-of-sales functions (IT Force (Hong Kong) Limited, 2014). Based on the functions provided, the system might fit a lot of clinics in Hong Kong. However, from the screen capture provided in the website (IT Force (Hong Kong) Ltd., 2014), it seems they mixed the domain of sales and TCM clinics. The functions buttons of the

two domains mixed in one panel and this would make the user confused. From the user interface captured, it can be seen that this system requires a lot of word typing for entering the diagnosis and health records. Since doctors, especially those experienced, may not be familiar with word typing and thus cannot use the system.

2.5. Summary

In the systems developed by Hospital Authority, both of them possess with a common type feature, which is drug checking. This drug checking function includes the checking of drug compatibility and patient allergy history. The HA implements this kind of function in both systems, which may indicate that the function could probably reduce prescription faults due to carelessness. Therefore, this function can be considered to implement in this project.

For the problem of frequently changing user interfaces, this problem may be able to solve by changes on-demand. The layout or order of permissible options will only be changed when the user wants to change the order.

Consider the business domain mixing problems, this would be solved by separating the domains by two systems, like the system to be developed in this project only focus on clinical part and the one to be developed by AU-YEUNG's will be focusing on pharmacy and sale part.

3. Technology and Tools Reviews

3.1. Application Type

In business setting, most commonly used devices should be personal computers. Most of these computers are using Windows as their operating systems (Net Application.com, 2014). Thus, applications used on these computers mainly three types, Windows applications, Java applications and web applications. However, Java applications run on Java Virtual Machine which requires more resources and may not be able to run on slow or old computers. Therefore, in this project, only Windows application or web application will be considered as type of the application.

3.1.1. Windows Application

Windows application for this system will mainly consist of two parts, client application and server. The server is the connected database. For Windows application, developers can use .NET framework for the development. With the frameworks, useful libraries provided allow programmers to develop the system with nice graphical user interface easily. However, Windows applications can only be run of Windows, thus limited the user scope on Windows users.

3.1.2. Web Application

Web application for this system will mainly make up of three parts, web browser, web server and database. This type of application can provide a cross platform feature. However, the user interface is rendered by the web browser and different browser or even different version of browser may have different behavior on the same coding. This may trigger some abnormal behavior of objects on the user interface and increase the degree of difficulty on development.

3.1.3. Conclusion

Windows application would be chosen for this system. The system should be stable enough for users to use. It should not depend on third-party software too much as defects in those software will let the errors propagate to the system to be developed, thus decrease the confidence of using the system. Web application depends on web browser while Windows application not. Furthermore, Web application rely on two remote components, web server and database while Windows application only depends on one, which is database. The system to be developed is target for small to middle size clinics and they usually do not have much budget to have back-up or stand-by server for them. Thus, one of this component fails will lead to the system collapse. Also, the network condition may affect the performance in data transfer. More remote components, higher the chance of data transfer. Relying on more remote component may decrease the reliability of the system. Therefore, Windows application in client server model may be more suitable for this project.

3.2. Reporting tools

In the system going to be developed, it possesses with document generation and reporting functions. A reporting tool can help doing these job well with ease. In this project, JasperReports and Crystal Reports will be considered as the writer is more familiar with.

3.2.1. JasperReports

According to Jaspersoft Community (TIBCO Software, Inc., 2014), JasperReport is one of the popular open source reporting engines. It is written in Java and able to use different kinds of data source. The generated documents can be print or exported to different format including PDF.

3.2.2. Crystal Reports for Visual Studio

Crystal Report is a well-known commercial tool for reporting. According to its

official webpage (SAP, n.d.), it provides a developer version for Visual Studio development environment for free with some restriction on profit making. Developers can design the report layout under the Visual Studio environment and deploy and sell the product without putting extra charges on the client. However, the reports or documents generated requires a freeware, Crystal Reports Viewer, to view and print the reports.

3.2.3. Conclusion

Crystal Reports for Visual Studio will be chosen as the client application will be a Windows application and will use Visual Studio as the integrated development environment. Also, the application will not use Java as the programming language, if JasperReports is chosen, extra container and engine will be needed and which the setup is tedious. Therefore, Crystal Reports for Visual Studio would be better for this project.

4. Proposed Solution, System and Design

4.1. Solution and System Overview

This solution is aimed at supporting the clinical operation for all scales of TCM clinic business, from single staff clinics to chain-store like clinics operate by healthcare cooperates, in Hong Kong. Different from the many of existing solutions, which only simply support single user or single clinic with multiple user, it supports multiple clinics and multiple users.

This system provides health records sharing feature. Nowadays, doctors may work for multiple clinics and their patient may also have consultations offer by them at different clinics. If those clinics are using hardcopy health records or those single clinic system, the health records may not be able to transfer from clinic to clinic for an instantaneous reference by the doctor. Once the clinics joint together and use this system, the health records can be viewed in the same clinic when the records issued or by the doctor in-charge at any clinics using the system. This can let the practitioners know the patient history more and provide better treatments.

Considering the diversity of Chinese typing ability of TCM practitioners in Hong Kong, this system will provide some commonly used drug names and terms for user to choose which is different from a lot of solutions in the market, require a lot of text typing effort. In this system, user can easily choose the term they want by clicking the screening criteria. If the term is not exists in the database, they can still enter it by free-text. Furthermore, the preset terms related to cases differentiation, symptoms and diagnosis are based on the World Health Organization (WHO)'s WHO International Standard Terminologies on Traditional Medicine in the Western Pacific Region (WHO Regional Office for the Western Pacific, 2007).

