ISCTE Business School
Instituto Universitário de Lisboa

Improvement of Outpatient Service Processes Based on BRP Theory and Information Technology – A Case Study of the University of Hong Kong-Shenzhen Hospital

CHEN Jinsong

Thesis submitted as partial requirement for the conferral of the degree of

Doctor of Management

Supervisor:

Prof. Braulio Alturas, Professor, ISCTE Lisbon University Institute

Co-Supervisor:

Prof. Tachia, CHIN, Professor, Guangdong University of Foreign Studies

July 2015

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Doutor Pedro Teixeira Isaias, Professor Associado da Universidade da Aberta
Doutor Álvaro Manuel Reis da Rocha, Professor Auxiliar com Agregação da Universidade de Coimbra
Doutor Zhao Di, Professor of Southern Medical University
Doutor Braulio Alexandre Barreira Alturas, Professor Auxiliar do Departamento de Ciências e Tecnologias de Informação do ISCTE-IUL

July 2015

Declaration

I declare that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university and that to the best of my knowledge it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: Chen Jinsong Date: July 16 2015

Name: chen Jinsong

作者申明

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姓名(拼音)：chen Jinsong

Abstract

Currently, due to some irrational allocation of medical and healthcare resources, a considerable proportion of state-of-the-art medical equipment and talented medical personnel are concentrated in large urban hospitals. This situation is particularly common in 3A hospitals (3A hospitals are hospitals which are equipped with more than 501 beds, can provide medical and healthcare services with high-level specialty to various regions and with scores higher than 900 according to the grading standard), which are often crowded with patients. According to the normal outpatient process, patients need to undergo a prolonged procedure from registration, treatment, laboratory test, diagnosis to drug dispensing. Often patients have to spend a long time waiting for treatment, receiving tests and paying for medical care. The congestion of patients at certain time-consuming processes allows doctors little time to check and treat patients thoroughly. As a result, doctors are often unable to make accurate and comprehensive diagnosis.

Considered the window of a hospital, outpatient service is extremely important. Whether the design of its process is reasonable and whether its management is able to maximize interests for patients will directly affect the hospital's medical level, and even its social benefits and reputation. Therefore, it has become a major issue for a hospital achieves to optimize the business process of its outpatient service.

Outpatient process, as a core business process of a hospital, is critical to improving the quality of its medical service, upgrading its performance and minimizing its operating costs. Therefore, re-designing the outpatient process of a hospital can help enhance its comprehensive strength by endowing it with a core competence. In addition, the hospital will be impelled to provide patients with more convenient medical services with higher quality and lower price.

This work conducts a case study on The University of Hong Kong-Shenzhen Hospital (HKU-SZH), which was the first to implement an outpatient appointment registration system. This thesis gives an anatomy of the outpatient process of the hospital through various methods and theories, such as literature review, field research, expert consultation, Business Process Reengineering Theory and Information technology, aiming to identify objectives and strategies of the case hospital in

improving its outpatient process. The study consists of:

- An investigation into the current situation of HKU-SZH's outpatient registration process: through questionnaires and structured interviews, the defects and weak links in the hospital's appointment registration model were analyzed. A structural equation model for existing outpatient processes was established and the influence of different variables on patients' satisfaction level as well as the correlation between these variables was analyzed by means of a simulation model.

- Research on outpatient process reengineering: with the needs and satisfaction of patients as a goal, this thesis reexamines the strategic goals and internal and external environment of HKU-SZH on the basis of Business Process Reengineering Theory, Queuing Theory, Six Sigma Theory and Information technology. This thesis improves HKU-SZH's registration process, using methods of order modification, integration, simplification and automation and materializes the process by network technology and outpatient information system.

- An empirical study on outpatient process: this thesis conducts a systemic and empirical analysis in a functional integration of registration and payment, process reengineering research through information technology (development of new functions of appointment system) and an empirical study on queuing theory.

- Research on local adaptation of outpatient process: this thesis explores solutions and suggestions for HKU-SZH with the objective of optimize its outpatient process through the perspectives of hospital organizational structure, information technology, human resources, building of outpatient culture and optimization of waiting cost.

By means of outpatient process reengineering, this thesis aim to increase the case hospital's efficiency and raise its patients' satisfaction so that the hospital may enhance its comprehensive competence. In addition, an effective and operable methodology will be generated, which is expected to serve as a reference for other hospitals to improve their operation and their management.

Key Words: outpatient process, Business Process Reengineering, information technology, local adaptation
JEL Classification: M15 – IT Management, I12 – Health Production

Resumo

Atualmente, devido a alguma atribuição irracional dos recursos médicos e de saúde, uma proporção considerável de modernos equipamentos médicos e pessoal médico talentoso estão concentrados em grandes hospitais urbanos. Esta situação é particularmente comum em hospitais 3A (hospitais 3A são os hospitais que estão equipados com mais de 501 camas, e que podem fornecer serviços médicos e de saúde com alto nível de especialidade para diversas regiões e com pontuações superiores a 900 de acordo com o padrão de classificação), que são frequentemente sobrelotados com pacientes. De acordo com o processo ambulatório normal, os pacientes precisam passar por um procedimento prolongado desde o registo, tratamento, análise laboratorial, diagnóstico, até à distribuição de medicamentos. Muitas vezes os pacientes têm de passar um longo tempo de espera para tratamento, para receber testes e para pagar por cuidados médicos. O congestionamento de pacientes em determinados processos demorados, leva a que os médicos tenham pouco tempo para verificar e tratar os pacientes completamente. Como resultado, os médicos são muitas vezes incapazes de fazer um diagnóstico preciso e abrangente.

Considerado a montra de um hospital, o serviço ambulatório é extremamente importante. Se o desenho do seu processo é razoável e se a sua gestão é capaz de maximizar os interesses dos pacientes, irá afetar diretamente o nível médico do hospital, e até mesmo os seus benefícios sociais e reputação. Portanto, tornou-se um importante problema para um hospital conseguir otimizar o processo do seu serviço ambulatório.

O processo ambulatório, como um processo de negócio nuclear de um hospital, é fundamental para melhorar a qualidade do seu serviço médico, aumentar o seu desempenho e minimizar seus custos operacionais. Portanto, reprojetar o processo ambulatório de um hospital pode ajudar a aumentar a sua força global dotando-o de uma competência essencial. Além disso, o hospital será impelido a oferecer aos pacientes serviços médicos mais convenientes com maior qualidade e menor preço.

Este trabalho apresenta um estudo de caso sobre o Hospital da Universidade de Hong Kong-Shenzhen (HKU-SZH), que foi o primeiro a implementar um sistema de registo de consulta externa. Esta tese apresenta uma análise do processo ambulatório

do hospital através de vários métodos e teorias, como a revisão de literatura, pesquisa de campo, consultas a especialistas, teoria da reengenharia de processos e tecnologias da informação, com o objetivo de identificar os objetivos e estratégias do hospital na melhoria do seu serviço ambulatório. O estudo consiste em:

- Investigação sobre a situação atual do processo de registo ambulatório de HKU-SZH. Através de questionários e entrevistas estruturadas, foram analisados os defeitos e pontos fracos no modelo de registro de consultas do hospital. Um modelo de equações estruturais para os processos ambulatórios existentes foi estabelecido, e a influência de diferentes variáveis sobre o nível de satisfação dos pacientes, bem como a correlação entre essas variáveis foi analisada por meio de um modelo de simulação.

- Investigação sobre a reengenharia do processo ambulatório. Tendo as necessidades e satisfação dos pacientes como objetivo, esta tese reexamina as metas estratégicas e o ambiente interno e externo de HKU-SZH com base na Teoria da Reengenharia de Processos, Teoria das Filas, Teoria *Six Sigma*e Tecnologias da Informação. Esta tese melhora o processo de registro de HKU-SZH, usando métodos de modificação, integração, simplificação e automação e materializa o processo através de tecnologias de rede e um sistema de informação para o processo ambulatório.

- Estudo empírico sobre o processo ambulatório. Esta tese conduz uma análise sistémica e empírica sobre a integração funcional de inscrições e pagamentos, a pesquisa de reengenharia de processos através de tecnologias da informação (desenvolvimento de novas funções do sistema de consultas) e um estudo empírico sobre a teoria das filas.

- Investigação sobre a adaptação local do processo ambulatório. Esta tese explora soluções e sugestões para o HKU-SZH para otimizar seu processo ambulatório através das perspetivas de estrutura hospitalar organizacional, tecnologias da informação, recursos humanos, construção da cultura do ambulatório e otimização do custo de espera.

Por meio do processo de reengenharia do serviço de ambulatório, esta tese visa aumentar a eficiência do processo de internamento e aumentar a satisfação dos seus pacientes para que o hospital possa aumentar a sua capacidade global. Além disso, foi

gerada uma metodologia eficiente e operacionalizavel, a qual se espera possa servir como referência para outros hospitais, para melhorar o seu funcionamento e a sua gestão.

Palavras-chave:outpatientprocess, Business Process Reengineering, informationtechnology, local adaptation

Classificação JEL: M15 – IT Management, I12 – HealthProduction

Acknowledgement

It is a great honor for me to study in ISCET- Lisbon University Institute. Over the past five years, I have improved my management ability and broadened my international horizon, which is of significant benefits. Moreover, I have acquainted many scholarly mentors and beneficial friends that can last a lifetime. In retrospect, although I have suffered the hardship, depression and toil during my learning process, all the pleasure I gained has outshone anything else and all the efforts have been worthwhile. Therefore, I would like to extend my sincere gratitude to some mentors and friends.

Firstly, I would like to express my thanks to my two supervisors, Ta Chia Chin and Braulio Alturas. During the study, they have given me valuable guidance and devotedly modified my dissertation. Thanks to their earnest modification, my dissertation can be improved greatly.

Secondly, I would like to express my thanks to the officials and teachers of Southern Medical University. It is because of the platform provided by the university that I can receive instructions from teachers, acquire available knowledge and acquaint good classmates and friends of healthcare industry to exchange ideas and benefit from each other.

Over the past five years, I have gained support and directions from Virginia, Xu Ruimin, Ou Weiyan and the Dean. I cannot enumerate them one by one because the list must be fairly long, but there is one thing I must emphasize: I cannot complete my study and finish my dissertation without everyone’s help. I hope that everything will remain unchanged in the future and our friendship will last forever.

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Chapter 1 Introduction

1.1 Foreword

With intensifying competition between major hospitals, patients tend to seek medical services with higher quality. In the past, hospitals used to adopt a hierarchical management system driven by power and a functional management pattern based on division of labor. However, this pattern has gradually fallen short of the need for competition in the socialist economy. If a hospital wants to have a sustained competitive edge, it should unremittingly raise its medical service level. At the same time, it should also foster a service philosophy of "treating patients like customers". In addition, it should establish a strategic business process to respond to the changing internal and external environment. By renewing operational and management methods and rebuilding outpatient processes, a hospital can build a process management model in the interests of patients.

1.1.1 Current Situation of Traditional Outpatient Treatment Model in Chinese Hospitals

After 30 years of development, remarkable achievements have been made in China's economy. In addition, people's living standards and purchasing power have also enhanced significantly. As people become increasingly rich, they start to attach more importance to their health. However, with such a large population and gradually deepening urbanization, China has experienced a drastic increase of urban population. These urban residents have urgent demands for high-quality services from hospitals and medical staff. In China, large and medium hospitals are mainly concentrated in cities and the scale of these hospitals is determined by the registered population in these cities. As a result, medical resources in cities are inadequate and this situation is unlikely to be reversed in a short period. Currently, as appointment registration model has not yet been widely implemented in large and medium hospitals, large crowds rush to see doctors in the morning. In this way, patients have to spend longer time in registration, payment and drug dispensing, while they have far less time in the critical

diagnosis by the doctor. In order to allocate medical resources in a reasonable way and reduce patients' length of waiting to ensure sufficient time for their treatment, it has become inevitable to optimize the management model of outpatient process. By introducing the appointment mechanism, patients can arrange their schedule to see a doctor in advance, which saves their unnecessary queuing time and minimizes conflicts between doctors and patients.

Chen (2003) finds that currently most Chinese hospitals still adopt the traditional outpatient process model, namely: queue for registration → wait to see the doctor → see the doctor (doctor issues a checklist or prescription) → queue to pay fees → queue for body check (or drug dispensing → further consultation with the doctor (doctor issues a treatment list or prescription) → queue to pay fees → queue for treatment (or drug dispensing). This traditional outpatient process model is very common in major hospitals, but it has many shortcomings, particularly in overcrowded large hospitals. In this model, only a small part of patients' time in hospital is for treatment, which severely harms the social and economic benefits of the hospital. It is clear that in this model there are many steps and patients have to wait for a long time in nearly every step. As patients have to spend much more time in waiting than in treatment and diagnosis, both their time and energy go wasted. As a result, nearly all outpatient services of large general hospitals are mired in a severe problem of "three longs and one short", which means long queuing time for registration, long waiting time for treatment and body check, long waiting time for payment and drug dispensing and short time for treatment.

Dai & Sun (2002) contend that the long time for queuing and congestion of patients in hospitals are mainly caused by the fact that only ten percent of the time patients spend in hospital is effective time of treatment. According to Wang's (2011) survey on outpatient processes in many general public hospitals, the per capita time for registration is two and a half hours, the per capita time from appointment to body check is about one and a half hours, while the time for analysis and diagnosis is only eighteen minutes, and the remaining time is all consumed in waiting and queuing. In general, the average time a patient spends in outpatient services is an hour to one and

a half hours, whereas a doctor spends only ten to fifteen minutes in analysis and diagnosis. In some large general hospitals, treatment time is even as short as three minutes, which is too short for a doctor to fully understand a patient's condition. As a result, overall medical quality cannot be effectively guaranteed, level of medical service remains low and patient satisfaction needs to be improved. In some hospitals, medical guide service is not in place and guiding signs do not stand out well. Therefore, when getting a checklist from doctors, nearly half of the patients do not know where to take the physical examination. In addition, some physical examinations cannot be done right away or the results cannot be obtained immediately. As a result, patients have to go home and come back to the hospital once again for the results. These problems all directly result in considerable inefficient movement of patients in hospitals. In contrast, patients don't need to wait too long in hospitals in some developed countries. For instance, patients only wait for five to ten minutes before they see a doctor in Ang Mo Kio Family Medicine Clinic in Singapore.

1.1.2 Development of Outpatient Process Model in Chinese Hospitals

Before identifying the research questions, it is necessary to define some key words or terms in the thesis so that readers of this thesis can have an unequivocal understanding of the research subjects. With HKU-SZH as the case, this thesis carries out an in-depth analysis of problems and shortcomings in its outpatient process and offers suggestions for improvement. Therefore, terms like outpatient service, process and outpatient process must be clearly defined.

In the broad sense, outpatient service refers to the behavior of a doctor to give his or her patients non-hospitalization diagnosis and medication or recommend them to be hospitalized. Generally, outpatient departments often receive people with minor illnesses. The outpatient doctors will give preliminary diagnosis through systematic means of diagnosis and routine auxiliary examinations. However, if a patient is in critical condition, the outpatient doctor will recommend hospitalization so that scientific methods can be used to conduct further examination or surgery.

According to *Cihai* (Xia & Chen, 2010), a large-scale Chinese dictionary and

encyclopedia, outpatient is a way of treatment used by medical prevention institutions to offer diagnosis and treatment to patients who don't need hospitalization or have not been hospitalized yet. It includes a preliminary diagnosis and treatment (hospitalization if necessary), physical examination and vaccinations, antenatal examination for pregnant women and follow-up visits to discharged patients. Outpatient departments set up for certain diseases are often called specialist outpatient department such as Neurology Department and Orthopedics Department.

The deepening reform of medical and healthcare systems will exert a profound influence on the building and development of outpatient departments. Bai (2007) believes that the reform will change the management model, operational mechanism, functional roles, services and culture of outpatient departments. The change is manifested in the following five aspects:

(1) Most diseases will be treated in outpatient departments. With advancement in medical technology, huge progress has been achieved in medical research and clinical practice. Particularly, major breakthroughs have been made in Life Sciences and Biotechnology. Together with the change of disease spectrum, it has become possible for most diseases to be treated merely in outpatient departments.

(2) It will be the most convenient and efficient way to treat diseases in the outpatient department. Living in a fast-paced environment, people are geared to pursue higher efficiency and greater effectiveness. In addition, due to stress from competition in work, people don't want to be hospitalized until they are left with no other choice. As the most convenient method of treatment, outpatient service can minimize the influence of diseases on patients' life and work. Therefore, a sound medical and health care system makes outpatient service an optimal choice for patients. Furthermore, in China's current medical security system such as the basic medical insurance system for urban employees, there are a lot of limitations on the examination and approval procedures of medical expense reimbursement to those who are hospitalized, but there are no such severe limitations on treatment in outpatient departments. This policy has also encouraged people to favor outpatient service.

(3) The function of outpatient departments will be maximized. According to Cao

and Dai (2007), medical science is playing an increasingly important role in society and it is becoming more holistic, integrated and diversified. As a result, the role and functions of outpatient departments will definitely be extended. Outpatient departments will become a center for disease treatment as well as a platform to carry out health education. Physical examination will be a major service provided by outpatient departments and outpatient surgeries will be a new growth point of revenue.

(4) Specialized departments will be more highlighted in the new structure of outpatient departments. With the development of medical science, the structure of outpatient departments will change accordingly. For example, new departments like Psychological Department, Interventional Medical Science Department, Genetic Diagnosis Department and Endoscopic Treatment Center will be added. An interdisciplinary center for treatment and diagnosis of a specialized disease will also come into place. The different departments will focus more on their specialized areas and their expertise will all be displayed through the outpatient department, an increasingly important showcase of the hospital.

(5) An accurate, safe and efficient medical communication system will be established in the outpatient departments. Information technology will change the way medical items are delivered. For instance, modern logistics management makes it possible to deliver a variety of medical equipment, supplies and patients' test specimens to designated locations rapidly through a special channel. The establishment of medical communication system in a hospital will greatly shorten the patients' waiting time, signifying the high level of modernization of the hospital.

As a showcase of a hospital, an outpatient department must take the following questions into consideration: Is the quality of medical service good? Do patients wait too long? Do doctors have enough time to treat patients thoroughly? Is prescription pricing efficient and accurate? Are payment and drug dispensing convenient and efficient? Whether the outpatient department can perform well in the afore-mentioned respects can directly affect the general order and medical service quality of the

hospital and even its social reputation.

1.1.3 Necessity to Improve Outpatient Process

Outpatient process is not only a core process but also a form of process assets of a hospital. It can connect activities of different departments in the hospital, reflect the correlation between these activities and identify the relationships between different people in these activities. Optimization and reengineering of outpatient process is an important way for a hospital to improve quality of medical services, increase management efficiency, minimize resource costs, raise treatment efficiency and enhance social benefits. Outpatient process reengineering can shape and continuously enhance the core competency of a hospital as well, thus helping it sharpen its unique competitive edge. With this advantage, the hospital can provide the general public with medical services of lower price, higher quality and greater efficiency. Therefore, outpatient process optimization and reengineering is critical to the management of hospital operation, building of an efficient organization and application of information and technology.

In recent years in particular, optimization and improvement of working process has often been adopted to boost productivity and efficiency. Through an analysis and reengineering of working process, many businesses have drastically shortened the time needed to complete a whole process. In addition, the quality of hospital services is improved and the productivity and efficiency have been increased by many folds. Service process, unlike process in manufacturing, cannot be measured in a standardized and quantified way. Many scholars believe that time index is the best choice for its optimal measurability and comparability. Therefore, in most studies on process efficiency, time is used as the index.

The Hospital Information System (hereinafter referred to as HIS) of a hospital can be used to formulate an index for its outpatient process efficiency, because there are historical records of medical services in this system and the data can be easily retrieved. Without too much manpower or too many material resources, the efficiency of outpatient process can be monitored on-line in real time. When Queuing Theory is

applied to outpatient services, it can be used to analyze distribution regularities of patients' time from arriving at the hospital, to receiving treatment, and then to leaving the hospital. In this way, there will be a quantitative evaluation and it can be used to judge whether allocation of resources in the hospital is reasonable or not. This will lay a scientific foundation for process reengineering. At the same time, the optimization and reengineering of outpatient process can minimize the waiting time for patients and cost of medical services, avoiding waste of social resources.