Once the electronic health record sharing system developed by the government is ready for TCM sector and they adopt the same code set or

International Classification of Diseases 11th Revision (ICD-11) which is due by 2017 (World Health Organization, 2014), this system can adapt to it and sharing the health record with less effort.

4.2. System Function and Features

This system will provide four user roles and they can use different features and functions. The four user roles are system administrator, clinic administrator, doctor and staff respectively.

The main functions of the system are as follows.

Basic functions:

- Patient queue management
- Input consultation records
- Make prescription
- View patient medical history
- Document generation
 - Prescription
 - sick leave certificate
 - visiting certificate
 - pregnancy certificate
 - medical history report
- Administration
 - Add patient
 - Add/delete clinic
 - add/delete users
 - add/delete drug items
 - change patient information
 - change clinic information
 - change user information
 - change drug data
 - add/delete/change predefined prescription formula

Advanced functions:

- Consultation Booking
- Suspected overdose alert
- Drug allergy alert
- Incompatible drug alert
- Analysis and Reporting
 - Analysis on drug using within a designated period of time
 - Analysis on case diagnosis within a designated period of time
 - Report on no. of cases followed by each doctor within a designated period of time

Value-added function (co-operate with AU-YEUNG's project):

- Drug reservation
- Drug availability checking

For system administrator, he/she can use all the administration functions except functions for predefined prescription formula.

For clinic administrator, he/she can perform patient administration (registration and queue management), generate medical history report, change information of the clinic where he/she login, add user and user role for his/her clinic, drug data and predefined prescription formula administration and use the reporting function.

For doctor, he/she can perform patient administration, predefined prescription formula administration and consultation booking. He/she can also do consultation, including input and view prescription and consultation record, issue different certificates and medical history report. He/she can use the reporting function.

For staff, he/she can only perform patient administration.

4.3. Use Case Diagram

The following is the use case diagram for this system which can provide a better understanding and overview of functions that the system intended to provide. The use case for patient is not the main focus of this project. The system prototype can perform these use cases are for making the system complete.