It is of great significance to optimize outpatient process through Business Process Reengineering Theory. On the one hand, an optimized outpatient process can reduce unnecessary waiting time for patients and increase the rate of effective treatment. On the other hand, it can alleviate the heavy flow of patients, enabling the hospital to effectively manage outpatient resources so as to resolve the problem of "three longs and one short".

There are many differences between domestic and foreign literature on outpatient process in terms of research subject as well as scale and scope of research. But basically these studies all focus on processes of hospitalization and surgeries. Only a few focus on optimization and reengineering of outpatient process and they have little practical value, as most remain theoretical discussions. In general, domestic and foreign scholars are still in an exploration stage as regards application of Queuing Theory, BPR Theory and information technology in outpatient process. Therefore, in order to better outpatient process, it is necessary to have a thorough understanding of what domestic and foreign scholars have done in this area and combine the results with the actual situation of a hospital. Only through such a scientific and reasonable method can it be possible to establish an outpatient process in line with the actual situation of the hospital.

1.2 Research Questions and Framework

1.2.1 Research Questions and Research Objectives

As an important part and a showcase of a hospital, the outpatient department is

the first stop for patients to get medical services. According to Yin & Liang (2004), whether an outpatient process is reasonable, convenient and efficient is directly linked to the overall service quality and efficiency of the outpatient department. Ren & Wang (2007) point out that the management emergency process is critical to improving the overall medical service quality of a hospital. The emergency and outpatient departments involve nearly all departments in a hospital, therefore directly displaying the quality of medical services of these departments. They are an important part of a hospital's quality management system. There are five characteristics of outpatient services:

(1) Both the background and diseases of patients are diversified. Patients are from all walks of life, with different occupations, education backgrounds and experiences. The nature and severity of their diseases are different. Different patients are also different in needs and attitudes towards treatment. In addition, some have to pay by themselves while some are covered by insurance. Huang (2001) finds that the needs of treatment and behaviors of patients are directly affected by the way they pay for their medical services, whether they pay by themselves or enjoy free medical care or are covered by medical insurances.

(2) Patients visit hospitals without any regular pattern. There is no fixed pattern as to when and how many patients go to hospital. As a result, there are often too many patients in certain periods of time, leading to peak hours in outpatient departments.

(3) Outpatient treatment is time-bound and risky to some extent. Usually, within normal working hours, doctors have to receive a large number of patients, but they only have a limited period of time to finish a series of procedures for every patient including symptom inquiry, laboratory examination, review of previous diagnoses, judgment of patients' conditions, answers to patients' questions and diagnosis. Such a heavy workload tends to result in missed diagnosis and misdiagnosis. As a result, patients may miss the best period for treatment. The consequence may be medical disputes or even medical accidents.

(4) There's a high probability of cross infection in the hospital. As described in the first characteristic, backgrounds of outpatients are diversified. As a lot of patients,

both infected and non-infected, are crowded in the limited space of the hospital, cross infection is highly likely to occur.

(5) Outpatient businesses are characterized by diversification, professionalism and integration. An outpatient department consists of many disciplines with increasingly sophisticated division of labor and increasingly advanced medical technologies. It cannot operate smoothly without the cooperation and support from the Medical Technology Department, Logistics Department, Medical Affairs Department and Human Resources Department. Bai (2007) points out that judging from the composition of medical staff in outpatient department, it can be seen that these staff all have diversified backgrounds and specialties. Therefore, concerted efforts must be made by staff from different departments, specialties and disciplines to give diagnosis, analysis and treatment for patients.

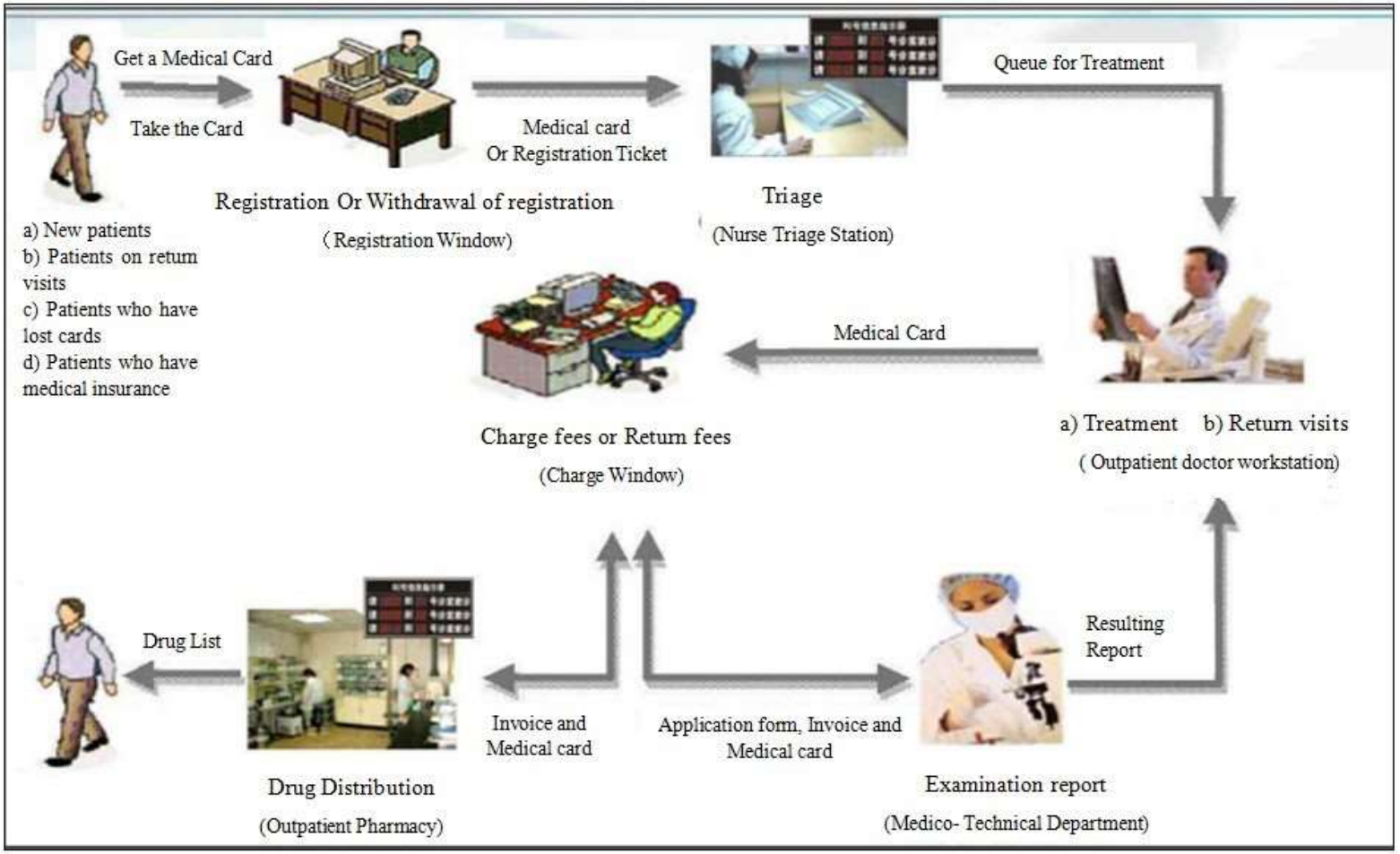
According to the Longman Dictionary of Contemporary English (Longman Publishing House, 1993), process refers to a series of activities or events that are correlated with each other. According to the Contemporary Chinese Dictionary (Lv & Ding, 2012), "process" originally refers to the path of water currents and is extended to a method of making something from raw materials to end products. In the Oxford English Dictionary (William，2004), "process" is defined as a series of actions or steps taken in order to achieve a particular end. Generally speaking, a process is composed of a series of single tasks from input to output. In the management academia, the viewpoint of Michael Hammer (1993）, an American management expert, is widely accepted. He maintains that "process" refers to a set of activities that are correlated with each other and that can create value for customers. He believes that there are two features of process: first, process is targeted at customers, including both internal and external customers; second, process is not limited to the existing area or boundary of functional departments, branch institutions or subsidiaries.

Originally, process is a terminology in Engineering. It appeared in the late 1980s and became popular mainly in some Western businesses. Later, management scientists introduced this concept into Management Science to explain or interpret corporate

behaviors. In this way, every working process of a business can be divided into a series of concrete sub-processes and tasks and they will make up a work chain that can be further divided. Objectives and necessity of behaviors in every stage of the work chain will be analyzed to distinguish scope of responsibility. The aim is to make sure that every specific task is taken care of by specially-assigned persons. The assembly line for automobiles adopted by Henry Ford in the Nineteenth Century and the organization change launched by Alfred Sloan in General Motors are both related to process. In a market characterized by increasingly fierce competition, businesses improve their management level by gradually introducing the concept of process so as to transform an extensive management model into an intensive one. Consequently, the concept of process becomes increasingly popular.

In general, outpatient process refers to the whole process a patient undergoes in hospital, all the way from registration, treatment, diagnosis to drug dispensation. A traditional outpatient process includes registration, payment, waiting, treatment (doctor inquiry, prescription, examination list), queuing for payment, queuing for body check, queuing to leave specimens, queuing to get laboratory report, a return visit, prescription, a second-time payment, queuing to get medicine and departure (or hospitalization). The outpatient process is illustrated in the following picture:

Figure 1-1 Outpatient Process



Source: The author

As mentioned in the introduction part, allocation of medical resources is inadequate in Chinese cities. The traditional outpatient process model has resulted in severe problems like "three longs and one short" and doctor-patient conflict. At the same time, with the increasingly open market economy and a market-oriented reform of the medical and health care system, hospitals are faced with problems including how to improve doctor-patient relationship, increase outpatient efficiency, optimize the allocation of medical resources and meet the needs of patients. Research shows that implementation of Business Process Reengineering via advanced information technology is effective to optimize and improve outpatient process. However, hospitals are different from each other in systems, management philosophy of executives, human resources and local outpatient culture, all of which affect the results of process optimization and improvement in different hospitals. In reality, some hospitals are met with strong resistance in the reform, leading to unsatisfactory results. Therefore, to effectively solve the afore-mentioned problems facing hospitals, the primary problem for them is to identify whether the current outpatient process is conducive to raising the effective hospital visit rate per unit time and explore how to reduce unnecessary waiting time for patients, how to identify defects and weaknesses of the current outpatient process model and where to start the reform.

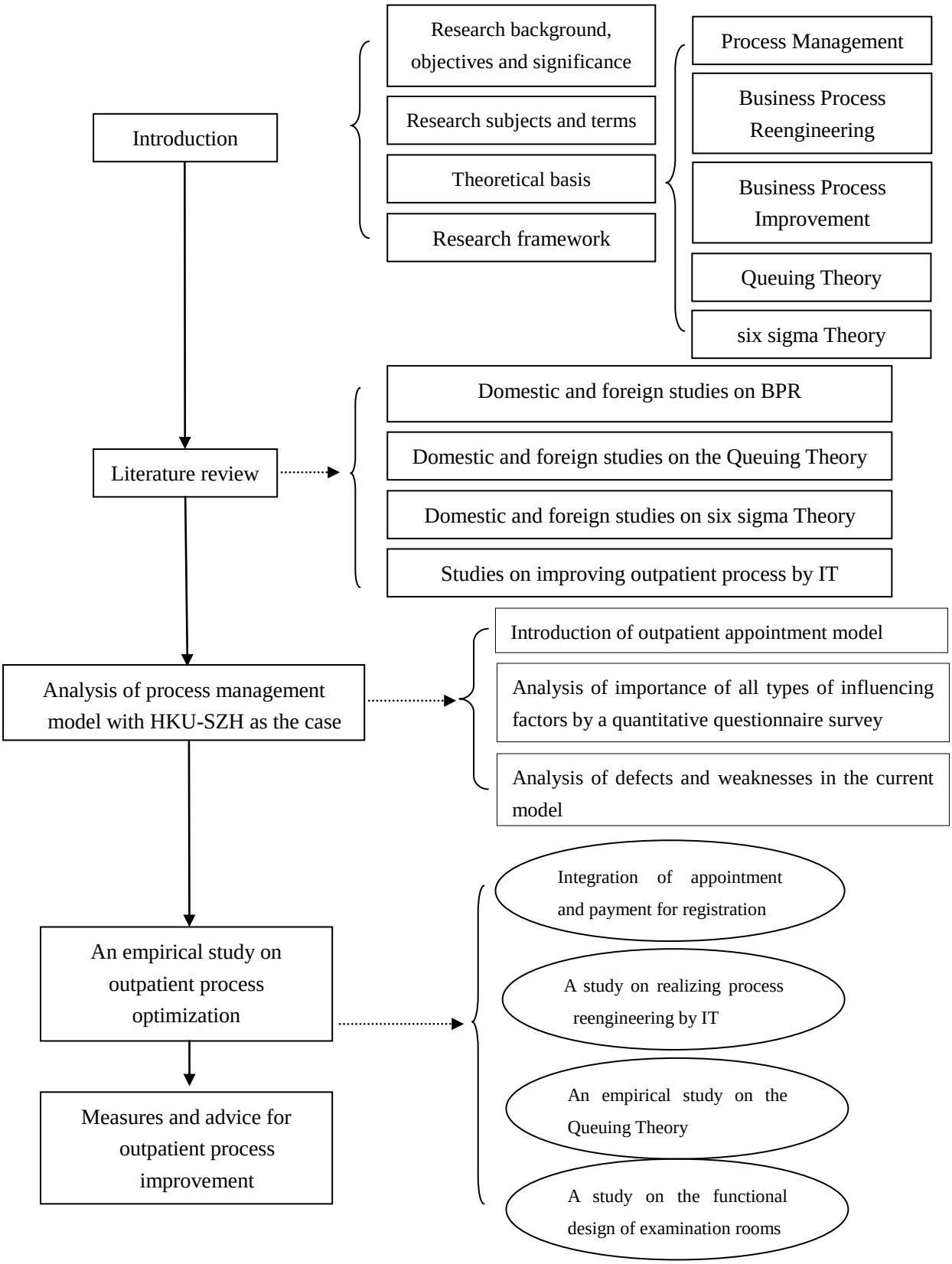
After the primary problems facing hospitals are identified, the next step is to analyze what influences these defects and problems exert on the current outpatient efficiency and what measures hospitals should take to solve these problems. A review of literature shows that most hospitals solve problems in their outpatient process models through Queuing Theory, Business Process Optimization Theory, Business Process Reengineering Theory, Six Sigma Theory and information technology. However, what problems can be solved through these methods or tools? Are there any limitations in using these methods and tools as hospitals are faced with rapid development of China's economy and ongoing reform of the medical system? Can the methods or tools increase the efficiency of outpatient process? Will these methods and tools be in conflict with the actual situation of different hospitals? How can the effect of these methods and tools be maximized by combining them with the operating

characteristics of hospitals? The main purpose of this thesis is to find answers to the above-mentioned questions. It is believed that the actual situation of a hospital should be taken into account prior to the optimization or improvement of its outpatient process, which is a matter of local adaptation.

1.2.2 Research Content and Framework

This thesis uses BPR Theory, Queuing Theory and System Theory with information technology as its core to analyze the process management model of outpatient appointment in HKU-SZH. A quantitative analysis is made by means of questionnaire survey to identify defects and weaknesses of the current model. On this basis, the principles, methods and techniques of BPR Theory will be used to analyze various problems existing in outpatient process and the extent of their influence. A structural equation model will be established for scientific and quantitative analysis. This model can help identify the goals of optimization and measure improvement of the outpatient process. The aim is to maximize existing resources in outpatient departments, optimize the management model and operation service model of hospitals, reduce unnecessary waiting time of patients, increase effective hospital visit rate per unit time, eliminate the phenomenon of "three longs and one short", build for hospitals a social image as providers of efficient, convenient and premium medical services, and enable patients to have easy access to medical services. In the literature review part, BPR Theory, Queuing Theory and Six Sigma Theory are reviewed and commented on. In the case study, a questionnaire survey of the process management model of outpatient appointment in HKU-SZH is conducted. By establishing a structural equation model of the current outpatient process, this study analyzes the influence of factors in outpatient process on patient satisfaction so that objectives and measures of improvement can be identified. The research framework is displayed in Figure 1-2:

Figure 1-2 Research Framework



Source: The author

Chapter 1: This chapter introduces the research background, research questions, research objectives, research framework and research methods.

Chapter 2: Review on theoretical research. Theoretical and technical research literatures of Process Reengineering, Queuing Theory and Six Sigma Theory both in China and overseas are reviewed and evaluated.

Chapter 3: Domestic and foreign studies on hospital process improvement. Studies on the application of BPR theory, QT, Six Sigma Theory and information technology in hospital process improvement are reviewed and commented on.

Chapter 4: Five hundred patients who pay an outpatient visit to The University of Hong Kong-Shenzhen Hospital are chosen randomly as respondents. Then questionnaires are distributed to them to find out how they think of the outpatient appointment registration process of the Hospital. Based on the problems discovered in the questionnaire survey, interviews with staff of the hospital, including the president, deputy director of the Outpatient Department, staff of the Outpatient Department, staff of the Information Center and concierge medical advisors are conducted. After that, qualitative and quantitative evaluations are carried out, leading to identification of the deficiencies and weak links in the current model.

Chapter 5: An empirical study on outpatient process is conducted. To be specific, systematic empirical analysis is made from multiple aspects, including integration of appointment registration and payment, process reengineering research through information technology (such as development of new functions of the appointment system), empirical study of Queuing Theory and research on function design of the clinic system.

Chapter 6: An analysis of outpatient process from the perspective of local adaptation. This thesis explores measures for HKU-SZH to realize outpatient process optimization from the perspective of its organizational structure, information technology, human resources, building of outpatient culture and optimization of waiting cost.

1.3 Research Methods

Research methods in this study include documentary research, field investigation, Delphi method, BPR method and IT method. With HKU-SZH as the case, this thesis strives to combine empirical analysis with theoretical research and integrate outpatient process improvement into the analytical framework of BPR and IT. This thesis mainly uses Business Process Reengineering Theory, Business Process Improvement Theory, Six Sigma Theory and Queuing Theory for analysis, and adopts structural equation model and 6σ tools to analyze patient satisfaction and process reengineering plan. Analytical methods in IT are also used.

This thesis selects HKU-SZH as the case for study because the author is an employee of the hospital. Therefore, he has a thorough understanding of the hospital and has easy access to the data needed for this research. In addition, according to Yin (1989), as a method of empirical research, case study mainly applies in the following scenarios: First, a current phenomenon is investigated in a real context; second, the boundary between phenomenon and background is blurring and the problem is complex; and third, evidence from various sources is needed to analyze the problem.

According to Eisenhardt (1989), case study may be prospective (in which criteria are established and cases fitting the criteria are included as they become available) or retrospective (in which criteria are established for selecting cases from historical records for inclusion in the study).

This study attempts to analyze problems in the current outpatient process and use relevant theories and techniques to propose a feasible solution for outpatient process improvement and optimization.

1.3.1 Documentary Research

To explore the optimization and improvement of outpatient process, it is necessary to look at existing results and methods employed in domestic and foreign research. This thesis adopts documentary research method to analyze and summarize the management model, development status and research results of outpatient process in domestic and foreign hospitals as well as application of BPR Theory, Queuing

Theory, Six Sigma Theory and information technology in hospitals.

Review of literature in areas of Business Process Improvement, Business Process Reengineering, Queuing Theory and Six Sigma Theory has been in progress since September, 2013. After a considerable number of relevant monographs and papers are read, methods of outpatient process improvement and reengineering are summarized and a literature review of the above-mentioned theories is completed. On the basis of the literature, the results of research on hospital outpatient process reengineering are reviewed and commented on. The common features and limitations of these studies are pointed out, which lay a solid theoretical foundation for subsequent discussion and analysis.

The literature mainly includes:

(1) Government reports (such as the Outline of National Development Plan for Health Information), national regulations and policies and newspaper of medical science;

(2) Bibliographic databases like CBMDISC, CNKI, MEDLINE and evidence-based medicine databases.

1.3.2 Field Investigation

With HKU-SZH as the research platform, this thesis uses questionnaire survey and in-depth interviews to solicit patients' attitudes toward and opinions on outpatient appointment process. Five hundred patients are selected at random to answer questions regarding the efficiency of outpatient process, patients' needs and satisfaction with outpatient appointment registration, as well as other service processes. This thesis also conducts structured interviews with the hospital staff (hospital chief executive, deputy hospital chief executive in charge of outpatient department, employees of outpatient department and information center and hospital guides).

1.3.3 Delphi Method

In the analysis of some qualitative questions, opinions of government departments of Shenzhen (such as the Health and Family Planning Commission of

Shenzhen), medical experts, public affairs management experts and professionals are consulted on the problems reflected in investigation and analysis, formulation of strategies for improvement and identification of objectives for improvement. On this basis, the present thesis summarizes and categorizes the problems in outpatient appointment process of HKU-SZH. In addition, the influence of these problems on outpatient satisfaction is analyzed and the problems are ranked in terms of importance.

1.3.4 BPR Method

According to Mei & Teng (2004), there are six steps to business process reengineering, namely, design of objectives, diagnosis of process, redesign of process, implementation of process, evaluation of process performance and maintenance of process. This thesis will use these steps to reengineer and optimize the current outpatient process.

1.3.5 Information Technology

Information technologies like bankcard technology, internet technology and outpatient information system (used in outpatient fee collection, drug dispensation management and doctor workstation) are used to help create and stabilize new processes.

1.4 Research Significance

The characteristic of outpatient services in the new period requires a higher standard of work in outpatient departments. In the traditional outpatient process model, patients have to spend a large amount of time queuing and waiting, which severely damages social benefits and economic benefits of hospitals. Therefore, it is of great significance for hospitals to use the advanced Business Process Reengineering Theory and process reengineering technique to optimize their outpatient process. Li (2011) finds that the efficiency of outpatient treatment can be considerably increased by reengineering outpatient process and reasonably allocate and optimize existing medical and health care resources because the time patients spend on unnecessary

queuing and waiting will be minimized.

Business process management is fundamental to the management of a modern hospital. It is an indicator of the overall management level and economic benefits of a hospital as well as a prerequisite to smooth operation of the hospital. Many businesses have introduced Business Process Reengineering to their operation and have achieved fruitful results. Business Process Reengineering is equally important to hospitals, particularly to outpatient departments. It has become a widely acknowledged fact that Chinese hospitals, especially large 3A general hospitals, are always crowded with patients (3A hospitals refers to the hospitals that own more than 501 hospital beds, provide high-quality specialized medical services to more than one districts and score more than 900 in rating evaluation), Patients go to hospitals for good health, but they have to spend a large amount of valuable time in queuing for registration and payment. It not only wastes patients' time, but also reduces hospital efficiency. Outpatient process reengineering is patient-centered. It helps a hospital reflect upon its deficiencies in outpatient progress, transform its philosophy of service and strategy of operation and utilize information technology. The advanced Business Process Reengineering Theory and process reengineering technique are introduced for hospitals to rethink and redesign their outpatient process so that they can improve performance indicators in the cost, quality, service and efficiency of outpatient department. In this way, the medical service model will be changed and an efficient treatment process to the satisfaction of patients will be created, which can deliver efficient and convenient medical services to patients, raise operation efficiency of hospitals and increase the social benefits and economic benefits of hospitals. Therefore, it is of great significance for hospitals to use the advanced Business Process Reengineering Theory and process reengineering technique to optimize their outpatient process.

This thesis first analyzes and summarizes the current situation of outpatient registration in Chinese hospitals and then explores the current situation and deficiencies of domestic and foreign research on effects and influence factors of

outpatient appointment process. As the first Chinese hospital that adopts a system of appointment registration for all patients, The University of Hong Kong-Shenzhen Hospital is selected as the case. An in-depth study on the influencing factors of the Hospital's business process reengineering is of significance as it has value in scientific research as well as application value in formulation of policies.

Value for scientific research: As the first Chinese hospital that adopts a system of appointment registration for all patients, The University of Hong Kong-Shenzhen Hospital is selected as the case. It is a groundbreaking study on process reengineering of a wholly appointment registration system.

Application value for formulation of policies: this thesis studies the effects and influence factors of outpatient process reengineering of HKU-SZH, which is the first to adopt an all-round appointment registration system. The study not only lays a theoretical foundation for HKU-SZH to optimize medical resources and increase efficiency, but also provides other hospitals with empirical support and scientific guidance to optimize their outpatient process.

Through methods like documentary research, on-site interviews and the Delphi method, this thesis attempts to explore a management model and medical mechanism suitable for HKU-SZH so as to safeguard the medical interests of patients in the stage of process design and to secure a smooth progress of hospital business process reengineering. This study is of considerable realistic significance both theoretically and practically to improve medical services for the public and establish harmonious doctor-patient relationships.

1.5 Major Innovations and Limitations

The main innovations of this study are as follows:

1. In this thesis, diagnoses and analyses of outpatient process of HKU-SZH are made through field investigation and measurement of patient satisfaction. Rather than regression analysis, correlation analysis or factor analysis, the measurement is based on structural equation model, through which influence of different processes on

patient satisfaction can be accurately calculated. This method not only embodies the service philosophy of “putting patients first”, but also serves as an entry point of process reengineering.

2. An in-depth analysis is carried out on deficiencies of the appointment registration for all patients model. A plan for improvement is also proposed to solve the existing problems.

3. Information technology is used to reengineer the outpatient process of HKU-SZH so that its medical resources are utilized reasonably and efficiently. In this way, the difficulty of accessing medical services is solved to some extent. This empirical study is of practical significance as it is in line with the Outline of National Development Plan for Health Information.

4. This thesis uses structural equation model and research methods in a variety of theories such as BPR Theory, Queuing Theory and Six Sigma Theory. The study is conducted in accordance with standardized processes of business process reengineering. The research methods are unconventional and are in line with the actual situation of HKU-SZH.

5. At present, most hospitals use card technology to reengineer their outpatient process. But most of them issue their own cards and manage the advanced payments by themselves. However, this study proposes a practical and novel idea, which is to cooperate with banks to launch co-branded cards.

The major limitations and suggestions for further study are as follows:

1. There is no quantitative analysis to evaluate the effects of process reengineering. A method to improve and perfect the process reengineering plan is as follows: a scientific measurement scale for patient satisfaction should be devised for a more in-depth investigation of patients and hospital staff. The effects of hospital progress reengineering should be evaluated through the Cost-Benefit Analysis Method. Special attention should be paid to the changes of patient satisfaction, especially in hospital process, before and after process reengineering.

2. As regards resource sharing of treatment information, it is necessary to seek

help from government departments like Shenzhen Health and Family Planning Commission. Only with their help can a medical information-sharing platform be built to ensure sharing of treatment information between different hospitals.

3. It is advised to communicate and negotiate with medical security institutions to recommend a functional integration of social security cards and co-branded cards. In this way, patients only need one card for medical services, which is convenient and efficient.

Chapter 2 Literature Review of Relevant Theories

This chapter mainly reviews the theoretical literature currently applied in process improvement, including Process Management, Business Process Optimization Theory, Business Process Reengineering Theory, Queuing Theory and Six Sigma Theory, which will be applied in the case study and analysis when necessary.

2.1 Process Management Theory

Process Management, as an important management method in modern enterprise management, has been playing a bigger and bigger role in enhancing business performance and raising customer satisfaction level. It has also attracted widespread attention from management specialists in the business circle. Its successful application in enterprise management has also drawn great attention from hospital management scholars.

2.1.1 Origin of Process Management

In the Eras of Taylor and Ford, maximization of operation efficiency was the primary target. As a result, the idea of process management gradually developed into a formal management theory. Management master Taylor first proposed the idea of job analysis, followed by the idea of process management in 1920. In 1980, the idea of quality management became very popular. In 1984, the US-based International Business Corporation, abbreviated as IBM, proposed Quality Focus Business Process (QFBP) and listed “quality” as the core element of process. In 1988, IBM officially changed QFBP into Business Process Management (BPM). In 1990, the American management master Michael Hammer and James Champy first proposed the idea of “business process reengineering” in their best-seller *Reengineering the Corporation*. This idea fitted the economic development requirements of the new period, because Hammer and Champy both agreed that enterprises should adapt to the changing external environment, gradually establish the customer-oriented operating principle, and reengineer the business processes to suit the external business development. In

response to Business Process Reengineering, IBM formally put forward the idea of Process Management (PM).

2.1.2 Evolution of Process Management

At the end of the 1980s, the previous logical processes could no longer meet the demand of business development due to changes in the global economic environment. Plus, development of information technology posed new practical requirements on business process management. Under such conditions, development of the Process Management Theory entered a "dilemma". At this moment, Michael Hammer formally put forward the idea of "Business Process Reengineering" for the first time. Particularly, in the book entitled *Reengineering the Corporation: A Manifesto for Business Revolution* jointly published by Michael Hammer and James Champy (1993), it was put forward that "Business Process Reengineering" is "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed". From then on, Business Process Reengineering, as a new management idea, quickly become very popular in the United States. It generated widespread attention from the business circle and gradually became a guiding theory for business restructuring and management reform for enterprise managers in Europe, the U.S. and even the world at large.

However, with the application of Business Process Reengineering in enterprises, it was found that the implementation effect fell short of what was expected. A survey conducted in 1994 revealed that around 70% of business process reengineering projects failed or yielded few results. After analysis and demonstration, business specialists such as Hammer and Champy concluded that "human factor" had been largely ignored in "process reengineering" in the application of "Business Process Reengineering". As a result, users of this theory could not thoroughly understand the principles and ways of reengineering. With this discovery, "Business Process Reengineering" gradually went back to its reasonable track and incorporated the idea of Business Process Improvement (BPI). Later on, after summarizing experience from previous successes and drawing lessons from previous failures, IBM proposed the

idea of "Business Process Management" (BPM), regarding Process Management (PM) as a research method that takes standardization of process design as its core and continued improvement of enterprise organizational performance as its fundamental principle. It includes process overview and analysis, definition and redefinition, resource reallocation, time management, quality assessment and efficiency rating and process re-improvement.

Compared with "Business Process Reengineering", Process Management is also defined as encompassing terms such as standardization, process, continuity and systemization. But what's different between Process Management and "Business Process Reengineering" is that the former explicitly points out that it is not absolutely necessary to thoroughly and fundamentally redesign process. Rather, systematic design of unreasonable processes should be carried out in light of actual conditions. In other words, the processes that need to be redesigned should be redesigned, whereas those do not need to should be improved. Besides, Process Management underlines the importance of meeting the demand of customers. Once changes in the internal or external environment occur, such processes will need to be re-optimized. Therefore, Process Management highlights the practicability of processes more and focuses more on the systemized, continued and constantly improved processes.

2.1.3 Combination and Integration of Process Management and Other Management Theories

In the healthcare sector, management scholars have always maintained a positive attitude towards the successful management theories and methods in the business circle. While findings on application of management theories such as Business Process Reengineering, Business Process Management and Process Management have been published in documentary research, empirical studies on application in other aspects have also been published in various academic journals. For example, Wong & Doyle gave an explanation of process management in 1975. From then on, scholars have been following their steps in the study of process management, which has gradually become a hot topic for research. These articles, which have been penetrating

deeper and deeper in research, expanding from rudimentary theory introduction to systematic research and from hospital management to clinical practice, have been more and more widely applied. The moment "Process Management" was introduced into the healthcare sector in China, it immediately attracted widespread attention from, and was intensively studied by, hospital managers. Scholars of different sectors have all conducted applied research on Process Management and integrated other theories and practices in their respective research. As a result, combination and integration of process management and other management theories have become a trend.

(1) Information Technology and Process Management

In terms of individuals, Information Technology (IT) has changed the way people communicate with each other. As to enterprises, IT has changed the distribution of power within organizations, altered corporate structure and reduced management hierarchies. As a result, corporate structure has become more and more flattening, which puts enterprises in a better position in market competition. IT has opened up space for process improvement, and to some extent, pushed forward process management reform. However, IT, in itself, is not characterized by the thoughts and ideas of "Process Management". Therefore, debates on medical process arose right when IT was first applied in the medical industry. For example, Shen (2003) proposes several questions, such as "whether information technology should be used to reengineer hospital management or information technology should accommodate hospital management model; and whether information technology should be used to simulate traditional manual work or new ways of work should be redefined." These questions can all be boiled down to the collisions between modern management technologies and traditional management ideas. For instance, the IT-based "One-Card" can integrate all medical processes, including outpatient registration, triage and payment. Using the "One-Card", patients can finish all the aforementioned processes at one time and significantly reduce the length of waiting; in comparison, outpatient doctor workstation has given rise to the management model where "patients choose doctors"; application of PACS and electronic medical records has reduced the storage time of medical records and accelerated the information

transfer of medical records; information system can also further shorten the time required for completion of discharge procedures; besides, internet technologies also make online consultation, booking and registration possible. Therefore, it is believed that full use of IT is necessary for process optimization so as to enable HIS to bring about outpatient services with high quality and efficiency.

(2) Queuing Theory and Process Management

Li and Xu (2003) point out that Queuing Theory, which is also referred to as Stochastic Service Theory, is a branch of Operational Research. It is widely applied in practices and bears a lot of similarities to Process Management. For example, a mathematic model based on elements of Queuing Theory, such as customer, service, input and output, can be designed to quantify and optimize various links of process and relationships between different links. In China, Zhao and Yang (2003) have discovered the distribution of the time consumed by patients in accessing medical services using mathematical modeling and analysis. They have also found that many processes in accessing medical services can be optimized so as to provide scientific bases for improvement of service system, betterment of management models, optimization of service processes, and integration of hospital organizational structure. Seeing from this, Queuing Theory, as a very practical tool for analysis of process management, is expected to become a major theory for process management research in the future.

(3) Clinical Path and Process Management

Wu and Ying (2002) conclude from research that clinical path, in the broad sense, refers to everyone that provides medical services to patients in each medical process, including clinical medical specialists, nursing specialists, pharmaceutical specialists, psychologists, nutritionists, laboratory staff and logistics service personnel. These people together form a major department that provides a set of “premium” service and management model for certain diagnosis and treatment. In the beginning, clinical path drew from Critical Path management technologies in industrial enterprises. After being introduced to hospital management, clinical path started to be used in new areas.

Back then, medical procedures were referred to as medical processes or medical service processes in medical service industry. However, although Process Management Theory had been profoundly used in much literature on medical service, there were a lot of similarities in the distinctions, or even no clear distinctions, between "medical process" and "clinical path" in both theory and practice. For example, the "clinical path" studied in the United States in the 1990s refer to a set of comprehensive, professional and diverse service standards. From the perspective of process refining research, study of "clinical path" further deepens the study of process management. Besides, from another perspective, it better conforms to the Theory of Clinical Path, and will definitely push forward the research and application of BPR and BPM.

(4) IS09000 and Process Management

ISO9000 standards, which are acknowledged by international counterparts, are formulated by ISO/TC176 Technical Committee. Formulation of the standards is mainly based on successful quality management experience of advanced enterprises in industrialized developed countries. The standards, which have profound and positive influence on improvement of quality management, realization of quality targets, improvement of product quality and enhancement of customer satisfaction level for many enterprises, have attracted broad attention from, and been widely adopted by, enterprises in different countries of the world. Zhu (2003) finds through research that by far, ISO9000 standards have been adopted in more than eighty countries and that adoption of the standards is recognized as the "passport" to international market. Since China's accession into the WTO, its medical industry and medical services have gone global. Healthcare enterprises in China have to not only cope with the fierce competition from Chinese counterparts, but also compete with multinational companies in the global market. Under such conditions, hospitals must enhance their management level if they want to remain competitive in the long term. In particular, hospitals need to introduce advanced quality management thoughts and ideas, establish a medical quality assurance system, push forward standardized management and enhance the level of medical services, so as to increase their social and economic

benefits.

Ye (2003) summarizes the basic guiding ideas of hospital quality authentication. a. Write what you have done; b. Do what you have written down; c. Record what you have done; d. Check what you have recorded; e. Make corrections and take precautions. Hospital quality authentication underlines systematic management, the importance of putting customers first and continuous improvement amid process management and control. Relevant documents on ISO9000 quality demonstrate the following structure from bottom to top: form records sit at the first layer; operation standards and job specifications rest at the second layer; books on procedures occupy the third layer; and manuals form the fourth layer. Judging from the characteristics of ISO standards themselves, books on procedures are standardized documents, emphasizing on standardizing and coordinating procedures of different departments. They have many similarities and a certain degree of mutual-complementarity from the perspective of quality management. Yan (2002) believes that hospital process reengineering and adoption of ISO9000 standards are complementary to each other. Relevant standards in the healthcare industry in China are yet to be formulated; experience in authentication is yet to be enriched in various major hospitals; and authority of authentication institutions is yet to be enhanced. Therefore, hospitals can choose to apply ISO9000 standards on a trial basis first, implement the standards step by step and gradually improve them in actual use.

(5) Six Sigma Theory and Process Management

Cao and Zhu (2003) point out that "σ" (sigma), which refers to standard deviation in Statistics, is used to describe how much the standard value of a process or product data has deviated from the target value. Generally, "σ" is used to measure the overall deviation of quality coefficient from the target value. Six Sigma, which is calculated as six times of the standard deviation, means that only 3.4 mistakes occur if there are one million chances to make mistakes. In other words, it refers to 99.99966% of pass. As a management method, Six Sigma Theory is defined by many scholars as "a comprehensive management system and development strategy that enables an

enterprise to achieve and sustain success in operation and maximize business performance. It is an operation model that enables enterprises to achieve rapid development." Its management philosophy requires people to put customers first, regard organizations as system, make decisions based on data, and focus on process management. Generally, application of Six Sigma Theory in process management is divided into five steps (DMAIC). First, Define. Customers' key demand and the products or processes that need to be improved should be identified in order to define the to-be-improved projects in a reasonable range; Second, Measure. The benchmark and target value of the existing processes should be determined based on measurement of the respective processes and the effectiveness of the measurement system should be evaluated; Third, Analyze. The key points that affect processes should be pinpointed through data analysis; Fourth, Improve. Measures to optimize the output process should be employed or proposals to eliminate or lower impact be formulated so as to reduce process faults to the minimum level; Fifth, Control. The improved processes should be standardized and implemented in accordance with procedures; and effective testing methods should be used to sustain process improvement results.

According to Yu and Chen (2005), currently many American medical institutions have achieved remarkable progress in process improvement projects where the Six Sigma Theory has been applied. Zhang and Zou (2005) discover through study that Mount Carmel from Columbus, Capital of Ohio State, the U.S., after realizing that Six Sigma is a management tool that can help him realize ground-breaking benefits, applied Six Sigma Program in six key aspects, namely, raising income, reducing bad loans, increasing the flow of patients, regulating employment, recruiting and retaining staff, as well as guaranteeing patient safety. He achieved remarkable results.

Hospitals in China have also carried out brave practices and exploration in the application of Six Sigma tools. A case in point is the improvement program of the six patient-oriented external processes by West China Hospital completed in July, 2004. The six processes refer to "shortening the length of finishing hospital discharge procedures, shortening the length of waiting for examinations, making the queue for

receiving medicine outside the Pharmacy less crowded, shortening the length of completing hospital admission procedures, increasing the efficiency of registration for outpatient service and payment in the Cashier, and optimizing the prescription pricing and payment procedures for emergency cases." Chen (2010) finds in his research that in 2009 Taizhou Hospital in Zhejiang Province reduced the defect rate from 39.6% to 12.9% by using Six Sigma Theory management method to define, measure, analyze, improve and control the defect in the dripping speed of outpatient venous transfusion. The Six Sigma Theory value was raised from 1.76 to 2.63. As a result, the purpose of preventing transfusion reaction and guaranteeing the transfusion safety of outpatients was achieved.

2.2 Business Process Reengineering Theory

The term Business Process Reengineering (BPR) originates from the idea of Reverse Engineering in software maintenance in IT industry. The most representative definition was given in 1990 in the book entitled *Reengineering the Corporation*, jointly written by Michael Hammer and James Champy. They believe that "business process reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed. In this way, corporations can best fit the external modern business environment characterized by customer, competition and change". In 1995, Michael Hammer and Steven Stanton jointly published another book entitled *The Reengineering Revolution Handbook*, which started an upsurge in "organizational reengineering" among Western countries. Some scholars hold that "organizational reengineering" is the latest progress in Management Science. It will definitely bring about a brand new management revolution. What sits at the core is business process reengineering.