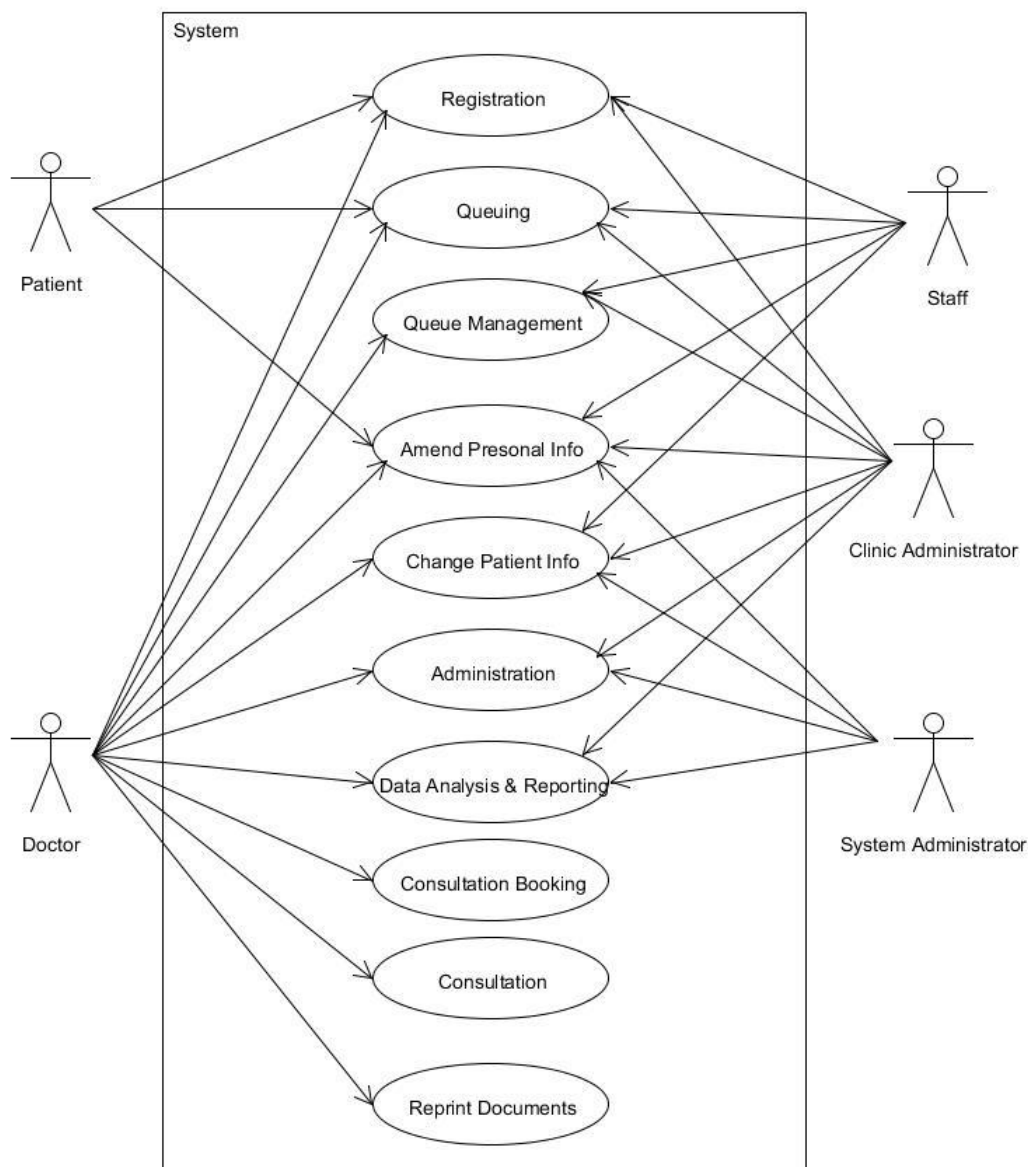


Fig 4.1 Use Case Diagram

4.4. Functional Requirement

4.4.1. Registration

This function allows new patient to register a patient record for receiving services. It allows users to enter patient's personal particulars such as name, gender, date of birth, Hong Kong Identity Card (HKID) or Passport number, contact phone number and account password. If the patient have known drug allergy or have special genetic condition like Glucose-6-phosphate dehydrogenase deficiency (G6PD, in Chinese layman term: 蠶豆症) and need to avoid using certain drugs, the information also can be specified within this function. If the record is created successfully, Patient ID generated from the system will be shown on the screen.

4.4.2. Queuing

For using this function, the patient must be an existing patient in the system. Patient record can be founded by using Patient ID, contact phone number and/or HKID/Passport number. If more than one records found, the program will ask the user to choose the correct record. Once entered the queue, the position of the patient in the queue will be shown on the screen. The patient can leave the queue while waiting for consultation. Once patient enters the queue, they will be given a status. Further discussion on the implementation of queuing and the mechanism for the status flow will be in Section 5.2.8.

4.4.3. Queue Management

For clinic administrator, staff and doctor only. Clinic staff can perform call names and assign doctor in-charge for the patient. They also can give a priority consultation to a designated patient. Once the patient is called, the patient's status will change from waiting to "entering consultation". Doctor can also perform the same action, but the status will change to "in consultation" instead. Doctor can also change the patient who has just been called by staff, i.e. with status "entering consultation" to "in consultation" when seeing the

patient. Staff can change the assigned doctor in-charge when the patient's status is not yet change to "in consultation" in case of assigning the wrong doctor.

4.4.4. Amend Personal Information

For all users, they can change their own personal particulars and password in this function.

4.4.5. Change Patient Information

This function allow users to change patient information, including patient's personal particulars, allergic history and password.

4.4.6. Administration

This function is for administrators and doctor only. System administrator can create, amend and suspend clinic records and user accounts. They can assign role to users for all clinics. Clinic administrator can create, amend and suspend user account and amend their own clinic information. They can assign role to user for their clinic only. Administrators and doctors can add, amend and suspend drug items and predefined prescription formula.

4.4.7. Data Analysis and Reporting

This function is for doctors and administrators only. They can get the report on drug dispensing frequency, diagnosis and number of cases attended within a given period of time.

4.4.8. Consultation Booking

This function is for doctors only. They can manage their booking schedule over all the clinics where they have the doctor role. Patient cannot do booking through this system prototype by their own. They must do booking through the doctor they would like to see.

4.4.9. Consultation

Doctors can enter the symptoms, differentiation and diagnosis by choosing or searching item from the predefined list or enter by free-text. They can make prescription by choosing predefined prescription formula and drugs from drug list. All drugs used should be on the drug list. The system will check the compatibility of the prescription with allergic history of the patient and the dosage limit. If it is suspected incompatible, the system will warn the doctor. If this system is use with the product made by AU-YEUNG's final year project, the system will also check the drug availability and do reservation if the patient would like to get the drugs from the same clinic. If the drug is not available, the system will notify the doctor. Remarks can also be entered on the prescription using free-text input or standard phrase pre-defined in the system. They can print the prescription and issue certificates under this function.

4.4.10. Reprint Document

Doctors can reprint certificate and documents. If the certificate is not yet issued on the same day of consultation, the certificate cannot be issue afterwards with this function.

4.5. Design

This system is in server client model. All the window can instantiate corresponding data manager to get the required entities or prepare data for entering the database. The data manager classes can instantiate a database manger which is responsible for communication between the windows application and the database. The data manager objects can create entities objects by data retrieved by database manager and pass to the call windows form GUI.

In this system, most of the business logics are implemented as stored

procedures in the database. If business logics need to be changed later, most likely only the stored procedures' logics need to be changed instead of change to the windows application and apply patches to all the client machine. Also, computation are done in the database, only the necessary data will be passed to the client application, thus reduces the change of imposing extra security threads to the system as it deals with a lot of personally identifiable information and confidential data.