The systematic reintegration of business process refers to the systematic redesign and reorganization of previous processes in accordance with the four major principles, namely, elimination, simplification, integration and automation on the basis of the

previous operation procedures. The aim is to ultimately better satisfy demand of customers, increase efficiency and reduce cost.

Hammer & Champy (1993) point out that BPR, which takes business process as the core of reengineering, customer demand as the premise and enhancement of satisfaction level as its goal, is aimed at achieving improvements in indicators such as cost, quality, service, and speed through rethinking and redesign of business processes. In essence, it proceeds from operation procedures and satisfaction level of customers and makes use of simple design processes and organizational structures to enable corporations to fit into the modern business environment characterized by "customer, competition and change" to the maximum extent. In the following text, this thesis will elaborate on the main principles, composition, ultimate goal, guiding principles and research methods of BPR.

(1) Main Principles of BPR

a. Put patients first. All medical staff should put patients first in their work. The aforementioned "patients" include both patients from outside and hospital staff. Performance of hospital staff will no longer be assessed by superior leaders, but by "customers".

b. Regard "process" as a priority in medical business. A process, completed through the cooperation of a series of functional departments, is mainly aimed at creating valuable services for patients. Any factor that undermines the running of "process" will be eliminated. Excessive departments and repetitive "processes" will all be further optimized and improved.

c. Improved "processes" promise improved effects. Improved processes run with increased efficiency, reduced waste, reduced time loss, improved patient satisfaction level and enhanced quality of hospital comprehensive service.

(2) Composition of BPR

The fundamental objective of BPR is optimization of business processes. Processes are composed of a series of work activities in line with certain joints of framework. Take the daily hospital outpatient and emergency treatment as an example. Work activities can be divided into three categories:

a. Initial treatment, including clinical reception, consultation, treatment and transfer treatment;

b. Laboratory examination and dispensation;

c. Non-effective links, such as awaiting diagnosis in a queue, job mistakes and excessive laboratory examination.

(3) Ultimate Goal of BPR

a. Identify the core hospital business processes. In other words, reorganize ways of work and service mode based on core processes in order to offer convenience to patients to the maximum extent;

b. Simplify or consolidate non-effective work links or processes and identify repetitive or non-effective processes in order to lower process cost;

c. Staff of all departments must all take patients as the priority and carry out work in order to satisfy their needs.

(4) Guiding Principles of BPR

a. Key success factors of BPR

Key success factors include: A hospital's strategic orientation, organizational structure and core team, measurable reengineering target, feasible implementation plans, financial support, closeness to customers and suppliers and inclusion of them into the scope of reengineering, understanding of the relationship between information technology and BPR, as well as emphasis on human factor.

b. Framework model of BPR

The five factors of BPR framework model are: process, management, organization, personnel and information technology. The core factor is process, including three types of process, namely, inter-organization process, cross-functionality process within an organization and intra-functionality process. Four sub-systems are involved, namely, management sub-system (model, system, measures and risk preference), personnel sub-system (work, skill, culture and values), information technology and technology sub-system (data and information, IT, decision-making, simulation and modeling approach), as well as organization sub-system (formal and informal organizations, team mode, coordination and style of

management & control). The aim of BPR is to enable reengineered processes to provide services of higher quality and lower price and a higher degree of customer satisfaction.

c. Ways of implementing BPR

There are mainly to ways to implement BPR: progressive implementation and radical implementation. The advantages of radical reform are its immediate completion and low time cost. Yet it exposes the project to bigger risks. The advantage of progressive reform is its low risk probability of failure. But it requires long time and huge time cost.

d. Time and scale of BPR implementation

The time BPR implementation depends on the actual conditions of the specific hospital. If the hospital has the capacity to go through BPR for a long time, then the time of implementation can be extended to certain extent; the scale of BPR implementation should also be decided in light of local conditions. But the first step should be to identify the key business processes of the hospital so as to clearly foresee changes in hospital performance after reengineering and make sure hospital reengineering proceeds sustainably.

(5) Research Methods of BPR

a. Preparation Phase

i Set process reengineering objectives: Establish the service principle of "putting patients first" and develop the service philosophy of "providing all services for patients", including reducing length of waiting, simplifying treatment procedures, optimizing the treatment order, improving service quality, raising work efficiency, reducing medical costs and enhancing level of patient satisfaction.

ii Conduct risk assessment of change: Two major aspects, namely, environment assessment and process risk assessment, are included. Environment assessment is aimed at assessing whether new processes comply with relevant national policies and regulations and whether enough funds are available for the project. Process risk assessment includes assessment of operational risks, authorization risks, information and technology risks and financial risks.

iii Build a reengineering team and draw up implementation plans: The reengineering team can be built according to the "1+1" pattern. To be specific, the majority of the team members should be from the hospital staff, because they are the most familiar with existing processes, including their strengths and weaknesses and every link of each process. The team should also include a portion of external staff, such as HIS experts. They can assist the internal staff in examining existing processes from an external perspective and finding out deficiencies that internal staffs are unable to discover. To conclude, the reengineering team is responsible for analyzing existing processes, identifying problems, putting forward right solutions to the problems and maintaining the reengineered processes.

b. Investigation Phase

i Research methods such as literature review and case study should be employed to classify existing complaints of outpatient services into different categories according to indicators such as job responsibilities, job attitude, results of diagnosis and treatment, medical costs and quality of medicine. Besides, priority should be given to analysis of complaints about problems that exist in outpatient processes.

ii Design questionnaires and employ methods such as typical case analysis, survey of intention and expert consultation to conduct analysis and assessment of the current situation of outpatient processes.

c. Analysis Phase

i Find out the connections between problems of different categories with systemic analysis method; study the development or evolution trend of various problems; and conduct quantitative analyses of the impact of various problems with expert consultation method.

ii When problems have been classified and put into order by importance, a structural equation model for existing outpatient processes should be established in light of the details and data obtained in field research and interviews. Then a quantitative analysis of the importance of different factors in outpatient processes

should be conducted on the basis of simulating and operating the model. After that, a flow chart of existing processes should be drawn based on an analysis of existing outpatient processes with management tools such as the Six Sigma Theory. Finally, the time needed to complete each step of existing process (including register, awaiting diagnosis, treatment, examination, payment, dispensation and therapy) according to the flow chart so as to identify the steps that are yet to be optimized in existing processes.

d. Implementation Phase

ⅰ Sum up the optimization objectives based on results of the above-mentioned research and use of tools such as expert interview and situational analysis. Use a combination of theories, such as Business Process Reengineering Theory and Process Stage Theory to analyze the internal and external environment of the hospital during different phases, define its system boundary and organizational structure and analyze its weak links so as to form objectives and strategies of improvement. After that, a complete set of strategies should be formulated and necessary feasibility assessment conducted. Finally, optimization plans and development strategies of outpatient processes should be formed, new outpatient processes established and simulation calculation conducted.

ⅱ Amend the original processes according to the reengineering objectives; determine new processes and carry out information construction of outpatient services. Make an overall arrangement in the implementation phase; determine the order of precedence by which each step is to be implemented; make reasonable distribution based on resource allocation; and implement each step one by one according to the order of precedence.

2.3 Business Process Improvement Theory

Business Process Improvement (BPI) is a methodology aimed at keeping the competitive edge of an enterprise by constantly perfecting and optimizing the business process. The process must be continuously improved in its design and

implementation so as to achieve the best result. BPI means to do the right thing in the right way. Its aim is to increase service time and improve efficiency of valuable services as well as minimize the time spent on non-value-added services. Usually there are three stages in BPI: first, description of business process, which includes a clear definition of the business or operation process of the target company through field research in the enterprise; second, analysis of business process, which means to look into the current process of the target company to identify major causes of existing problems; third, formulation and implementation of improvement plans, in which redundant or overlapping processes are redesigned and optimized on the basis of the identified problems and their causes.

In some foreign hospitals and healthcare institutions, BPI has already been successfully implemented. For instance, in The Stockholm Hospital in Sweden, an "Operation Preparation Room" has been established to anesthetize the patients in advance so that the average time between two surgeries spent on anesthetization is shortened; Hillingdon Hospital in London has adopted BPI by allowing patients to receive blood test in respective departments instead of in the Central Laboratory as before, thus drastically cutting the waiting time for blood test.

Modern hospitals in China, unlike their foreign counterparts, still insist on operating in a traditional manner, thus making them more bureaucratic. Therefore, those large hospitals are now less and less able to meet the medical needs in China, which have become increasingly diversified and personalized. According to Ding (2010), most Chinese hospitals follow a serial working mode, which means the work is divided step by step, and only after one step finishes can the next start. Such a process is rarely value-added since it leads to unreasonable distribution of medical resources, low degree of information sharing capacity and low operating efficiency. Zhao (2006) suggests that the effective treatment time of outpatients is only 10% of their stay in a hospital, as patients have to queue up for treatment and payment. If the percentage can be raised to 30%, then the stay of patients in hospitals will be cut by two thirds, and if raised to 50% the stay will be reduced by four fifths. However,

while carrying out BPI projects, some hospitals have been met with great difficulties brought about by their system and structure. Improvement of patient service satisfaction in these hospitals is particularly difficult. Lin (2004) insists that Hospital Business Process Management (HBPM) should be applied. Being process-oriented, a hospital should work on the basis of its development strategy and patients' needs so as to enhance the doctor-patient relationship, improve working quality and efficiency and eventually enhance patient satisfaction. For Lin, the HBPM mode offers a new way to strike a balance between increase of medical demands and a short supply of medical resources. It can lower medical cost, optimize use of medical information resources, and promote new technology and new programs. Qi (2007) adopts the ECRS principle to simplify, combine and rearrange the traditional treatment process. Consequently, outpatients can spend much less time queuing up for services and moving between different departments. He also suggests a "One-Card" service system for hospitals, which aims at simplifying the healthcare procedures by establishing an integrated information service system.

With successful case studies of foreign hospitals and domestic research in this field, this study insists that adopting IE approaches to improve the healthcare process will greatly increase the current low efficiency of outpatient service. The increasingly deepening informatization cannot only help to improve the treatment process, but also break the information asymmetry between hospitals and patients through an integrated information system that can share medical information. As a result, it will be faster and more convenient to see a doctor, and the problem of difficult access to medical service, which is common among Chinese hospitals, will be resolved.

2.4 Queuing Theory

According to Li and Xu (2003), Queuing Theory, or Stochastic Service System Theory, is an important branch of Operations Research. It studies the probabilistic properties of queuing in various service systems so as to achieve optimal service system efficiency. In 1909, Agner Krarup Erlang, a Danish engineer, published *The*

Theory of Probabilities and Telephone Conversations, the first monologue on Queuing Theory, which mainly calculates and studies service time and queuing efficiency. Lu (1994) finds in his research that Queuing Theory has been constantly improved and enriched with the rapid development of IT technology and has been applied extensively in various sectors such as transportation, health care, shopping and banking.

2.4.1 Structure and Characteristics of Queuing System

According to Jin and Yu (1998), usually there are three parts in a queuing system: arrival process, queue discipline and service mechanism.

(1) Arrival process: Also called customer flow, it refers to a process in which customers in need of services arrive at the queuing system in certain patterns. The process usually describes the arrival of customers in three aspects: whether the calling population is finite or infinite; whether it is a single or batch arrival; and whether the arrival interval is fixed or random. Within a certain time span, there are two arrival patterns to describe the probability of how many customers arrive at the service facility:

First, Fixed-length distribution: the inter-arrival time is fixed;

Second, Poisson distribution: the arrivals are single and independent; the number of arrivals in a certain time presents Poisson distribution pattern; the inter-arrival time, expected value and variance are irrelevant to the time factor; and the characteristics are relatively stable.

(2) Queue discipline: the discipline mainly describes whether the customers are allowed to queue or not by the service provider, customers' tolerance of queue length and waiting time and the sequence in queuing for service. Usually there are three major types of queue disciplines:

First, losing mechanism: as all servers are occupied when a customer arrives at the queuing system, the customer leaves and never returns. As demands on medical service are less flexible, the chance for a patient to leave the hospital and never return due to a busy queuing system is rare. So this phenomenon seldom happens among

outpatients.

Second, waiting mechanism: the customer automatically joins the queue waiting for service if all servers are occupied when the customer arrives. Usually this mechanism consists of four disciplines: first come first served (FCFS); last come first served (LCFS); service in random order (SIRO) and priority, which means customers with high priority are served first.

Third, mixed mechanism: a mixture of the above two mechanisms, which means the service system allows queuing only if the queue length is limited.

(3) Service mechanism: it includes the number and arrangement of servers as well as the service time of a single server.

In terms of the number of servers there are single server systems and multi-server systems. Considering the arrangement of servers there are: single queue, single server; single queue, multiple parallel servers; multi-queues, multiple parallel servers; multiple tandem servers; and mixed queuing pattern. Considering the service pattern there are single service and bulk service.

2.4.2 Distribution Pattern of Common Queuing Models

Since the arrival rate and service rate in the queuing system are random, according to the rules in statistics, they follow certain distribution patterns. Based on the distribution of customers' inter-arrival time and servers' service time, there are six distribution patterns:

(1) M—Negative Exponential Distribution:

Assume the number of arrivals follows Poisson distribution and the parameter λ denotes the mean value. Then the intervals of arrival time will present a negative exponential distribution with λ as the parameter and the arrival rate has the Markov property. The density function of the distribution is:

$$f(x)=\begin{cases}\lambda e^{-\lambda t} & t\geq 0\\ 0 & t<0\end{cases} \qquad (2.1)$$

The mean value and variance are: **E (T)=1/λ, D(T)=1/λ^2**.

(2.2)

(2) E_k—K-Erlang Distribution:

When the servers are in parallel, the distribution density function for each operating server is:

f (t)=kue^{-kut}, and T= $\sum_{i=1}^{k} Ti$ **.**

(2.3)

The mean value and variance are: **E (T)=1/u,D(T)= 1/ku^2**.

(2.4)

(3) D ——Deterministic Distribution:

For E_k, if K=∞, then D (T)=0, and the distribution is a deterministic one. The density function of D is given by

$$F(t)=\begin{cases} 0 & t<a \\ 1 & t<a \end{cases}$$

(2.5)

Here “a” refers to service time or inter-arrival time.

The mean value and variance are: **E (T)=a, D(T)=0**.

(2.6)

(4) G——General Distribution:

The distribution function of G is: **F (t)=p{$x_n \le t$}=1-e$^{-\int_0^t u(x)dx}$**

(2.7)

The mean value and variance are: **E (T)=1/u, D(T)= σ ^{2}**.

(2.8)

(5) PH Distribution:

PH distribution is the distribution of time until absorption with finite states and Markov property. For a Markov chain with a set of states {1, m, m+1}, the only

absorbing state is state m+1, and there exists an infinitesimal matrix:

$$\mathbf{Q}=\begin{bmatrix}\mathbf{T} & \mathbf{R}\\ \mathbf{0} & \mathbf{0}\end{bmatrix}$$

(2.9)

Here T is an m× m square matrix, satisfying $T_{ii}<0$, $T_{ij}\geq 0$, $i\neq j$, and e denotes the all-ones column vector with the same dimensions of matrix T. Its initial probability vector is $(\alpha_1, \alpha_2, \ldots\ldots \alpha_{m+1})$, if $\alpha= (\alpha_1, \alpha_2, \ldots\ldots \alpha_m)$, then $\alpha e+\alpha_{m+1}=1$.

Assume F (t) denotes the absorption time distribution of states, $V_i(t)$ denotes the probability of the Markov process falling in state i at time t, then based on Chapman–Kolmogorov equation, $V'(t)=V(t)T$, $t\geq 0$ and $V(0)=\alpha$.

Then the matrix form of F (t) is $\mathbf{F(t)=1-V(t)e=1-\alpha e^{Tt}e,\ t\geq 0}$.

(2.10)

Only when it is a finite dimensional Markov process within 【0, ∞】, can it be called PH distribution. Therefore, the Erlang distribution in its broad sense can be regarded as PH distribution.

(6) Geometric Distribution:

Geometric distribution, as a discrete probability distribution, is the probability of one success out of n times of Bernoulli trials. The distribution function is:

$$\mathbf{P(X=k)=(1-p)^{k-1}p}$$

(2.11)

The mean value and variance are: $\mathbf{E(T)=1/p}$, $\mathbf{D(T)=}\frac{1-p}{p2}$.

(2.12)

3.4.3 Analyzing the Outpatient Process with Stochastic Service System Theory (Queuing Theory)

Peng and Dong (2005) find that the outpatient process flow consists of many independent links following one another, including registration, diagnosis, laboratory test, treatment, payment and drug dispensing. The two scholars regard outpatient process as a circulated queuing network with multiple servers and a serial connection. The structure and characteristics are showed in Table 3-1:

Table 3-1 Structure and Characteristics of Outpatient Process in Hospitals

Structure of the Queuing System for Outpatient Service	Distribution Pattern	Manifestations in the Outpatient Process
The inter-arrival time and distribution of customers	Poisson distribution (M)	Arrival at Cashier Arrival at Laboratory Arrival at Pharmacy
	Constant input (D)	Random arrival of patients
	E_K	Patients arrive with the same time pattern
	General distribution (G)	--
Distribution of service time	Negative exponential distribution	Time spent in registration, payment, diagnosis and treatment, ultrasonic B-scanning, chest radiography test
	Deterministic distribution	Time spent in the Laboratory and the Radiology Department
The number of servers	Single	Service provided by staff in a single window or equipment
	Multiple	Service provided by staff in multiple windows or equipment
Maximum number of customers allowed in queuing system	Finite (K)	Emergency treatment and wait for hospitalization beds
	Infinite（∞）	Ordinary out-patient service
Calling population	Finite (K)	Physical examination at fixed time
	Infinite（∞）	Random arrivals of customers at hospitals
Serving disciplines	First come first served	Ordinary out-patient service
	Last come first served	Rarely happens
	Priority	Emergency treatment Aged patients and cadres first

Source: The author

2.4.4 Major Calculation Indicators and Patterns

The queuing system mainly adopts the following calculation indicators:

λ - The mean arrival rate of customers, representing the mean number of customers entering the system seeking for service per unit of time;

1/λ – The mean inter-arrival time;

μ – The mean service rate, representing the mean number of customers served by the service per unit of time;

1/μ – The mean service time;

P – The service intensity, representing the mean service time of single server per unit of time;

L_S – The system length, or the number of all customers in the system, including those being served and those waiting in the queue;

Lq – The queue length, representing the number of customers queuing up in the system. The expected value of all possible queuing lengths is denoted by Lq;

Ws - The total time from arrival to departure, including the time spent in the queue and on being served. Its expected value is denoted by Ws;

Wq - The time customers spend in queues before service begins. Its expected value is denoted by Wq.

On the basis of the Little Equation, this thesis discusses two service models: M/M/1 and M/M/C.