4.5.1. Simplified Analysis Stereotype the Application

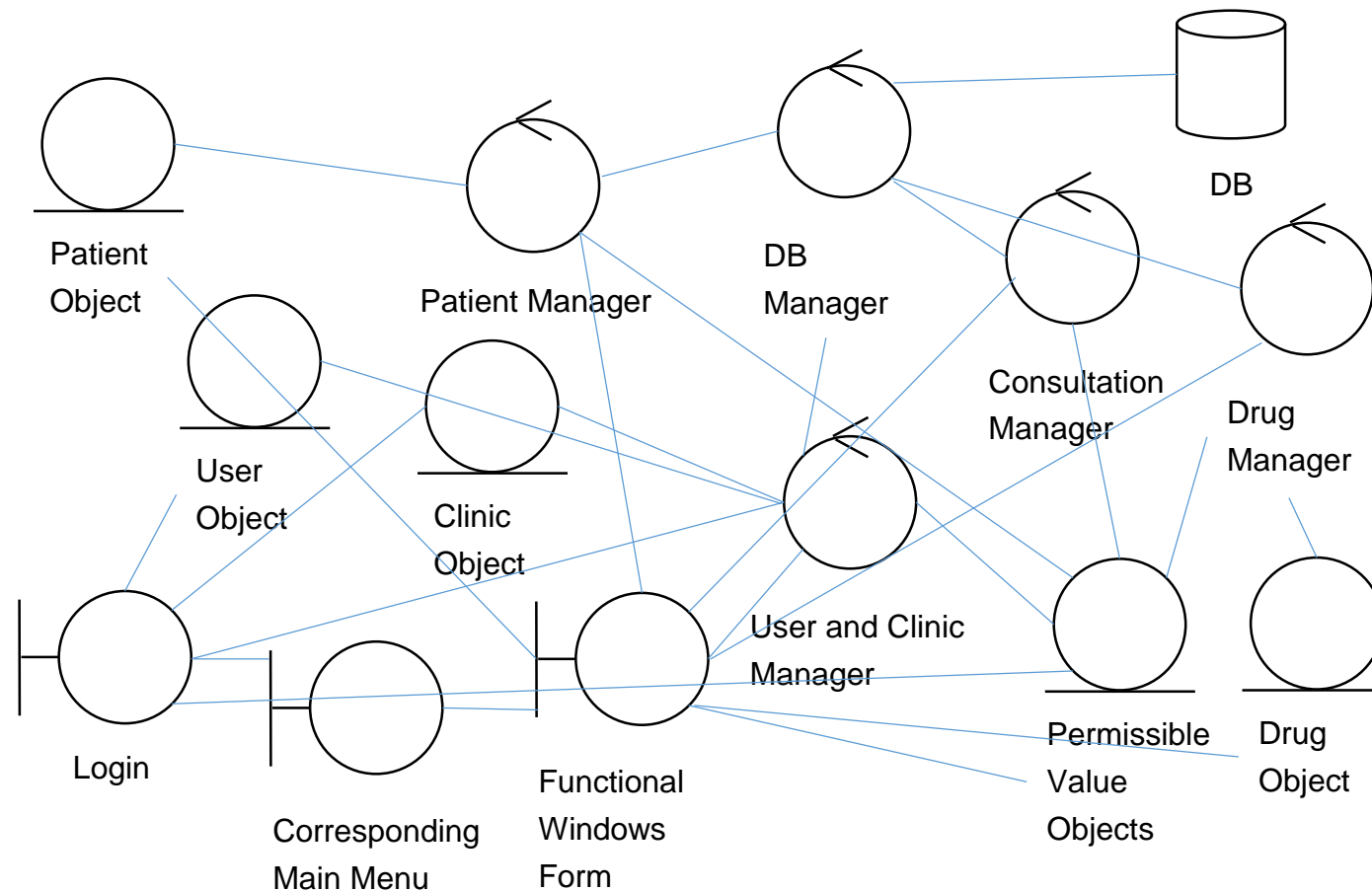


Fig 4.2 Simplified Stereotype Class Diagram for the Application

5. Detailed Methodology and Implementation

5.1. Methodology

5.1.1. Drug Name

Drug names are not strictly standardized in the TCM industry in Hong Kong. In this system, a drug list will be provided for users to select from for entering drug related information like prescriptions. In order to provided drug names which can be recognized by most of the users in Hong Kong, the drug items information will be incorporated to the system would base on a reference book which applicable for the professional examination.

5.1.2. WHO Standard Terminologies

In this system, terminologies for diagnosis, symptoms, treatment methods and case differentiation will be provided for user to select in order to reduce the word typing effort when using the system. However, there are no agreed standard being used in the TCM industry in Hong Kong.

For the current systems in the HA, the terminologies for diseases and procedures are following some International standards. For Modern Medicine, International Classification of Diseases (ICD) 9th Revision (ICD-9), ICD-10, ICD-9-Clinical Modification are used. However, traditional medicine is not yet covered by the currently published version, i.e. ICD-10, and it will be covered in the new version of ICD, ICD-11 which is due by 2017. At the moment, one of the standard using by the HA for TCM terminologies is another standard published by WHO, WHO International Standard Terminologies on Traditional Medicine in the Western Pacific Region (ZIEA, 2012).

In the foreseeable future, the electronic health record (eHR) sharing system developed by the Hospital Authority (HA) for the Hong Kong Government will ready for the TCM industry. In order to enable data sharing from the system to

the eHR system which ease, the WHO standard should be used. At the development time of the system prototype, ICD-11 beta is available. However, it is not yet used by the HA. As both standards are developed by WHO, they should not be contradicting to each other and could be easily convert from one to another. Therefore, WHO International Standard Terminologies on Traditional Medicine in the Western Pacific Region would be used as the reference for the terminologies stored in the system in advanced.