(1) Standard M/M/1 Service Model

In this service model, arrivals follow a Poisson distribution pattern. There is a single server, and the service times have a negative exponential distribution. Calling population and service capacity are infinite and the queuing discipline is FCFS. Its statistical indicators are as follows:

Service intensity: $\boldsymbol{\rho=\lambda/\mu}$;

(2.13)

The probability of servers being free: $\boldsymbol{P_0=1-\rho}$

(2.14)

The probability of n customers in the queuing system: $\mathbf{P_n=\rho^n(l-\rho)}$

(2.15)

$\mathbf{L_s=\frac{\lambda}{\mu-\lambda}}$; $\mathbf{L_q=\frac{\rho\lambda}{\mu-\lambda}}$

(2.16)

$\mathbf{W_S=\frac{1}{\mu-\lambda}}$; $\mathbf{W_q=\frac{\rho}{\mu-\lambda}}$

(2.17)

(2) Standard M/M/C Service Model

In this service model, arrivals follow a Poisson distribution pattern. The service times have a negative exponential distribution. The calling population and system capacity are infinite and there are C parallel servers with the same mean service rate, each working independently. Its statistical indicators are as follows:

Service intensity: $\boldsymbol{\rho=\lambda/c\mu}$;

(2.18)

The probability of servers being free: $P_0=[\sum_{K=0}^{c-1}\frac{1}{K!}(\frac{\lambda}{\mu})^k+\frac{1}{c!}\cdot\frac{1}{1-\rho}(\frac{\lambda}{\mu})k]^{-1}$

(2.19)

The number of customers queuing up： $\mathbf{L_q=\frac{\rho(c\rho)cP0}{C!(1-\rho)2}}$

(2.20)

The mean number of customers in the system: $\mathbf{L_s=L_q+}\ c\rho$

(2.21)

The mean time customers spend in the system: $\mathbf{W_s=W_q+\frac{1}{\mu}}$

(2.22)

The probability of queuing up after arrival: $\mathbf{P(n\geq c)=}\sum_{n=c}^{\infty}\frac{1}{c!}(\frac{\lambda}{\mu})^nP_0$

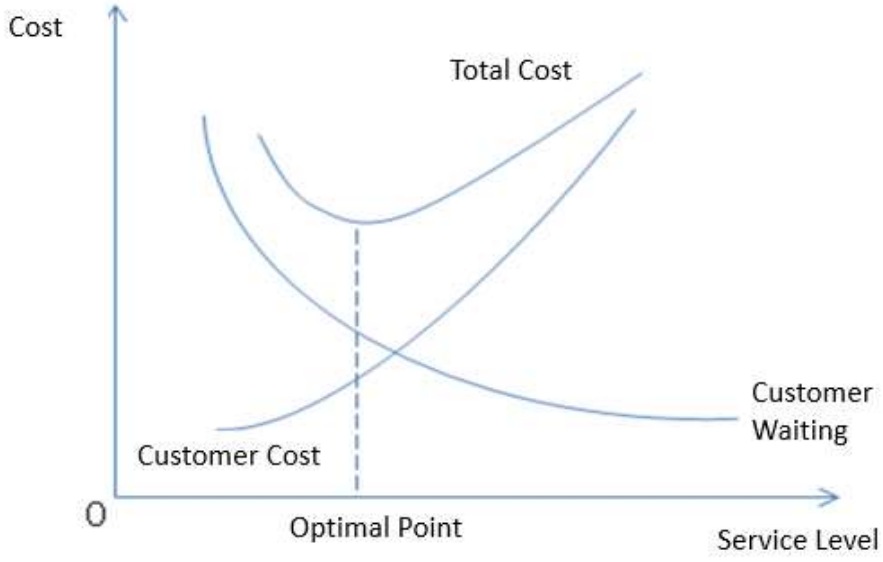
(2.23)

2.4.5 Optimization of the Queuing System

The optimization of the queuing system can be divided into design optimization and control optimization. Design optimization means to use certain indicators such as the optimal number of servers and the adequate system capacity to achieve a most economical system and maximize the profits of hospitals. Control optimization is a dynamic optimization that aims to optimize the service efficiency of system through the choice of control modes so as to achieve the optimal value of the objective function.

The hospital outpatient queuing system should take both patients and hospitals into consideration. On the one hand, patients want more servers so that the service will be more efficient, their length of stay shorter, and their loss will be minimized. On the other hand, to satisfy the need of patients, hospitals must increase the number of facilities (such as servers). However, restricted by their actual conditions, hospitals cannot invest unlimitedly on certain types of resources. As a result, in determining the optimum target value and optimal service level, a balance should be stricken between interests of patients and hospitals so as to minimize the sum of the queuing loss of patients and service cost of hospitals. Figure 1 shows the relationship between the total cost and service rate:

Figure 3-1 Queuing System Optimization



Source: The author

(1) Calculate the optimal service rate U^* and minimal mean total cost Y^* in the standard M/M/1 model:

Assume objective function Y is the expected value of the sum of service cost per unit of time and the cost of customers staying in the system, then

$$\mathbf{Y=C_s \mu +C_W L} \tag{2.24}$$

Here, Cs is the mean cost of the service institution per unit of time when $\mu=1$, C_w is the mean cost of each customer in the system per unit of time. It can be calculated that:

The optimal service rate: $$\mathbf{U^*=\lambda+\sqrt{\frac{CW}{Cs}}\,\lambda} \tag{2.25}$$

The minimal mean total cost: $$\mathbf{Y^*=C_s\lambda+2\sqrt{CsCw\lambda}} \tag{2.26}$$

(2) Calculate "s", the optimal number of servers, in M/M/C model:

$$\mathbf{f_s=C_z s+C_w L_s} \tag{2.27}$$

Here:

"s" denotes the number of tandem servers;

f_s is the mean total cost of the whole system per unit of time. It has a function relationship with "s";

C_z is the mean cost of each server per unit of time;

C_W is the mean loss of each customer while staying (waiting) in the system per unit of time;

L_s is the mean system length. It has a function relationship with "s".

2.5 Six Sigma Theory

According to Liu and Ma (2005), sigma (σ), a Greek letter, represents the level of process or operation. Sometimes the process capability is denoted by Z. For

example, Z=6 means the process or operation has a process capability of 6σ. The analysis of process capability usually focuses on whether the level of a process or operation can meet the expectation and to what degree the expectation is met. Usually Critical To Quality (CTQ) is employed as an indicator for analysis.

When it comes to medical service, the method of process capability analysis from Six Sigma Theory is widely adopted to evaluate the quality of a medical process or operation and in turn to identify problems in them. The goal is to reduce or control the frequency of medical service defects. The so-called medical service defects refer to medical negligence and malpractice leading to personal injuries in medical process. In the broad sense, it includes diagnosis defects, surgical operation defects, drug usage defects, nutrition defects, nutrition defects, cross-infection containment defects, health education defects, server and drug supply defects, patient compliance defects and expenditure defects.

The process capability analysis of Six Sigma Theory is based on the principle of normal distribution in statistics. It adopts CTQ to calculate Defects per Opportunity (DPO), Defects per Million Opportunities (DPMO), Process Capability Index (Cpk) and Process Performance Index (Ppk).

(1) The formula to calculate DPO is:

Number of defects per unit = total number of defects/total number of products

Or, $\mathbf{DPO=\frac{D}{UO}}$.

(2.28)

Here, D is the total number of defects, U is the number of units, and O is opportunities for a defect per unit;

Similarly, the formula to calculate DPMO is:

DPMO = (number of defects per unit/number of opportunities per unit) ×1,000,000

Or: $\mathbf{DPMO=DPOx10^6}$

(2.29)

(2) Calculation of Rolled Throughout Yield (RTY) and Throughput Yield (TPY)

RTY is the yields for each step of the entire process. TPY is the product of those yields, or the probability that a process will produce a defect free unit. Their relationship is as follows:

$$\mathbf{TPY=RTY_1\times RTY_2\times RTY_3\ldots RTY_n} \tag{2.30}$$

Calculation of RTY will help to find potential limitations or problems in a process and the fringe cost brought about by non-value added process or inefficiencies as well as the root causes of the problems.

(3) Calculation of the process capability Z value

To calculate process capability Z value (sigma value), the mean of the process should subtract the closest limit, and the reminder should be divided by the standard deviation.

a. Calculation of the Z value of continuous data

All Six Sigma projects are evaluated by Z value. For a process with only one upper specification limit (USL), the sigma value is the multiple of the variance and the distance between USL and the mean:

$$\mathbf{Z_{USL}=}\frac{(\mathbf{USL}\mathbf{I}\mathbf{X})}{\mathbf{S}} \tag{2.31}$$

For a process with only one lower specification limit (LSL), the sigma value is the multiple of the variance and the distance between LSL and the mean:

$$\mathbf{Z_{LSL}=}\frac{(\mathbf{X}\mathbf{I}\mathbf{LSL})}{\mathbf{S}} \tag{2.32}$$

For continuous data with both USL and LSL, Z_{Bench} should be calculated. Z_{Bench} is the Z value responding to the total probability higher than USL and lower than LSL. To calculate Z_{Bench}, the X_i probability of each tail will be added and the result will be entered into Z table.

$$\mathbf{Z_{Bench}=Z_{score}(P_{USL}+P_{LSL})=Z_{score}(P_{TOT})} \tag{2.33}$$

P_{USL} is the probability of defects responding to a process with USL, P_{LSL} is that

in the process with LSL, P_{TOT} is the total probability of defects, and Z_{Bench} is Z value corresponding to the total probability of defects, which can be checked in the normal distribution table.

Process capability Z value is divided into long-term process capability (Z_{LT}) and short-term process capability (Z_{st}). Z_{LT} has a longer time span than Z_{st}. Usually they can be converted in the following way:

$$\mathbf{Z_{shift}=Z_{st}-Z_{LT}=1.5} \tag{2.34}$$

b. Calculation of the Z value of discrete data

The Z value of discrete data can be calculated in two ways: in order to convert DPMO into DPO in the normal distribution table, check out Z_{lt}, and Z_{st} is Z_{lt} plus Z_{shift} (1.5); use Six Sigma Conversion Table to convert DPO or DPMO.

2.6 Summary

This chapter is mainly a literature review of works and theories in related fields such as the emergence and development of Process Management and its trend to be integrated with other theories. In addition, Business Process Reengineering Theory, Business Process Optimization Theory, Queuing Theory and Six Sigma Theory are reviewed. They are used as analytical tools for study of the case hospital in Chapter 4 and Chapter 5.

First of all, this chapter reviews the literature on Process Management, which is now a major method of management for modern enterprises. Various studies show that Process Management has a positive influence on a company's business performance and its customer satisfaction, and many business management experts have already successfully applied it in companies. Due to its widespread application and huge influence, Process Management has drawn great attention from medical researchers.

The chapter then moves on to review literature on Business Process Optimization Theory and Business Process Reengineering Theory, which are the two most widely

adopted theories in the academia. They have also been successfully applied in domestic and foreign hospitals. Business Process Optimization aims at keeping the competitive edge by constantly perfecting and optimizing the business process. It can also greatly improve the process efficiency. Business Process Reengineering, oriented towards customer satisfaction, tries to help organization to adapt as far as possible to the modern business environment characterized by "customer, competition and change". It designs simple and clear workflows and organizational structures with a series of scientific procedures such as early-stage preparation, objective establishment, risk evaluation, team organization and analysis and improvement.

Lastly, the chapter reviews Queuing Theory and Six Sigma Theory. Although Queuing Theory is a branch of Operations Research, it contributes considerably to analyzing the bottleneck of efficiency in the current process. It can be used to calculate the efficiency of service time and queuing, without damaging the common interests of patients and hospitals. In addition, an optimal balance will be stricken between the queuing loss of patients and the resource allocation of hospitals. In Six Sigma Theory, process capability is also often used to assess the effectiveness of medical service process so as to identify existing problems in the current process. It works on the principle of normal distribution in statistics.

Chapter 3 Domestic and Foreign Studies on Hospital Process Improvement

This chapter consists of four parts. The first part is a review of studies from both home and abroad on applying the theory to hospital management and the achievements and potential problems of this application in terms of shortening the average length of stay, reducing waiting time for patients, improving efficiency of hospital services and promoting application of ICT. The second part is a review of studies from both home and abroad on the application of Queuing Theory in hospital management. Queuing Theory is used to analyze distribution regularities of patients' arrival time and measure the amount of bed usage and efficiency of outpatient process. The results will serve as a quantitative basis for the coordination and planning of medical resources in a hospital. The third part is a review of studies from both home and abroad on the application of six sigma in hospital management. The results are good when this theory is applied in studies on increasing the service quality and business efficiency of hospitals, shortening waiting time for patients and cutting costs for hospitals. In the fourth part, the extensive application of information technology in hospitals both home and abroad is reviewed and ways to improve the outpatient process efficiency on the basis of information technology are explored. In summary, this chapter offers more background knowledge about the research on HKU-SZH.

3.1 Domestic and Foreign Studies on the Application of BPR Theory in Hospital Management

In the 1990s, Business Process Reengineering Theory enjoyed widespread popularity in the U.S. medical circle and was gradually put into practice. According to a research report on medical institution restructuring conducted by the American Hospital Association (AHA), only 15 hospitals had began to implement BPR program in 1991. The number increased to 46 in 1992. However, by the end of 1997, nearly 60%

of the US hospitals had more or less reengineered business processes, and about 22% of them were about to implement business process reengineering programs (Jia & Duan, 2007). The business process reengineering referred to in this thesis includes outpatient process reengineering.

According to Murray & Mark (2003), some hospitals and health care institutions focus on evaluation of patient satisfaction. With an aim to enhancing patient satisfaction, they evaluate the effect of process improvement by the following indicators: patient satisfaction, registration process, waiting time, medical diagnosis, auxiliary examinations, nursing effects, medical environment and costs. Hospitals, especially those in developed countries, will use a business process management system to shorten treatment time, reduce medical costs and improve hospital efficiency. Ho & Chan (1999) point out that the aim of business process reengineering in a hospital is to adjust the working processes of different hospital departments, such as readjustment of the working process of the whole hospital, redistribution of responsibilities among departments and redesign of medical products. They believe that a change of business process is as important as a change in the organizational structure of a hospital and that the key to business process reengineering is to improve quality of medical services, increase patient satisfaction and reduce operating costs for the hospital.

Fehrman & Thor (2000) established a surgery preparation room in the Stockholm hospital in Sweden. By carrying out anesthesia in the preparation room, the surgery process was improved because previously when anesthesia was carried out in a surgery room, the whole surgery process took as long as 59 minutes. In addition, they integrated functions and optimized the layouts of different surgery rooms so that the rooms were not exclusive to only a certain type of surgery.

In the course of applying Business Process Reengineering, the St. Charles Medical Center in Oregon “outsources” some nursing jobs to people who haven’t obtained certificates for licensed medical practitioners. The medical center also redesigns its financial management system. As a result, the number of staff in its administrative department is cut from 54 to 16, which saves about $ 1,100,000 for the

hospital every year (http://www.tricare.osd.mil/her/downloads/other/rptchapl.doc).

According to Zhou (2005), the Hillingdon Hospital in London assigns the work that used to be done by two departments to only one department. For instance, blood tests, which used to be done in the laboratory, are now carried out in clinical departments. As a result, the time for patients to get results of the tests drops sharply from at least one day to five minutes. In order to ensure successful implementation of business process reengineering, the hospital sets up a professional team to monitor the service process from time to time.

Since the late 1990s, Chinese scholars have gradually begun to explore and study hospital management process. It can be seen from literature that the business process reengineering of many hospitals is accompanied by the application of ICT. If a hospital applies ICT in its operation more extensively and thoroughly, it will find that it's easier to carry out business process reengineering. Most of the business process reengineering programs start from reengineering the process of outpatient registration and payment to reengineering the clinical diagnosis and treatment system, and to ultimately building an information network system. At present, more than 90% of hospitals in China have realized informatization of management and carried out business process reengineering in part or all of their departments.

Ma & Ying (1999) carried out research on the hospitalization process reengineering of four types of diseases that need elective surgery in a 3A general hospital in Beijing. These four diseases are breast cancer, chronic cholecystitis with choleliths, nodular goiter and leiomyoma of uterus. Based on Restuccia's Criteria of Appropriateness of Day of Care, the two scholars analyzed statistics from a survey on the rationality of 2,487 hospitalization days of the above-mentioned four diseases. Statistics show that in the 2,487 days, 1,375 are appropriate from hospitalization, taking up 55.29% percent, while 1,112 are inappropriate, accounting for 44.71% one percent.

Zhou & Hu (2000) also reengineered the hospitalization process of the general surgery department of a 3A hospital in Beijing. After the two-phase reengineering

program, the medical service efficiency of the hospital improved significantly; its business revenue increased sharply; and the excessive growth of hospital costs slowed down. However, there were no evident changes in the quality of medical services.

Zhu & Li (2001) researched on a joint emergency process reengineering program carried out by Tianjin University, Tianjin Medical University and University of Alberta. Based on the BPR Theory and its methods and tools, the two scholars used a software called “ITHINK” to quickly identify the key factors that influence patient satisfaction and efficiency of the current medical services provided by the hospital. These key factors helped them to improve and reengineer the business process of the hospital. Through sensitivity analysis and Monte Carlo simulation method, an optimal solution to improve service efficiency and enhance business revenue of the hospital was ultimately put into place. In this solution, emergency treatment rooms increased by six, and facilities in these rooms were updated. In addition, the amount of entrances to these rooms was adjusted. After business process reengineering was carried out in the hospital, the number of patients to the hospital increased significantly; the use of facilities in the hospital was maximized; the quality of medical services was improved evidently; and the competitiveness and social influence of the hospital were raised considerably.

Cheng & Kang (2001) analyzed the outpatient process of hospitals and proposed solutions to existing problems. On the basis of outpatient doctor workstation, they went a step further to optimize the outpatient process, aiming to put themselves in the shoes of patients so as to provide them with convenience and to enhance management efficiency of a hospital. Dai, Sun & Wei (2002) proposed a thought for management of hospital business process improvement. Based on the analysis of extensive data, they found that large general hospitals are often crowded with patients. There is no fixed pattern as for when and how many patients go to hospital. Instead, they choose the time based on the severity of their diseases and their own needs. As a result, there are often too many patients in certain periods of time, leading to peak hours in outpatient departments. This phenomenon will bring negative effects to the current outpatient process. For instance, effective treatment time of patients is not sufficient

and patients waste a long time moving meaninglessly to and fro in the hospital. As a result, it is hard to improve the effect of treatment, leading to potential doctor-patient conflicts. Therefore, reduction of patients' unnecessary waiting time can make a hospital less crowded and maximize utilization of its resources as well.

Luan (2003) argues that business process reengineering is a prerequisite for the informatization of a hospital. It means that a hospital must strengthen its awareness of business process reengineering, establish a standardized process reengineering program and continuously push forward the program. The methods of business process reengineering are also useful for a hospital to carry out digital information construction. In addition, the implementation of Business Process Reengineering will inevitably accelerate the promotion of digital information.

Based on an analysis of different phenomena and problems in hospital processes, Zhou & Liang (2004) proposed to introduce business process reengineering into outpatient processes. They believe that business process reengineering is not only a one-time reform, but a major internal revolution that gets the whole hospital involved. The aim of reengineering is to cut ineffective outpatient processes and increase effective treatment time for patients so as to improve internal management of the hospital. However, they did not explain whether process reengineering can reduce medical costs and if so, to what extent the costs will be reduced.

Based on Business Process Reengineering Theory, Chen (2005) formulated a new model of outpatient process management, which is "patient-centered". With the use of information technology, he first analyzed existing problems in the current process and critical steps in the process that need to be improved, and then used information technology and Business Process Reengineering Theory to improve and reengineer the process. In the course of process improvement and reengineering, he also strived to make it compatible with local hospital system, residents and government policies.

With the Affiliated Children's Hospital of Zhejiang University as a case, Wu (2006) carried out research on process reengineering in its pharmacy. Similar to Chen

(2005), she also used information technology to improve and reengineer pharmacy process so as to further shorten patients' waiting time to get medicine as well as to enhance overall management level and patient satisfaction of the hospital.

There are also many scholars who research on problems in the application of Business Process Reengineering Theory in hospital process management. From the American Hospital Association, Walston (2000) obtained past research reports from 1997 on hospital process reengineering. The research subjects included 30% of the U.S. hospitals with more than 100 beds. The Association suggests that a special reengineering committee and a program team should be set up in the implementation of Business Process Reengineering in order to identify the core business processes that need improvement. The committee and team should start the process reengineering by fostering a culture and atmosphere of reengineering. Only in this way can the overall competitiveness of the hospital be enhanced. Jackson.(2000) attributes dysfunction of business process reengineering in the medical and health care system to the fact that bureaucratic institutions in the system are unable to adjust to this change and innovation. Ho (1999) conducts a survey on 215 hospitals in the United States and Canada. According to the survey, executives of these hospitals had an in-depth understanding of the aims and principles of business process reengineering. But the reform did not end up well. As a result, the executives assumed that the hospital staff were not enthusiastic about the program and did not support it. With 192 hospitals as his research subjects, Caccia-Bava (2005) summarized and analyzed their experience of success and failure in the implementation of Business Process Reengineering. He contends that there were two major reasons of their failure. First, they are insensitive to the needs of customers and market, which lead to failed self-adjustment; second, they do not know how to correctly use some innovative technologies due to lack of training.

3.2 Domestic and Foreign Studies on the Application of Queuing Theory in Hospital Management

As a branch of Operations Research, Queuing Theory has been researched systematically by foreign experts for a long time. They mainly focus on optimizing the allocation of medical resources in hospitals.