5.2. Implementation

5.2.1. Login Form

User can do the following by using this form:

- Login to the system
- Showing the patient menu

5.2.1.1. Login to the System

Administrators, doctor and staff can enter their user name and password and choose the login clinic and user role to login the system. The reason why users are required to choose the login clinic and user role to login is due to the same user can work in multiple clinics with multiple roles. This will be further discussed in Section 5.2.4.7. When the combination of the four items is incorrect, an error message will be shown. At the first time of using this system, only the system administrator account (user name: SYSADM) with access clinic ID “ALL” is exist in the system. When successfully login, the client application will store the user and clinic information as data for other windows forms until logout.

5.2.1.2. Show the Patient Menu

Clinic staff can show the Patient's Menu for self-access to register, amend personal particulars and queue up. This action also require user to enter the user name, clinic ID, user role and password in order to ensure the application is launched with the correct clinic.

5.2.2. Patient Registration

5.2.2.1. New Patient Registration

User can enter patient's particulars including Chinese name, English name, identification document number (e.g. Hong Kong ID Card number), phone number, date of birth, gender, address and password. Two checkboxes will be provided for user to check if the patient has Glucose-6-Phosphatase Dehydrogenase Deficiency (G6PD) or pregnant. The pregnant checkbox will only be enabled when the gender is chosen as female as it is extremely rare for male to become pregnant. This status can be changed by doctor during consultation no matter the patient is male or female. If the patient has known drug allergy history, the drug name can be entered to the system by choosing from the drug selection panel. Once the register button is pressed, the system will check whether the identification document number exists in the system. If it exists, the registration will be rejected. If the patient is successfully registered, the record will be inserted to the patient record table in the database and the patient ID will be shown on the screen.

5.2.2.2. Amend Patient Information

First, user can search the patient by patient ID, identification document number and/or phone number. A checkbox will be provided if the patient being searched is marked as deceased. The search result will be shown in a list box. User can select the record that is needed. Then, the patient information will be shown in a similar panel as the one in patient registration, the only difference is a deceased checkbox is available for staff to mark the patient as deceased. When confirm button is clicked, the database record will be updated.

5.2.3. Drug Administration

Administrators and doctor can enter drug entry to the system by this drug administration form. After clicking the added button, the system will check

whether the drug name exists in the database, the entry will be rejected. If not, the entry will be added to the database and the corresponding drug name will be shown in the drug selection panel. If the drug item possesses with sub-drug, i.e. prepared drug, user can select the drug item by the drug selection panel and enter the sub-drug name into the textbox provided.

Drug data will be stored in the database with two tables. One is called master drug list and another one is called master sub-drug list. When the drug is prepared with different method, its name and usage may have slightly different. The name and sub-drug ID of that prepared drug will be stored in the master sub-drug list with its original drug ID. And its original drug information will be stored in the master drug list. The information including its properties, suggested dosage range. For stroke number of the first character of the name, it will be based on the data provided by Unicode, UniHan_DictionaryLikeData. If the drug should be avoided or must not be used for G6PD or pregnant patient, a record will be added to the “absolute contraindication table” with the drug ID and the level of contraindication.

For amend drug or sub-drug information, user can choose the drug item from the drug selection panel in the amend drug info tab and update the corresponding information.

5.2.4. Prescription Panel

It provides three ways for user to select drug for making a prescription. The three ways are select drug using drug selection panel, text-based search and use predefined prescription formula. When the drugs are selected, the item will be shown on a data grid view and user can specify the dosage, unit and preparation method like decoct first and decoct later for each drug item.

5.2.5. Predefined Prescription Formula

5.2.5.1. Add Predefined Prescription Formula

It provides a textbox for administrators and doctor to enter the prescription

name and a prescription panel for user to make the prescription formula. When add button is clicked, the system will check whether the prescription exists in the system. If it exists, the action will be rejected. The system will also check the dosage and drug combination whether they are normal and with no contraindication. If any suspected mistake is detected, message will be show to user. If the prescription is valid, i.e. dosage of each drug is within the suggested range and the drug combination does not have any contraindication, then record will be inserted to the database. If not, the system will ask the user to double check the formula is correct. User can choose to revise the formula or to ignore the checking and add the formula to the system.

The database will store the prescription with two tables. The first table will store the predefined prescription ID, name and a deleted flag. Another table will store the drug details, including the prescription ID, drug and sub-drug ID, dosage and preparation method ID. Preparation ID is a reference key to the table storing preparation methods.

5.2.5.2. Amend Predefined Prescription Formula

A dropdown list will be provided for administrators and doctor to select the predefined prescription formula. Then, user can change the formula name, drug items and dosage or to mark the formula as deleted. When update button is clicked, the system will do the similar checking as new predefined prescription formula and update the two tables in the database.

5.2.6. Clinics Administration

5.2.6.1. New Clinic Entry

The system allows System Administrator to enter clinic ID, clinic name, clinic address, phone number for the new clinic. A checkbox also provided for user to select whether the clinic is suspended or in use. When confirm button is clicked, the system will check whether the clinic ID is exists. If it exists, the entry will be rejected. Clinic ID is a key field for the clinic table and also for

user to have an easier reference to the clinic as clinic names can be repeatedly used due to some reasons. For example, a Doctor, say Dr CHAN Siu Ming, have 2 clinics. Both of them are called Dr. CHAN Siu Ming TCM Clinic. Then, user may have difficulties to distinguish two different clinics. At this moment, Clinic ID can help. The one in place A can have the Clinic ID as CSM1 and the other one in place B can have the Clinic ID CSM2. So that, user and the system can distinguish between the two clinics.

5.2.6.2. Amend Clinic Information

A dropdown list will be provided for Administrators to select the clinic ID. The system allows user to change all the items entered when creating the clinic entry except clinic ID. When confirm button is clicked, the system will update the entry in the database.

5.2.7. User Administration

5.2.7.1. New User Account

The system allow administrators to enter the user ID, name, TCM petitioner registration number (if applicable) and password for the new user. When creating the account, a clinic and a role should be assigned to the new user. A checkbox is provided for user to indicate the account is in use or suspended. When confirm button is clicked, the system will check whether the user ID and registration number is exists. If it exists, the action will be rejected. If not, the record will be inserted to the database.

5.2.7.2. Amend User Information

A dropdown list will be provided for Administrators to choose which account to be amended. Only the account under his/her management will be shown and can be selected in the list. All the accounts with authority lower than System Administrator are under System Administrators' management. All the accounts with roles in certain clinic are under the management of the Clinic Administrator of that clinic. The user can change all the information for the

selected account except user ID. He/she cannot suspend his/her own account. When confirm button is clicked, the record will be updated in the database.

5.2.7.3. Amend/Add User Role

A dropdown list will be provided for administrators to choose which account to be amended. Only the account under his/her current login user-role management will be shown and can be selected in the list. The authority of the user role granted to the account should higher than the user's current login role. And the clinic associated to the role should under his/her management.

5.2.7.4. Database

There are four tables related to the user and role management. They are user account table, clinic table, user role table and user-clinic-role mapping table.

Account information entered in new user account function and amend user information function will be stored in the account table.

Clinic table stores the information for clinic administration function.

User role table is a constant table and maintained by the system developer and database administrator. It stores the role ID and role description. As patient do not need to login the system by their own patient account, the system only have the role representation for clinic staff users, it means only the roles for clinic staff will be recorded in the user role table. The content in descending order of role authority are as follow:

Role ID	Description
40	System Administrator
30	Clinic Administrator
20	Doctor
10	Staff

Role ID	Description
0	No Access Right

Fig 5.1 User role table content

Role 0 is a special role. When it is applied to the account, the account cannot login to the system with the corresponding clinic even if he/she has some high authority role in that clinic. The use for this role is to suspend the access of the user from a certain clinic for some reasons. For example, the staff has do something wrong and the clinic administrator would like to suspend the staff's work to have further investigation. Then, the clinic administrator can apply Role 0 to the staff account during the period of suspension to stop the staff to access the system.

User-clinic-role mapping table is a table storing the information about which clinic and role that the user possesses with. It has three fields, user ID, clinic ID and role ID, which are the key fields for the three tables previously mentioned. This table is used, instead of storing the clinic and role item with the user account entry, is because each user can work in different clinics with different and multiple roles. For example, Doctor A has his own clinic and he is the clinic administrator, he will have Role 20 and 30 for Doctor A's clinic. Besides, he also can work in his friend's clinic, say Clinic B, as a doctor. Then, he also will have the Role 20 for Clinic B. This can reduce the redundancy of data stored.

5.2.8. Patient Queue

5.2.8.1. Enter / Leave Waiting Queue

User can search and select patient with the search panel. When patient is selected and register button is clicked, the patient will be put into the waiting queue of the currently login clinic. The patient cannot double register to the queue. The position of the patient in the queue will be shown on the screen. When the patient is selected and cancel registration button is clicked, the patient will be removed from the queue if he/she exists in the queue. Message

will be shown to notify the user no matter the action is successful or not. Both actions will trigger the update of the waiting list shown on the windows form.

5.2.8.2. Calling

When the patients are going to be seen by the doctor, their name will be called.

For clinic administrator and staff, they will have a dropdown list to choose which doctor is going to see the next patient. Only the doctor who have doctor role in that clinic will be shown in the list.

For all the clinic staff, they can click the next patient button to start the calling procedures. A flag in the system will control only one staff can execute this procedure at the same time. When the button is clicked, the dialog box will ask whether the first patient in the queue is in the clinic. Then the user can call the patient's name. User can click "Yes" for the patient answer he/her call, "No" for not here or no response from patient and "Cancel" to stop the calling procedure. If "Yes" is selected, the patient status will be updated. For doctor's call, the status will change from "waiting" to "in consultation". For others, the status will change from "waiting" to "entering consultation". If "No" is selected in the dialog box, the second patient's information will be shown and so on until all patient have been called and the procedure will stop or one of the patient answered the call and clicked "Yes". When the procedure stop, the missed call counter of all the patient have called with response "No" will be increased by one. And this counter is for further development to implement some penalty mechanism for too much miss call.

A textbox is provided to enter the patient ID which exist in the queue and with status "waiting" to have a priority consultation. All the patient with status "consult later" can only use this function to have consultation as the system cannot determine when is ready for the patient to continue the consultation.

For doctors, if staff called a patient, he/she can change the status of the

patient from “entering consultation” to “in consultation” by clicking “called patient” button. At each time, at most one called patient for one doctor will exist in the queue. After any call patient action has been done successfully, a consultation form will be shown for the doctor to do the consultation.