McClain (1976) built a mathematical model based on Queuing Theory. Through statistical analysis, he made overall plans for the allocation of hospital beds.

Morriss (1978) collected data of newborn infants between 1975 and 1976 on the process from birth to being delivered to nursing units at different levels and constructed a queuing model to simulate the process. Based on the bed needs of a Level-Three nursing center, he estimated the actual usage of special care beds in the area.

McManus (2004) argues that a mathematical model can be built based on Queuing Theory to allocate the scarce ICU resources rationally. By collecting and analyzing the two-year data of ICUs in the city, he constructed a theoretical model of patient flow. By contrasting predictions from the model with the actual performance, he found that the predictions were very accurate and could be used as a simulation model to determine the appropriate supply of ICU beds.

Abujudeh (2005) evaluated the process of portable X-ray machine usage in emergency departments from the perspective of Queuing Theory. Examination data in eleven days and 116 individual X-ray images were gathered at random. Based on these materials, he calculated the rough time spent in data input, output and all the service procedures. He then used the Queuing Theory model to calculate response time in different steps and finally concluded that queuing and body examination were the two largest bottlenecks in the original process.

After searching databases such as CBMdisc and CNKI, it is found that since the end of 1980, many Chinese scholars have started to apply Queuing Theory in hospital management and hospital process.

Based on Queuing Theory, Yang & Gao (1999) carried out a systematic survey

on patients' queuing in emergency departments of general hospitals and proposed the optimal allocation and arrangement scope of the hospital beds.

Through Queuing Theory and statistical methods, Cai & Yang (2000) conducted a quantitative analysis of the efficiency and quality of services provided by the Emergency Department, Outpatient Department and Dispensary before and after the hospital adopted a singular database of patient information. Their research demonstrated that Queuing Theory and mathematical statistics method could provide hospital executives with a quantitative indicator to make decisions.

Based on Queuing Theory, Zhao & Yang (2003) carried out a study on hospital process reengineering. They put forward a three-level model to realize business process reengineering, namely reengineering of mindsets, processes and the whole organization. They argue that building a reengineering model is a prerequisite for medical process reengineering. But as described in Queuing Theory, the time patients go to hospital is not fixed and usually depends on their conditions. Therefore, it is very helpful to use Queuing Theory to systematically analyze the status quo and construct a model so as to find a way to start the medical process improvement.

Chang & Peng (2005) researched on the distribution regularities of patients' time in registration and treatment by employing Queuing Theory and its tools and mathematical models. They discussed the optimal allocation of information desks within a hospital. In addition, they analyzed and evaluated efficiency of the outpatient process by constructing a mathematical model. Queuing ToolPak 4.0, an analysis software, was used to predict a reasonable range of service coverage of different information desks so that existing problems in the current process were identified. In this way, these problems can be resolved more efficiently and finally the hospital can utilize its resources rationally and optimize them maximally. According to Huang and Peng, there are significant differences between patient flow in the morning and that in the afternoon in every department, because the time patients go to hospital varies from person to person. As a result, information desks are not efficient enough to meet the overwhelming needs of patients in the morning. Therefore, to achieve a balanced distribution of patients' arrival time, it is necessary to not only cut the average

queuing and waiting time, but also promote guidance of medical process to patients so as to improve their skills in receiving medical services.

A comparative study of foreign and domestic literature on this subject shows that differences exist in research objects, methods and tools and complexity of theories. However, nearly all the studies focus on processes such as hospitalization and surgical treatment. There is little literature on outpatient process optimization. Besides, there is still room for improvement in the application of theories. In general, most domestic and foreign research on the application of Queuing Theory and Business Process Reengineering Theory in hospital management is not yet mature. Therefore, in order to apply these two theories in improving outpatient process, it is necessary to both learn from the existing domestic and foreign studies and to take into account the actual situation of case hospitals. Only by analyzing problems specific to a hospital can it work out an appropriate plan for its outpatient process improvement.

3.3 Domestic and Foreign Studies on the Application of Six Sigma Theory in Hospital Management

According to literature, Six Sigma Theory was first applied in medical institutions in the late 1990s. Its application has been proved successful in many hospitals.

Yang (1999) finds in his research that in order to cut business costs, reduce treatment time in intensive care units, optimize information system of payment and increase staff efficiency and patient satisfaction, Florida applied Six Sigma Theory in improving hospital process. As a result, in 2004, $7,000,000 of business cost was saved in Florida hospitals. And in 2005, $12,000,000 was saved.

Jia (2002) found in his research that after Virginia Mason Medical Center in Washington applied Six Sigma Theory, the incidence rate of respiratory diseases and pneumonia decreased. As a result, $500,000 can be saved for the hospital. In addition, after the hospital process was improved, the effective patient reception rate of the hospital increased significantly and area of the department rooms for cancel patients

also increased considerably.

According to Jiang (2003), Missoula Community Medical Center in Montana also launched some Six Sigma pilot programs. Statistics show that after the diagnosis and treatment process was improved, it took only twelve minutes, down from the previous four hours, for a doctor to complete the process from writing out a treatment prescription to treating patients; it took only two days, down from the previous five days, for the morbid anatomy laboratory to submit a report; and it took only ten minutes, down from the previous 43 minutes, for hospital staff in relevant departments to respond to a doctor's prescription.

Jaap & Ronald (2005) find that the North Wick's Red Cross Hospital in New Zealand "put patients first". It aims to cut patients' length of stay in hospitals, reduce mistakes of issuing wrong invoices and reduce the use of intravenous antibiotics on patients.

Xiao (2007) points out in his study that in order to improve the overall business efficiency, the Children's Hospital of Duke University examined and analyzed on its business process. To tackle problems in the process, it used management methods of Six Sigma Theory to introduce a new business process system. As a result, its business efficiency increased from 10% to 15%. The hospital therefore became a model for all the other departments of Duke Medical Center.

The successful foreign cases above can serve as references for Chinese hospitals to carry out similar medical programs. Although these cases are simply descriptive overviews that need further in-depth analyses to serve as a theoretical guidance, a huge amount of literature has demonstrated that applying Six Sigma Theory in specific medical institutions will bring about effective results. The previous successful cases prove that good results have been achieved in cutting time for body check, increasing number of patients, reducing waiting time of patients, optimizing process of outpatient services and laboratory tests, as well as improving hospital efficiency and patient satisfaction.

At present, executives of Chinese hospitals are still unfamiliar with Six Sigma management philosophy. As a result, it is not used in hospital management on a large

scale. From the perspective of theoretical research, Xue & Cao (2005) explored the value of applying the process capability analysis of Six Sigma Theory to medical management. They identified four variables to measure process capability, namely, service quality, service costs, patient satisfaction and clinical results. These variables are key characteristic indexes to measure process capability with high predictive validity.

Wang & Chen (2008) argue that a hospital can take advantage of Six Sigma management philosophy to build its culture. A hospital is supposed to serve patients and it advocates a service culture of "putting patients first". Similarly, customers are important and are deemed as the core of management in Six Sigma Theory. Therefore, Six Sigma Theory is not in conflict with a hospital's cultural development.

In order to bring down the incidence of medicine-taking defects, Chen & He (2005) analyzed a series of nursing processes such as dispensing, transfusing and taking medicine. They used Six Sigma management model to bring down the incidence from 19.05% to 3.06%. As a result, the efficacy of medicine was ensured, and defects in medicine safety management were avoided. No medical problems caused by not taking medicine would occur.

Du & Zhu (2006) found in their research that Zhejiang Taizhou Hospital had been devoted to solving the problem of low bed rotation rate caused by long average length of stay. They chose the hospitalization processes of patients with seven representative diseases to conduct a pilot experiment on hospitalization process improvement by means of Six Sigma methods. Results showed that hospitalization time of three groups of patients fell significantly while that of the rest four groups tended to be longer. In addition, the hospital set up a joint training center for Six Sigma Theory with GE. Tangible achievements had been made in reducing hospitalization days of patients, improving quality of medical services, increasing efficiency of the hospital and cutting waiting time of patients.

In their research on the Shanghai Tenth People's Hospital which applies Six Sigma management philosophy to managing the quality of nursing services, Mao &

Dai (2006) found that the hospital had made great achievements in improving treatment process of patients, cutting waiting time for transfusion, lowering costs of medical services and reducing probability of inpatient falls. By setting up a Six Sigma Quality Management System, the hospital was able to find out the major reason of infections in venous catheterization. Through optimization and improvement of its nursing process, the hospital finally reduced the risk of infections in venous catheterization.

Tian (2008) found that after a Six Sigma program was launched in Nanfang Hospital of Southern Medical University, the hospital had made remarkable achievements in pharmaceutical management, operating room process optimization and outpatient process improvement in Department of Obstetrics and Gynecology. The promotion of this program greatly improved efficiency of various employees, reduced many inefficient processes and enhanced awareness of service of the whole staff. In addition, patient satisfaction increased significantly. As a result, a culture of innovation and reform spread quickly in the hospital.

The effects of domestic and foreign Six Sigma programs show that they have been proved useful in cutting medical costs of hospitals, increasing efficiency of treatment process, preventing risks of hospitalization and enhancing business efficiency of hospitals. Through these programs, hospitals executives, doctors and patients can achieve common progress.

3.4 Domestic and Foreign Studies on the Application of Information Technology in Hospital Management

Currently, with the rapid development of information technology, card technology has been widely used in hospitals. The widespread application of cards has attracted the interest of Chinese hospitals. Now, card technology is also widely used in Chinese hospitals.

Rice (2006) researched on the smart card program carried out jointly by Mount Sinai Medical Center and Elmburst Hospital. The program was mainly implemented

in hospitals in the New York City, aiming to provide patients with more convenient, safer and more accurate medical services.

Chien & Pei (2006) found that smart cards had been launched and promoted by local medical insurance institutions since 2003 in Taiwan and that it took only half a year for the cards to be widely used. As the cards were adopted in Taiwan for the first time, many problems occurred in use. To be specific, damage to the card accounted for 31.2% of the causes; failure of SAMs authentication accounted for 17%; errors of card reader accounted for 15.3%; and complexity of medical information system interface accounted for15.8%.

Chen (2004) points out that Chinese hospitals have also started to promote card technology. Among all the cards promoted, two types of medical cards are most widely used. The first type is used to store basic information of patients so that different hospitals are able to share information. However, due to technical difficulties, this type of cards is not promoted on a large scale. The second type is treatment card, which is more convenient as it can be used for settlement. Hospitals, such as Beijing Tongren Hospital, used to launch a pilot program of real-name treatment cards. Patients can use only one card to finish processes from registration and treatment to payment. In addition, the card helps to share medical information with other hospitals. Tian & Wang (2006) conducted a survey on patient satisfaction of Beijing Tongren Hospital by distributing questionnaires to patients at random. Statistics show that the time patients spent in waiting for registration and treatment decreased significantly. He also proposed suggestions such as self-service registration to reduce waiting time for patients.

Through an analysis of hospital treatment cards and bank cards, Chen & Zhang (2005) point out shortcomings of both cards and suggest to use IC bank cards with the function of electronic purse so that patients are able to substitute the previous two cards with only one card. With this card, patients don’t need to queue for several times to pay. In addition, their social security information can be stored fully and conveniently. However, the use of this card involves not only various government

departments, which means that its influence on society is huge, but also development of new software for Union Pay devices. Therefore, there is a big obstacle to put this type of cards into practice.

The advancement of information technology, especially card technology, generates QR code technology, IC card technology and radio frequency identification technology. To optimize and reengineer outpatient process through information technology is not common at present, but it will be a trend of future research. It is necessary to further innovate and explore theories and methods in this respect.

3.5 Summary

This chapter presents a review of domestic and foreign studies on the application of Business Process Reengineering Theory, Queuing Theory, Six Sigma Theory and information technology in hospital management. From the current literature, it is known that Business Process Reengineering Theory and Queuing Theory are relatively mature. BPR Theory can be used to cut patients' treatment time, reduce medical costs, improve hospital efficiency and accelerate hospital informatization. Queuing theory, its tools and mathematical models can be used to analyze and evaluate outpatient process efficiency, especially in measuring process efficiency. Six Sigma Theory is widely applied in manufacturing industry. Its process capability can be used in hospital management application space. But further research is yet to be conducted as regards ways to apply it in Chinese hospitals. Information technology is increasingly mature with the extensive application of Business Process Reengineering. Currently, technologies like IC card technology and radio frequency identification technology have already been put into practice.

Therefore, a correct analysis and understanding of outpatient process cannot be achieved without taking into consideration the actual situation of the hospital and application of appropriate theories chosen on the basis of the key steps that influence outpatient process. Only in this way can a hospital formulate a practical program for its process improvement.

Chapter 4 Status Quo of the Outpatient Process and Its Restructuring Goals

This chapter consists of two parts. In the first part, the internal and external environment of the University of Hong Kong-Shenzhen Hospital is analyzed. The internal environment covers the hospital's background information, such as its development history, fixed assets, human resource allocation, communication and cooperation, development trends and main problems. The external environment covers major problems such as the current status of health care resources in China, health care reform, health insurance coverage, health care cost control, competition in the medical industry in Shenzhen, and the development and application of information technology in medical industry, as well as a description of problems that exist in the hospital outpatient process. The second part is mainly about principles and objectives of the reengineering of the hospital outpatient process, and ultimately aims to optimize the outpatient process in three aspects, namely the hospital's business, technology and development, so as to improve patient satisfaction and the hospital's overall competitiveness. In short, this chapter mainly introduces the overall situation and the external macro-environment of the University of Hong Kong-Shenzhen Hospital and then provides a more detailed background.

4.1 An Analysis of the Internal and External Environment of the University of Hong Kong- Shenzhen Hospital

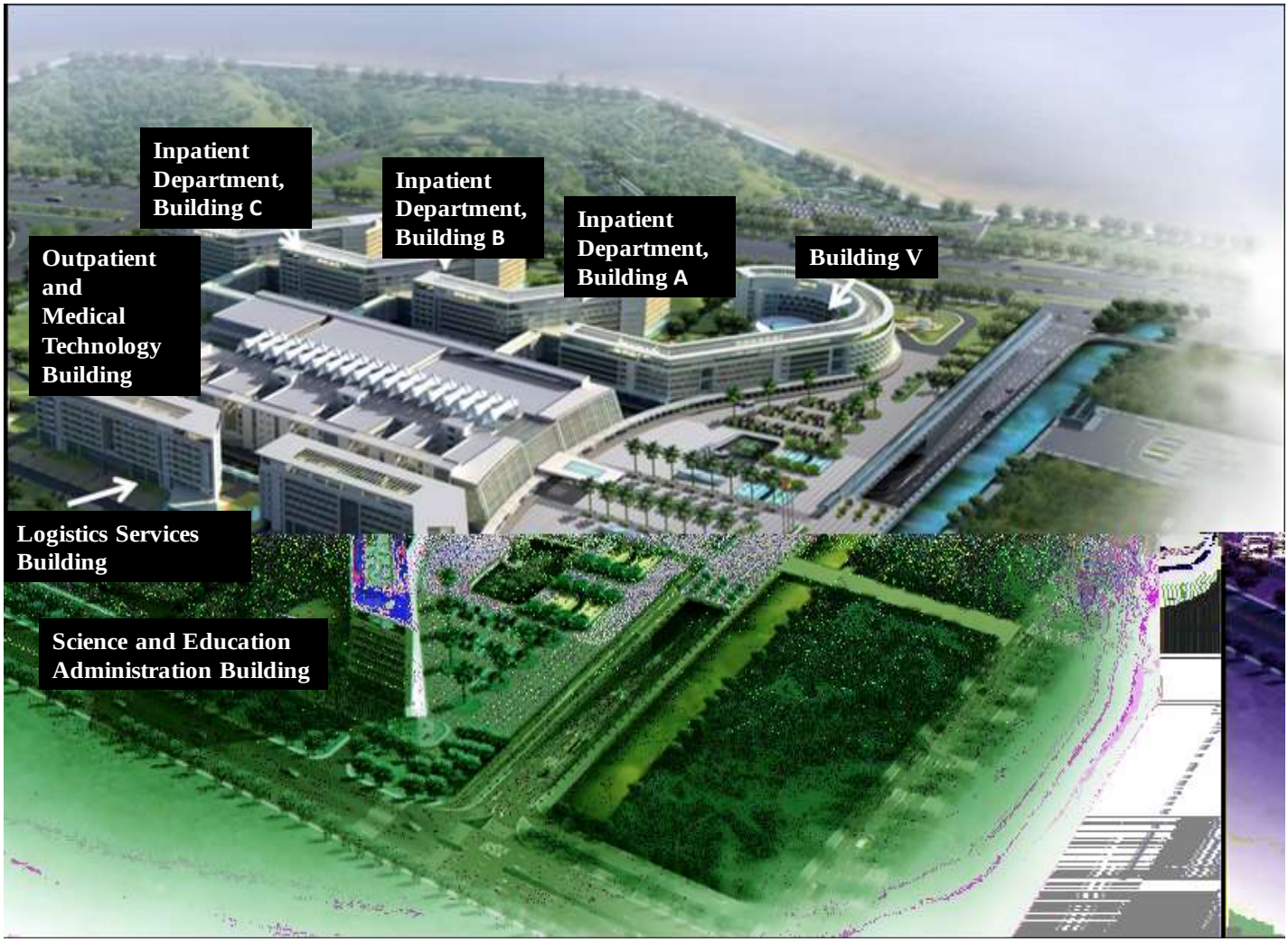
4.1.1 The Internal Environment

(1) General Information of the Hospital:

The foundation stone of the University of Hong Kong-Shenzhen Hospital (also known as Shenzhen Binhai Hospital) was laid in November 2007. It is a large comprehensive public hospital which gets full investment from the Shenzhen Municipal Government and also introduces the modern management mode from HKU

(see the aerial view below):

Figure 4-1 The aerial view of HKU-SZH--Modern Management Mode



Source: The author

The hospital is located in the 16th block of the Shenzhen Bay Reclamation Area and in the intersection between Binhai Road and Qiaocheng East Road (See the following picture). It is adjacent to mangrove conservation area and Shenzhen Bay coastal recreation zone. The transportation is convenient since the hospital is close to the Metro Line 1 and multiple bus lines. Besides, the Metro Line 9 and 11 which are to be built in 2016 will also be near the hospital. Stations for the three metro lines were set within 300 meters to the University of Hong Kong-Shenzhen Hospital.

Figure 4-2 The Position and Traffic Map of HKU-SZH

Source: The author

On July 27, 2011, the Shenzhen Municipal Government signed a 10-year cooperation agreement with the University of Hong Kong. On the basis of remaining as a public hospital and safeguarding the public welfare nature of basic health services, both sides agreed to set up a joint decision-making and management team to manage the University of Hong Kong-Shenzhen Hospital. The hospital will learn from and introduce world-class hospital management experience and advanced medical technologies. Through the reform and innovation in the hospital system and the complementation and integration of resources, it will also actively explore new models of public hospital management and strive to provide useful experience for the

management system reform of public hospitals in Shenzhen and in the whole country. On July 1, 2012, the University of Hong Kong-Shenzhen Hospital began trial operation, establishing departments including General Department, Department of Pediatrics, Department of Ophthalmology, and Department of Dentistry. On September 21, 2012, hospital in-patient departments, day operating room, and endoscopy center were partially put into use. On October 24, 2012, the University of Hong Kong-Shenzhen Hospital was officially put to use.

The University of Hong Kong (often referred to as HKU) is one of the highest-ranking universities in terms of academics in Hong Kong and is also one of the highest educational institutions in China and even in Asia. Located in Pokfulam of Hong Kong Island, it is a university focusing on public research. Founded in 1911 and officially put into operation in 1912, it was the first higher education institution in Hong Kong. According to Asia Week, in 2000, HKU ranked 3rd in the ranking of Best Asian Universities. In Asia Week's survey on the ranking in 2000, MBA courses from the Business School in the University of Hong Kong ranked 2nd after those in the Chinese University of Hong Kong. In Times Higher Education World University Rankings (2012-13): HKU ranked 43rd in the world, 3rd in Asia and 1st in Hong Kong. In Times Higher Education World Reputation Rankings (2013): HKU ranked 36th in the world, 5th in Asia and 1st in Hong Kong. HKU set up a Li Ka Shing Faculty of Medicine to train qualified doctors and nurses. Its medical research, such as SARS virus research, has yielded many achievements. Many laboratories also won the title of "State Key Laboratories of the People's Republic of China".