Any calling action with doctor has assigned patient in status of “entering consultation” and “in consultation” will be rejected.

In case of clinic administrator or staff select the wrong doctor, there is a change doctor in-charge function for them to do the correction. However, this change can only be done when the doctor is not assigned to any patient with “entering consultation” or “in consultation” status. For those changes cannot be done, the status will remain unchanged and wait for the doctor assigned to have consultation with them or use the change doctor in-charge function when the correct doctor has finish the current consultation.

In case of accidentally close of the consultation form by doctor, the called patient button will serve to retrieve the patient who is in consultation and in-charge by that user and get back the consultation form just closed.

Once the consultation is done, the patient will be removed from the queue.

The system allows doctor and non-doctor staff to do the calling because the system need to fit for different practices. For clinics with only the doctor and no other staff, then the doctor should do the calling. For some larger clinics, staff will help managing the queuing patients and calling the names. Then, the doctor has no need to call names but only get the called patient.

5.2.8.3. Database

Each clinic would have its own queuing table and flag for calling process. The name of table would be `queuing_table_<clinic_id>` and the flag will be an entry in the system parameter table with parameter name as `queuing_table_<clinic_id>_LOCK`. When first access to the queuing table and

the table is not exist in the database, the stored procedure accessing the table will create it and add the corresponding entry to the system parameter table using dynamic SQL, i.e. SQL statement prepared at execution time. In the queuing table, it records the patient ID, entering date time, status, assigned doctor and number of missed call.

Patient's status in this system can only be changed as the following figure:

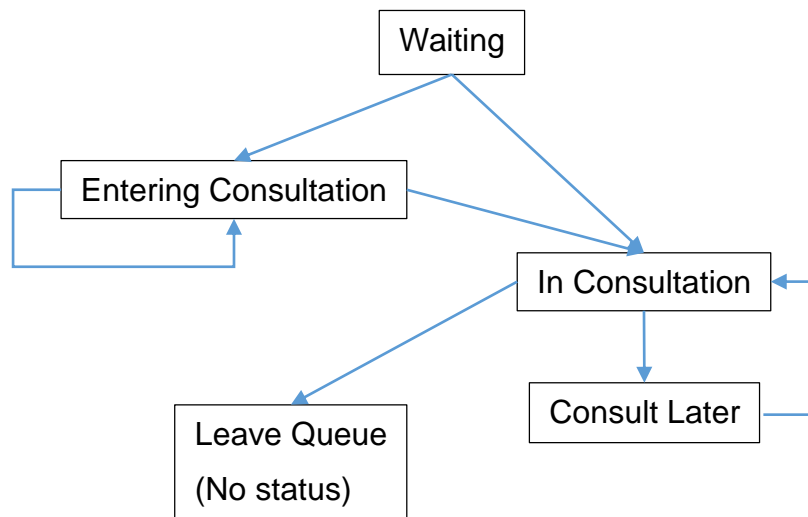


Fig 5.2 Patient Status Flow in Queuing Table

Assigned doctor field will be null when status is "Waiting".

Number of missed call field is for future development to implement penalty mechanism.

5.2.9. Consultation

In consultation windows form, doctor can view patient's personal particulars, drug allergy history and medical history. He/she can enter consultation information for the current one, including symptoms, differentiation, diagnosis, prescription and remarks. He/she can issue sick leave certificate, pregnancy certificate and visiting certificate. He/she can also change the pregnancy flag of the patient in this form. If the patient is not a new patient, his/her past consultation record will be listed out in descending order of consultation date

time. By default, only the consultation in the same clinic or by the same doctor will be listed out unless the patient choose to share the health record across different clinic. The doctor can choose one of the record as the template for the current consultation record. The old record will be copied to the database as the current consultation. The old record will not be affected. After the consultation, user should click the finish button in order to remove the patient from the waiting queue. If the patient is required to leave temporarily for some reasons, say to take a X-Ray examination, the doctor can click consult later and go on with another patient first. The status of the patient will change to "Consult Later". When the form is closed with the close button at the top right hand corner, the information in the form will be saved to the database but the patient status will not be changed, i.e. remain at "in consultation" status and the doctor cannot have consultation with other patient until the status of that patient change to "Leave Queue" or "Consult Later"..

5.2.9.1. Symptoms, Differentiation and Diagnosis

For these three items, they allow doctor to use stored phrases based on WHO standard by choosing from the selection panel provided or text-based search. They also accept free-text entry. No stored phrase can be used more than once in the same consultation. Both the display text string and the code for the phrase will be stored in the consultation record. The display text string is stored because it might be changed from time to time or as a result of changing in standard. To ensure same record is retrieved at anytime and the document can be regenerated, the display text string should be kept.

5.2.9.2. Prescription

Each consultation can have more than one prescription. The prescription ID will be shown in the dropdown list in the consultation form. Doctor can click the amend button to view or amend the prescription, delete button to remove the prescription and new button to create a new prescription. In the prescription windows form, doctor can enter the consumption method and treating method by free-text or select some stored phrases from the dropdown

list next to it. Doctor should also enter the number of dose of drugs that pharmacy should dispense to the patient. In this windows form, a prescription panel will be provided for user to make prescription. When user finish entering the prescription, the information will be stored to the database and the prescription ID will be added to the dropdown list in the consultation form.

The prescription data will be stored like the predefined one. The only difference is it will also store the drug name in order to make the prescription print-out reproducible.

5.2.9.3. Doctor's Remark / Reminder

Usually, doctor will give some remarks or reminders to the patient in order to have a better treatment result. Doctor can enter the remark or reminder by free-text or choose stored phrase from the dropdown list.

5.2.9.4. Print Prescription and Visiting Certificate

When print prescription or visiting certificate button is clicked, a windows form with Crystal Report viewer will be shown. The Crystal Report will generate the corresponding document by calling the corresponding stored procedure in the database with the consultation ID as the stored procedure parameter. Doctor can view and print the document by using the Crystal Viewer in that windows form.

5.2.9.5. Issue Sick Leave Certificate

Doctor can select the sick leave inclusive start and end date using the date pickers provided. The total number of days will be calculated and shown to the user. According to the Reference Guide on Issuance of Sick Leave Certificate by Registered Chinese Medicine Practitioners (Chinese Medicine Council of Hong Kong, 2003), doctor shall not issue a date back sick leave certificate. Therefore, the sick leave start date cannot be set to date before the consultation start date. After selecting the dates can clicking the “confirm and issue” button, the certificate information will be inserted to the sick leave

certificate table in the database and a Crystal Report viewer with the certificate will be shown to the doctor.

5.2.9.6. Pregnancy Certificate

If the patient is pregnant (pregnant checkbox is checked), the checkbox and date picker for estimated date of confinement (EDC) will be enabled. Doctor can choose to enter the EDC information to the certificate. When “confirm and issue” button is clicked, the certificate information will be inserted to the pregnancy certificate table in the database and a Crystal Report viewer with the certificate will be shown to the doctor. For patient is not pregnant, a certificate certify he/she is not pregnant will be issued.

6. Preliminary Result and Future Improvement

6.1. Preliminary Result

The coding part of all the basic function stated in Section 4.2 have been basically finished except for medical history report. The other features is still in progress. All the components are not yet adequately tested.

6.2. Future Improvement

6.2.1. Support Multiple Language for Document Print-outs

Nowadays, people in Hong Kong are come from all over the world. For Westerners, they may also use TCM services provided in Hong Kong. However, they may not able to read Chinese. They have the right to know what drug they are going to take and what the documents is about. Therefore those documents should be available in different language, at least in English.

6.2.2. Auto Generation for User ID and Clinic ID

When number of user and clinic increase, it will be difficult for user to think of any unused User ID and Clinic ID. The system can generate those ID with some systematic methods like using the initial of the user with a number count of user using the initial to make up a new User ID.

6.2.3. Functions for Patients

Functions for patients like registration and booking services can go online or mobile apps can be developed. In Hong Kong, people would like to do a lot of things in a very limited time. If online system or mobile apps are available to patients, they can book or queue for consultation without waiting in the clinic and waste time.

6.2.4. Implement Penalty Mechanism for Missing Calls

Some patients may register for consultation before their available time. And this trick can let them have the consultation immediately when they enter the clinic which is not fair to other waiting patients. In order to prevent this trick, mechanism should be implemented for missing calls over a certain number. For example, over 5 missed calls will be removed from the queue.

6.2.5. Allow Customization for Different Clinics

Different clinics may have different practices. For example, the penalty mechanism suggested in the previous part. Some may not want to have this feature, some may want to have this feature triggered at different missed call counts and some may want to have different penalty. Therefore, one practice cannot fit all clinics. Customization for clinics can be provided.

6.2.6. Connect to eHR

The eHR sharing system developed by the HA for the government is launched for Modern Medicine. And it is going to support TCM in the future. Once it is ready, this system can connect to it and have the ability to get a more comprehensive profile of the patients. Thus, to provide a better healthcare service.

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Appendix

Appendix A – Monthly Log

Month/Year	Monthly Log
October 2014	<ul style="list-style-type: none"> - Literature review - Requirement capturing - Interim Report I - Preliminary design
November 2014	<ul style="list-style-type: none"> - Revise Interim Report I
December 2014	<ul style="list-style-type: none"> - Coding for Patient's Application and Administrator's Application
January 2015	<p>The coding of basic functions of the followings have been finished:</p> <p>For patient:</p> <ul style="list-style-type: none"> - patient registration and changing personal particulars - patient queuing <p>For all staff roles:</p> <ul style="list-style-type: none"> - patient administration (registration / amend patient information) <p>For all administrators and doctors:</p> <ul style="list-style-type: none"> - drug data administration (add / amend / suspend drug items) - pre-defined prescription administration (add / amend / suspend formula) <p>For system administrators:</p> <ul style="list-style-type: none"> - user administration (create / amend user account for all clinic) - clinic administration (add / amend / suspend clinic)

	<p>For clinic administrators:</p> <ul style="list-style-type: none"> - user administration (create / amend user account for own clinic) - amend clinic information for own clinic <p>For doctors:</p> <ul style="list-style-type: none"> - enter consultation record and prescriptions - view consultation history summary of the patient (same doctor or same clinic only) - use past consultation entry as template - print prescription, sick leave certificate and consultation certificate <p>For normal staff:</p> <ul style="list-style-type: none"> - Patient queuing management (calling patient for consultation / register for consultation)
February 2015	<ul style="list-style-type: none"> - Print pregnancy certificate in consultation function - Interim Report II