By establishing "the world contacts network," HKU provides opportunities for about one-tenth of its students to study abroad every year, carries out student exchange programs with over 150 colleges in the world, and conducts teaching and research cooperation with more than 300 universities and research institutions in the world. To sum up, in research, the University of Hong Kong is one of the leading institutions in international arena; in management, it uses a modern world-class management practice; in academic achievements, it is outstanding; and in comprehensive strengths, it ranked the world's top 50 universities.

Shenzhen Special Economic Zone was formally established in May, 1980 when the city's population was about 600 000. Located on the southern coast of Guangdong province, it stretches from Meisha by Mirs Bay in the east to Shekou Industrial Zone by Shenzhen Bay in the west. It covers an area of 327.5 square kilometers in total. Adjacent to Hong Kong, it has convenient transportation, mild climate and beautiful scenery.

On May 31, 2010, the central government approved Shenzhen's application to expand the Special Economic Zone, which was extended to the whole city, with a total area of 1948 square kilometers, nearly twice the size of Hong Kong (Hong Kong's total area is 1103 square kilometers). By the end of 2013, Shenzhen's total population had reached about 13 million. The property of the University of Hong Kong-Shenzhen Hospital is owned by the Shenzhen municipal government. The hospital is managed by the joint hospital decision-making and management team set up by both sides, namely Shenzhen municipal government and the University of Hong Kong. Both sides carry out bold reforms in areas such as hospital management system, financial investment mechanism, personnel distribution system, safeguarding of the public welfare nature, enterprise-like operation, cost management, service model as well as service quality and working efficiency promotion, so as to achieve the separation between the government and the hospital, between management and operation, between clinic and pharmacy, and between for-profit and non-profit. According to the cooperation agreement, the University of Hong Kong-Shenzhen hospital, while remaining as a public hospital, is included in the public hospital services system, giving priorities to the basic health needs of Shenzhen residents and protecting the public welfare nature of health care services.

On January 4, 2013, Shenzhen Health and Family Planning Commission, the public hospital management agency of the Shenzhen municipal government, published on its official website a piece of information, saying that it approved the application from the University of Hong Kong-Shenzhen Hospital to become an affiliated hospital of the University of Hong Kong, and also agreed that Department of

Pediatric Surgery, Department of Oncology, and Department of Anesthesiology can be added and the hospital can carry out health examination services.

Major Events in the history of the hospital are as follows:

Table 4-1 HKU Timeline

October 10, 2003	The hospital chose to be located in the southwest side of the intersection between Shenzhen Bay Baishizhou and Qiaocheng East Road.
May 8, 2004	A working group was established to build Binhai Hospital.
December 16, 2005	The project was approved.
November 18, 2007.	The groundbreaking ceremony was held
June 5, 2008	The construction was officially started.
February 28, 2009	Prof. Lap-Chee Tsui, President of Hong Kong University led a group to study the preparation work for the hospital.
September 18, 2009	Mr. Tang Jie, Vice Mayor of Shenzhen visited the University of Hong Kong and started to discuss bilateral cooperation.
November 20, 2009	The capping ceremony for II-section of Binhai Hospital, namely the VIP building was held ahead of schedule on the top floor of the VIP building.
November 30, 2009	The Shenzhen municipal government signed the project agreement for "the University of Hong Kong-Shenzhen Teaching Hospital cooperative arrangement" with the University of Hong Kong.
February 11, 2010	A preparatory meeting of the board of directors of the University of Hong Kong-Shenzhen Hospital was held, forming a cooperation idea featuring joint building and management, mutual benefit and win-win cooperation.
July 27, 2011	The Shenzhen Municipal People's Government and the University of Hong Kong co-organized the signing and unveiling ceremony for the University of Hong Kong-Shenzhen Hospital.
April 12, 2012	The science and education administration building for the University of Hong Kong-Shenzhen Hospital was put into use.
July 1, 2012	The University of Hong Kong-Shenzhen Hospital was put into trial operation.
September 21, 2012	Parts of the hospital's in-patient departments, day operating room, and endoscopy center were put into use.
October 24, 2012	The University of Hong Kong-Shenzhen Hospital was officially put to use.

Source: The author

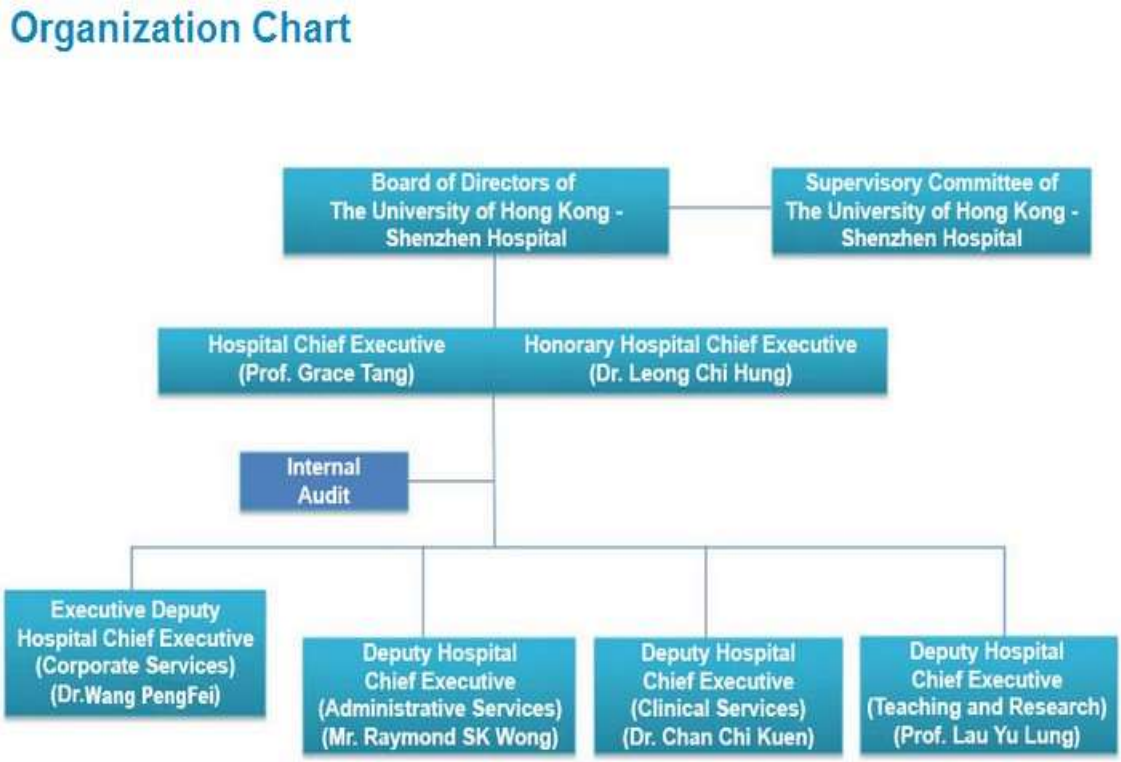
(2) Fixed assets: The University of Hong Kong-Shenzhen Hospital covers an area of 192,000 square meters and its scale of investment reaches 3.5 billion yuan. It enjoys 2,130 parking spaces and a total construction area of 367,000 square meters. Altogether it has 2000 hospital beds, which can accommodate 8000 to 10,000 outpatient visits (which are referred to the total number of patient visits that the outpatient department receives a day). Currently construction of all hospital wards is completed and hospital beds are all in place. By April, 2014, the hospital has opened 480 hospital beds, 4 day operating rooms and 9 central operating rooms. The hospital will further improve the health care system in 2014, aiming to reach 3600 outpatient visits and open 1200 beds by the end of 2014. The hospital invested about 2.5 billion yuan in construction and the total investment budget for medical equipment was 1 billion yuan. By December 2013, the hospital had purchased about 500 million yuan worth of medical equipment and the start-up costs, government subsidies and other costs amounted to about 500 million yuan. The Shenzhen municipal government in 2014 invested 900 million yuan in the construction of the University of Hong Kong-Shenzhen Hospital, with 300 million yuan for the purchase of medical equipment and 600 million yuan for routine expenses.

(3) Human resources and organizational structure: The University of Hong Kong-Shenzhen hospital implements management on the number of employees and the system of employment under contract for all employees. By April 2014, the hospital has hired a total of 1218 staff that is in office, including 285 doctors, 486 nurses and 146 medical technicians. By the end of 2014, the total number of employees is planned to reach 2,000. Among all employees, 212 Hong Kong experts (doctors, medical technicians, nurses) and one foreign doctor obtained short-term medical licenses in mainland China. All employees have signed a formal labor contract with the hospital and they are not included in the government institution staff system. The doctors can be divided into three sections: consultant doctors, associate consultant doctors and resident doctors, with several levels set within each section. Consultant doctors are the most senior ones. The second most senior ones are those in

charge of departments. Generally one clinical department has only 1-2 consultant doctors and several associate consultant doctors, with the majority being resident doctors. Sent from Hong Kong, the top leaders of all departments are called COS (Chief of Services). They make decisions on department affairs. Needless to say, COS is also the authority in the medical circle in Hong Kong, and some of them also gain international reputation. One typical example is Professor Yuan Guoyong, COS for Clinical Microbiology and Infection in the University of Hong Kong-Shenzhen Hospital. He was head of the Department of Microbiology in the Li Ka Shing Faculty of Medicine in the University of Hong Kong and also one of the world's leading experts in infectious diseases.

The hospital's organization chart is as follows:

Figure 4-3 The Hospital's Organization Chart



Source: The author

The hospital now adopts a president responsibility system under the leadership of the board. The board has 17 members, with 9 from Shenzhen and 8 from Hong Kong.

The chairman of the board is the Deputy Mayor of Shenzhen, Ms. Wu Yihuan. The work division for major leaders of the hospital is as follows:

Prof. Grace Tang, Hospital Chief Executive (Hong Kong side): in charge of the overall work in the hospital.

Dr. Wang Pengfei, Executive Deputy Hospital Chief Executive (Shenzhen side): in charge of the Department of Finance and the Department of Hospital Affairs.

Dr. Chan Chi Kuen, Deputy Hospital Chief Executive (Hong Kong side): in charge of all the medical business-related affairs, including the Department of Nursing and the Department of Medical Affairs.

Prof. Lau Yulung, Deputy Hospital Chief Executive (Hong Kong side): in charge of scientific research and education.

Dr. Raymond SK Wong, Deputy Hospital Chief Executive (Hong Kong side): in charge of the administration, including general affairs, equipment, computers, personnel, and statistics rooms for medical records.

The hospital, in compliance with the management mode of the University of Hong Kong, recruits employees on the basis of job requirements, and will not set special restrictions on employees' education background, job titles, and work experience (only with a basic requirement). The hospital will have 980 doctors and 1936 nurses, and the recruitment will be carried out batch by batch in the global arena. The salary of staff is determined according to posts. The hospital sets up eight departments and posts such as health care, medical technology, nursing, management, support, research, pharmacy, and engineering technology, and then formulates a reasonable and competitive salary and benefits standard according to posts. The hospital carries out the annual salary system. Each contract is signed for a three-year term, without any bonus or other benefits; and the assessment will be conducted annually, with rewards ranging between 0 and 30% of the annual income. When the three-year contract expires, another assessment will be undertaken, with rewards ranging between 0 and 15% of the three years' total income. The reward has nothing to do with individual work experience, job title, and qualifications, but is only

connected with job performance.

(4) Specialized departments building and operation: the hospital has basically completed a first-level department building, including departments covering internal medicine, surgery, gynecology, obstetrics, pediatrics, dermatology, traditional Chinese medicine, oncology, ophthalmology, dentistry, ENT, emergency medicine, rehabilitation medicine, laboratory medicine, radiology, and pathology. The hospital will open 20 clinic centers, 12 medical technology centers and an IMC (International Medical Center) clinic center. It has set up 16 centers, namely Cardiovascular Disease Treatment Center, Respiratory Disease Treatment Center, Digestive Disorder Treatment Center, Genitourinary Disease Treatment Center, Endocrine and Metabolic Disease Treatment Center, Neurological Disease Treatment Center, Orthopedic Disease Treatment Center, Gynecological Center, Intensive Care Treatment Center, Infant Treatment Center, ENT Disease Treatment Center, Dental Center, Emergency Center, Anesthesia Surgery Center, Oncology Treatment Center and Blood Disease Treatment Center.

The hospital will gradually introduce from HKU five advantageous medical specialties including organ transplant, comprehensive cancer treatment, orthopedics and trauma, reproductive medicine and prenatal diagnosis, and cardiovascular treatment. The hospital aims to reach the same level in these specialized fields as the affiliated hospital of the University of Hong Kong within five years. While carrying out a large number of medical specialty services, the hospital attracted patients from Shenzhen, Hong Kong, Macau and surrounding areas and even from abroad. Because the hospital has not been opened for a very long period of time, and it has no national-level specialized departments, it is currently applying to become a specialist (for General Medicine) training base in Guangdong Province. Therefore, the hospital starts the construction of an approximately 5000 m^2 central laboratory, introduces sophisticated equipment and talents to accelerate the library construction, and builds a digital resource sharing platform. In January 2014, the University of Hong Kong-Shenzhen hospital got ACHS Certificate (Australian council on healthcare standards) and became the first hospital in China to receive such certificate.

The outpatient volume from July 1, 2012, the opening date, to December 2012 was 41,787 person/visits, and the discharging volume was 120. In 2013 the volume of emergency outpatients was 301,208 person/visits, and there are 8594 people coming to have physical examinations (this data is not included in the outpatient volume), the patients discharged were 6487. Foreigners often came here for treatment. In 2013, there were about 160 foreign inpatients. And by April 2014, the daily volume of emergency outpatients has been about 2300.

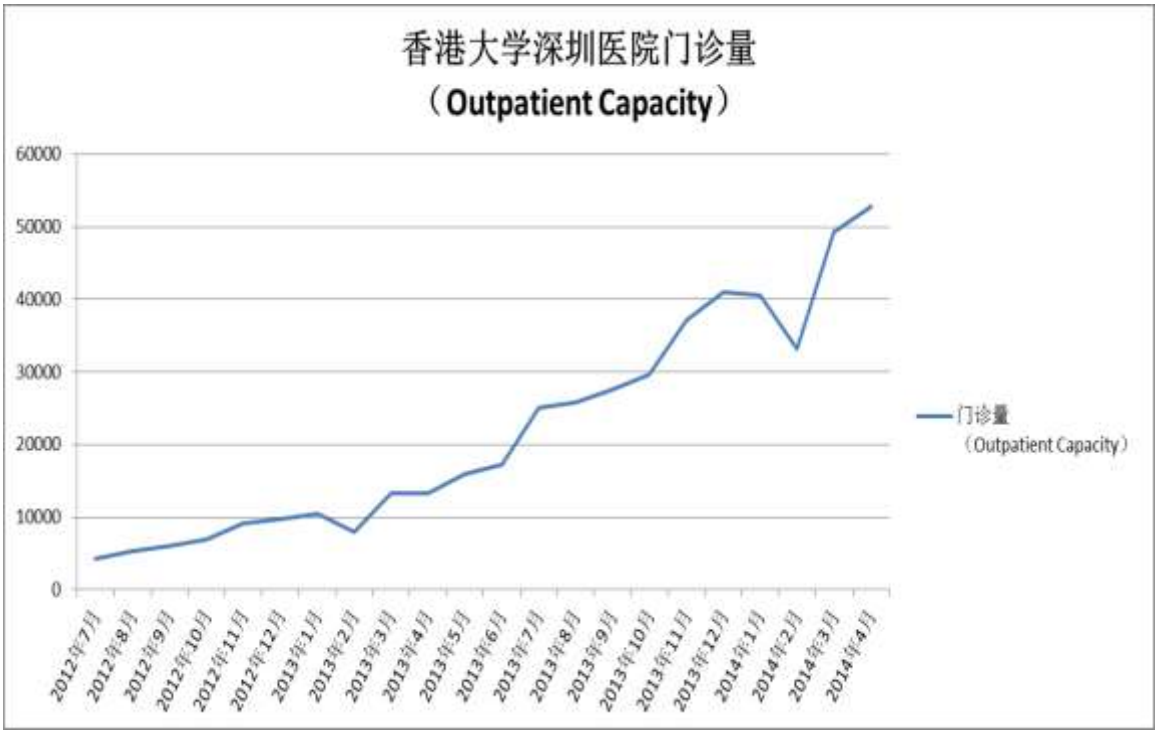
Since the hospital was opened on July 1, 2012, the number of patients coming for treatment has been gradually increasing. Thus it can be concluded that the registration-booking pattern in the University of Hong Kong-Shenzhen Hospital is recognized and accepted by patients. For details, see the table below:

Table 4-2 The Outpatient Capacity of HKU-SZH (per month)

Date	Outpatient Capacity
July, 2012	4279
August, 2012	5216
September, 2012	6013
October, 2012	6922
November, 2012	9099
December, 2012	9655
January, 2013	10478
February, 2013	7923
March, 2013	13287
April, 2013	13311
May, 2013	15911
June, 2013	17188
July, 2013	25016
August, 2013	25839
September, 2013	27649
October, 2013	29667
November, 2013	37187
December, 2013	41058
January, 2014	40567
February, 2014	33226
March, 2014	49290
April, 2014	52871

Source: The author

Figure 4-4 Outpatient Capacity in the University of Hong Kong-Shenzhen Hospital



Source: The author

The Spring Festival, a traditional Chinese festival, often falls in February each year. During the festival, many city residents will go to their old home in the countryside to celebrate the Spring Festival. From the outpatient volume and the chart, it is clearly seen that in spite of a significant reduction in the urban population during the Spring Festival, the outpatient volume is steadily increasing, reflecting to some extent the public recognition for the hospital.

On August 21, 2013, the Shenzhen Municipal Health Work Commission (Shenzhen Health Family Planning Commission) first published the public satisfaction ranking for 47 above-Grade II public hospitals (http://www.szhpfpc.gov.cn:8080/wsj/news/25766.htm). According to the results, Shenzhen Corning Hospital, the University of Hong Kong-Shenzhen Hospital, Shenzhen Eye Hospital respectively scored 90.40 points, 84.99 points, and 83.85 points and ranked the top three public hospitals in the ranking. Besides, a total of 10 hospitals scored below 60, among them Peking University-Shenzhen Hospital scored 59.18 points and ranked the bottom ten.

Table 4-3 The Ranking Results of Public Satisfaction with 47 Public Hospital over Grade II for the Second Quarter of 2013

Hospital	Expected Score	Final Score	Ranking
Shenzhen Corning Hospital	93.68	90.40	1
The University of Hong Kong- Shenzhen Hospital	88.07	84.90	2
Shenzhen Eye Hospital	86.89	83.85	3
Shenzhen Pinghu People's Hospital of Longgang District	73.17	81.00	4
Shenzhen Traditional Chinese Medicine Hospital of Bao'an District	73.80	80.81	5
Shenhzen Third People's Hospital	82.15	79.27	6
Shenzhen Sun-Yat Sen Cardiovascular Hospital	82.00	79.13	7
Shenzhen Xi Xiang People's Hospital of Bao'an District	72.20	79.06	8
Shenzhen Second People's Hospital	79.39	76.61	9
Shenzhen People's Hospital of Guangming New District	67.72	76.12	10
Shenzhen Guangming Hospital of Guangming New District	66.27	74.49	11
Shenzhen Henggang People's Hospital of Longgang District	66.59	73.72	12
Shenzhen People's Hospital of Longgang District	66.22	73.31	13
Shenzhen Longgang Central Hospital	64.49	71.39	14
Shenzhen Traditional Chinese Medicine Hospital	72.00	69.48	15
Shenzhen People's Hospital of Bao'an District	63.30	69.31	16
Shenzhen People's Hospital	70.48	68.01	17
Shenzhen Shajing People's Hospital of Bao'an District	61.70	67.56	18
Shenzhen Traditional Chinese Medicine Hospital Of Luohu District	88.10	67.48	19
Shenzhen People's Hospital of Luohu District	87.56	67.07	20
Shenzhen Traditional Chinese Medicine Hospital Of Futian District	76.66	66.69	21

Source: The author

It is quite remarkable that the University of Hong Kong-Shenzhen Hospital gets public recognition in just about a year, showing that the public thinks highly of the registration-booking pattern carried out in the hospital.

(5) Exchanges and Cooperation: the hospital is equipped with American CISCO Company's video conference terminal system for remote consultation, and this system was put into use in March 2013. It carried out remote consultations with the

Department of Pharmacy of the University of Hong Kong, Department of Surgery of the University of Hong Kong, Queen Mary Hospital, Hong Kong, Kyushu University, Japan, Hong Kong Sanatorium and Hospital, tested to transfer the recorded video of surgery, and transmitted real time endoscopic images to Hong Kong, achieving satisfying effects. Currently the Department of Surgery in the University of Hong Kong-Shenzhen Hospital carries out remote video training with the Department of Surgery in the University of Hong Kong 2 or 3 times every week. Meanwhile, the hospital's Endoscopy Center, NICU, and Hong Kong professors use WEBEX system to put projects that need to be discussed in the system, so that both sides can see and discuss cases, with the current frequency being once a month.

In November 2013, the hospital's information technology department had contacts with senior executives in the Chinese branch of the United States' ORACLE Company to discuss cooperation in and development of medical businesses.

In December 2013, the hospital's information technology department discussed with the staff from China's State Information Center to found a medical cloud platform in China, and confirmed the specific building steps in April 2014. The medical cloud project was started in May 2014, and the National Health Information Center allocated funds to have the hardware required by the medical cloud system tested and installed in the hospital.

In May 2014, the University of Hong Kong-Shenzhen Hospital and Peking University Medical Information Technology Co., Ltd. signed a cooperation agreement to carry out in-depth cooperation in terms of medical information. Peking University Medical Information Technology Co., Ltd. is one of the giants in medical information software in China, and one of the leading Chinese providers in digital hospital and regional health information technology solutions and services. It has provided more than 100 comprehensive IT overall solutions and services for large Level 3A hospitals and a large number of health care institutions.

The medical administration departments in all provinces and cities nationwide all came to have exchanges and discussions with the University of Hong Kong-Shenzhen Hospital. By April 2014, more than 320 batches of relevant government department

heads and medical staff home and abroad, with a total of about 4, 000 people, have come for exchanges and visits. Among them there are Han Qide, Vice Chairman for the Twelfth CPPCC National Committee, Zhou Bo, Deputy Director from Hong Kong and Macao Affairs Office of the State Council, Chang Jile, Deputy Director from the Division of Personnel in the State Planning Commission, Lin Shaochun, Vice Governor of Guangdong Province, and Xu Qin, Mayor of Shenzhen. All of them successively visited the hospital and fully affirmed and expressed their support for reform and development of the hospital. In addition, Guangdong Provincial Health Department, Beijing Medical Association, Chinese Medical Association, Asian Association of Chinese Health Management, Macau Pediatric Society, Association of Hong Kong Nursing Staff, Okinawa Medical Association in Japan, Consulate General of Canada, Queen Elizabeth Hospital in Hong Kong, the Cancer Institute and Hospital affiliated to Chinese Academy of Medical Sciences(CAMS), Peking University People's Hospital, Peking University First Hospital, the Fourth Military Medical University, Tianjin Medical University Metabolic Disease Hospital, the First Affiliated Hospital-Zhejiang University School of Medicine, Guangdong Provincial Hospital of TCM(Traditional Chinese Medicine), Beijing Tsinghua Hospital all paid visits and also affirmed and appreciated the medical model of the University of Hong Kong-Shenzhen Hospital.

On the morning of June 7, 2014, Sun Zhigang, Vice Minister of National Health and Family Planning Commission of the People’s Republic of China and Director of the Health Reform Office of the State Council and his delegation visited HKU-SZH. Director Sun said that the new exploration made by HKU-SZH on four aspects---- operation, management, practice and treatment---- has achieved remarkable results. These advanced ideas are worth spreading. He pointed out that HKU-SZH has made great breakthroughs in personnel administration, salary system, medical service, etc. Different from other public hospitals in China, the model of HKU-SZH will encounter difficulties and tests. He encouraged HKU-SZH to persist in this model and gradually improve supporting policies and measures. He also mentioned that the reform

conducted by HKU-SZH cannot be measured simply by economic benefits. As a useful exploration, this reform is a fresh take to public hospitals in China and needs full support from relevant parties. The public have a final say in judging the results.

(6) Development Goals: the hospital strives to build itself into a "first-class and internationally renowned", modern, digital and comprehensive public hospital which combines medical, teaching and research together. It aims to safeguard and promote physical and psychological health of the public, and build at least one national key specialized department and five or more medical specialties which can reach Chinese and international advanced level by 2020. Generally speaking, the hospital is positioned as:

a. A public hospital set up by the Shenzhen municipal government, and a place for the trial reform of public hospitals;

b. An affiliated hospital of the University of Hong Kong, and a platform for health care, teaching and research;

c. A modern, digital and integrated level-three A hospital;

d. A hospital providing multi-level medical services, including basic public health service and medical service for special needs;

e. A "first-class and internationally renowned" hospital, and one that continues to be in line with international modern hospital standards.

4.1.2 External Environment

(1) Shortage of medical resources. According to statistics from the National Health and Family Planning Commission of the People's Republic of China (http://www.nhfpc.gov.cn/mohwsbwstjxxzx/s7967/201401/c796ac5bdd4c41bbaa1409f4def9e1ab.shtml), by the end of November 2013, there had been 962,000 medical institutions in China, including 24,000 hospitals, 923,000 primary-level medical institutions, 12,000 professional public medical institutions and 2,000 other medical institutions. The number of Chinese medical institutions had increased by 294 compared with that by the end of November 2012. To be specific, the number of hospitals increased by 1,564, the number of primary-level medical institutions decreased by 1,606 (mainly due to mergers of village clinics after implementation of

integrated management in villages) and the number of professional public medical institutions increased by 247. However, considering the general public's demand for medical and health care, China's medical and healthcare resources are still in short supply. Most of the resources are allocated in large and medium-sized hospitals in major Chinese cities and the distribution of resources is unreasonable. In addition, high-end medical equipment and technologies are unduly concentrated in large hospitals, leading to a shortage of primary-level medical resources. According to the Shenzhen's Statistical Yearbook of the Medical Industry (2012), currently in Shenzhen, there are in total 2008 medical institutions, among which 352 are state-owned, with a total of 27,984 beds. There are altogether 115 hospitals in Shenzhen, including 91 county-level or municipal-level hospitals, 56 general hospitals and 24 township or sub-district hospitals. Suppose the population of Shenzhen is 13 million, then the number of hospital beds owned by every one thousand people is 2.15. However, this figure is 4.89 in Tianjin, according to a report in Tianjin Section of people.cn (http://www.022net.com/2011/9-5/415132153098400.html). In addition, the figure of the whole country is 3.81. Therefore, medical resources of Shenzhen are in extreme short supply by comparison.

Since there are only a few large hospitals equipped with more than one thousand hospital beds (For example, there are 2,159 beds in Shenzhen People's Hospital, 1,188 in Shenzhen No. 2 People's Hospital and 1,005 in Peking University Shenzhen Hospital), most patients tend to seek medical services in these large hospitals with advanced medical technologies. As a result, patients have to spend more time queuing in the overcrowded hospitals, imposing more tension on the doctor-patient relation.

(2) The medical and health care reform. On March 17, 2009, the CPC Central Committee released the Opinions of the CPC Central Committee and the State Council on Deepening the Reform of the Medical and Health Care System, marking the formal initiation of the medical and health care system in China. From 2009 to 2011, the reform focused on pushing forward the establishment of the primary-level medical service system, the basic drug system and the basic medical security system,

promoting equal access to and availability of basic public medical services and fulfilling five pilot tasks of the public hospital reform. Shenzhen and other 16 cities are selected as pilot cities for the public hospital reform. According to the Opinions of the CPC Central Committee and the State Council on Deepening the Reform of the Medical and Health Care System, overall goals of the reform are as follows: by 2020, a basic medical and health care system covering both urban and rural residents will be basically established; an improved public health service system and medical service system, a sound medical security system, a standardized drug supply security system and a scientific medical institution management and operation mechanism will be universally established; with diversified ownerships of medical institutions, the general public will have access to basic medical and health services and their multi-layer medical needs will be basically met; four systems including the public health service system, the medical service system, the medical security system and the drug supply security system that cover urban and rural residents will be established, facilitating to establish a fourfold basic medical and health service system.

In order to materialize requirements of the 2013 Municipal Work Conference on Reform in Shenzhen as well as the Municipal Work Conference on Medical Reform and to implement the Plan for Shenzhen to Further Medical and Health Care System Reform During the "Twelfth Five-year Plan" Period (Shenzhen's Municipal Government Document [2012], No. 204), Shenzhen has formulated a distinctive plan for the medical and health care system reform. The plan includes following measures: perfect the public health service system featuring "two-level hierarchy and three-level administration"; expand the scope of public health services; improve the long-term mechanism for hospitals to fulfill public health responsibilities and receive government compensation; launch campaigns to advocate wholesome lifestyles; complete the family doctor responsibility system; carry out an annual assessment on family doctors under the responsibility system to ensure that 80% of contracted residents are satisfied with medical services they receive; vigorously introduce international medical resources by encouraging foreign capital to co-establish medical institutions with Shenzhen's medical institutions, businesses and other organizations

by means of joint venture or cooperation; re-define the function, number, scale, structure and layout of public hospitals in a reasonable way; encourage public hospitals to share and recognize medical examination and medical image information of one another; further apply ICT in the medical and health care industry by establishing a data sharing and exchange platform with "digitalized health records of residents" and "electronic medical records" as the core and promoting "citizen health card" and "General Medical Information System for Digitalized Hospitals in Shenzhen"; continue to adopt a "package" charging system for general and specialized outpatient services in qualified hospitals; summarize and promote experience of The University of Hong Kong-Shenzhen Hospital, including terminating the current dual identity structure of official and unofficial staff, promoting the system of employment under contract in public hospitals and carrying out management on the limit in the number of employees; and establish a distribution system in which hospitals are able to decide the composition of job positions and salaries and salaries are dependent on the position responsibility and performance assessment.

On May 9, 2013, the Shenzhen Public Hospital Administration Center was officially established, indicating that the medical reform in Shenzhen had entered the toughest period. Public hospitals would witness "separation of administration from management" and "separation of government institutions from public institutions". The Shenzhen Public Hospital Administration Center will not only explore how to realize centralized purchasing of medical consumables, which account for the largest percentage of consumption goods in hospitals, and institutionalize assessment of hospital's commonweal. In the future, the amount of subsidy given to the 11 public hospitals in Shenzhen will be dependent on their quality of medical services and level of management. Establishment of the Shenzhen Public Hospital Administration Center has also transformed the functions of Shenzhen Health and Family Planning Commission, which will no longer "establishes" public hospitals but focuses on "managing" the entire medical and health care industry. On the other hand, as a public

institution under the direct jurisdiction of Shenzhen municipal government, the Public Hospital Administration Center represents the municipal government to fulfill the responsibility to establish public hospitals, supervise operation of public hospitals in terms of staff, capital and materials, promote institutional innovation of the public hospital system, improve the quality and level of medical services, ensure the commonweal nature of public hospitals and provide more affordable medical services to the general public so as to enable them to feel an evident improvement of the medical service quality.

It is reported that medical institutions under the administration of Public Hospital Administration Center include 11 hospitals, among which are Shenzhen People's Hospital, Shenzhen No.2 People's Hospital, Peking University Shenzhen Hospital, The University of Hong Kong-Shenzhen Hospital, Shenzhen Traditional Chinese Medicine Hospital, Shenzhen Sun Yat-Sen Cardiovascular Hospital, Shenzhen Maternity and Child Healthcare Hospital, Shenzhen Children's Hospital, Shenzhen Ophthalmologic Hospital, Shenzhen Kangning Hospital and Shenzhen No.3 People's Hospital, and Shenzhen Institute of Gerontology and Geriatrics.

The Center will set up a procurement center for public hospital supplies with certain rules and entry criteria. By connecting the procurement amount with the settlement price, there will be no room for corruption in hospital procurement. Procurement of the Center will be supervised by the Council of Public Hospital Administration Center, which is composed of department representatives, executives of Hospital Administration Center, experts and celebrities and has decision-making power and veto power on major issues. At present, drugs used in Shenzhen public hospitals are all listed in the sunlight procurement catalogue for drugs in Guangdong Province. Through packaging the 11 hospitals, drugs used by them can be purchased in a centralized way, which helps to reduce cost of drugs and enable the general public to buy drugs with lower prices.

The Shenzhen Public Hospital Administration Center will fully implement the fiscal subsidy policy so as to exert its directing role in facilitating public hospitals to materialize performance assessment indicators. In the past, the amount of government

subsidies is dependent on the number of permanent staff. However, it is now determined by the medical service quality and management level of hospitals, with an ultimate goal of benefiting the general public. In addition, a reasonable system to evaluate the technical level of doctors will be established. Gradually, doctors' salary will cease to be dependent on their professional titles, but on their experience, performance, medical ethics, influence and contribution. In this way, problems such as unfair treatment to temporary employees and competitive recruitment of high-level professionals will be resolved. It can also encourage medical staff to attach more importance to the improvement their own medical skills. This model will be first applied as a pilot operation in Shenzhen Ophthalmic Hospital, Shenzhen Kangning Hospital and Shenzhen No.3 People's Hospital. As for evaluation criteria, special committees under the Shenzhen Clinical Medicine Committee will work out scientific and sound criteria for different medical disciplines.

The Center intends to eliminate the binary management of permanent and temporary hospital employees, who receive different pays with the same work. With the implementation of the system of employment under contract, a staff performance evaluation and salary distribution system based on clinical technique grading management and with post management as the core will gradually come into place. Famous experts can be granted a large sum of annual salary to help create an atmosphere where experts and medical techniques are respected.

There are 15 members in the council of Shenzhen Public Hospital Administration Center, including Mr. Wu Yihuan, vice mayor of Shenzhen and president of the council, representatives from Shenzhen Public Sectors Reform Office, Shenzhen Development and Reform Commission, Shenzhen Financial Commission, Shenzhen Health and Family Planning Commission, Shenzhen Human Resources and Social Security Bureau and Shenzhen Public Hospital Administration Center and five social celebrities. Through collective consultation and voting, the council can make decisions on major issues. It is hoped that through integration of medical resources,

public hospitals can be managed in a holistic manner, which will also make government policies more efficient and scientific.

According to Professor Grace Tang, chief executive of The University of Hong Kong-Shenzhen Hospital, December 1990 marked the establishment of Hong Kong Hospital Authority, which started to manage medical services of all public hospitals in Hong Kong since then. It was also responsible for the financial and human resource management in all hospitals, minimizing the occurrence of corruption. Now Shenzhen is also trying to establish a public hospital management center, which is a very promising plan. However, she has pointed out that the Hospital Authority of Hong Kong is not immaculate, facing a surging cost and the fact that they cannot make ends meet. These problems may also face Shenzhen's public hospital management center.

According to an executive of a Level 3A hospital in Shenzhen, Beijing has tried to set up a hospital management center. However, because the authority over hospitals is not clearly separated, there are many conflicts between the center and the competent administrative department for medical and health care. "In fact, many of their functions are overlapped. Apart from conflicts between the two organizations, hospitals are now controlled by an extra organization." Shenzhen inherited the model of HK Hospital Authority by adopting a council-accountability model, but whether members of the council will conscientiously fulfill their responsibilities is still unknown. Obviously, there is still a long way for Shenzhen to go before establishing a public administration pattern with multiple participants. It also remains as a question that whether the separation of decision-making, execution and supervision can be realized. This executive stressed that the public hospital management center must clarify functions of hospital owners and managers so that there will be someone actually responsible for the efficient use of national assets in public hospitals.

Speaking of the relationship between Shenzhen Health and Family Planning Commission and the Hospital Management Center, Mr. Cai Li, director of the Health and Family planning Commission, said that from the perspective of department positioning, the Shenzhen Health and Family Planning Commission is the competent administrative department for the medical and health care industry in Shenzhen, while

the Hospital Management Center is a public institution that is directly under the municipal government and responsible for unified management on public hospitals. The Public Hospital Management Center focuses on public hospitals and is designed to provide more scientific, professional and refined services to them. However, the Health and Family Planning Commission aims to facilitate a sound development of the whole medical and health care industry in the city and improve health conditions of its residents. The Center aims to offer professional services to improve service capacities, service levels and service qualities of public hospitals so as to facilitate them to provide more secure, inexpensive and premium medical services to the general public.

The medical and health care system reform has brought huge challenges and reforms to managers of all large hospitals. Management model and operation philosophy of hospitals will be profoundly influenced.

(3) Application of ICT in the medical industry. According to the Development Report on Shenzhen's Health and Family Planning Cause During the "Eleventh Five-Year Plan" Period (http://www.szhpfpc.gov.cn:8080/wsj/news/17228.htm), in 2010, Shenzhen Health and Family Planning Commission cooperated with Shenzhen Human Resources and Social Security Bureau to create the "Resident Health Card" based on social security ID card. On December 27, 2013, the card was officially used in seven hospitals, including Shenzhen People's Hospital, Shenzhen No.2 People Hospital, Peking University Shenzhen Hospital, Shenzhen Traditional Chinese Medicine Hospital, Futian District People's Hospital, Luohu District People's Hospital and Nanshan District People's Hospital. With the card, patients' health records can be retrieved from the doctors' work station, self-service is provided for outpatient registration and payment and citizens can consult health records by themselves.

During the period of China's "Eleventh Five-Year Plan" (It started in 2006 and ended in 2010. On March 14, 2006, the Fourth Plenary Session of China's Tenth National People's Congress formally ratified the country's Eleventh Five-Year

Plan), Shenzhen vigorously promoted application of ICT in health and family planning. To this end, Shenzhen initiated the "139 Project", namely, one data center, three platforms and nine application systems. To be more specific, 1 refers to one data center, 3 refers to medical information publishing and service platform, data sharing and exchange platform and medical decision-making information support system, and 9 refers to nine application systems including hospital business network internet information system, public health emergency response system, disease control network internet information system, medical regulation and law enforcement information system, maternity and children healthcare business information system, first-aid business information system, primary-level medical business information system, health education business information system and other business information system. With "139 Project" as the core, application of ICT in regional medical industries has been pushed forward in an orderly, effective, comprehensive and systematic manner. 107 state-owned medical institutions have established a backbone data sharing network, incorporating 16.74 million pieces of residents' basic health information and health records of 6 million residents. Medical information from the 58 state-owned hospitals can be transmitted every day on a regular basis. The building of the data sharing and exchange platform as well as the medical information publishing and service platform has been basically finished. A pilot experiment to establish digitalized hospitals is finished, while medical service price management information system, medical statistics information system, telephone and internet booking registration system and maternity and children healthcare system have been established. The "centralized construction and management project of the information system of newly-built hospitals" is launched to integrate resources to build and manage information systems of 11 newly-built, renovated, expanded or relocated hospitals.

(4) Control of medical expenses. According to the Development Report on Shenzhen's Health and Family Planning Cause During the "Eleventh Five-Year Plan" Period (http://www.szhpfpc.gov.cn:8080/wsj/news/17228.htm), in 2010, the per capita medical expense of outpatients in hospitals of all levels (including maternity

and children health care hospitals and specialized hospitals for certain diseases) reached 128.7 yuan, up 4.5% over the previous year; the average medical expense for hospitalized patients amounted to 6167.1 yuan, up 7.5% over the previous year. The increase rate of medical expenses is smaller than that of residents' disposable income (From the first quarter to the third quarter of 2010, residents' disposable income increased by 10.4% compared with the same period of last year). In Shenzhen, the average per capita medical expense for hospitalized patients accounts for 19.6% of the annual per capita disposable income, while the national figure is 34.7%. Shenzhen's figure is only higher than that of Chengdu and Harbin in all the 15 sub-provincial cities. In Shenzhen, the per capita medical expense for outpatients accounts for 4.9% of residents' monthly disposable income, while the national figure is 11.2%. Shenzhen's figure is the lowest in all the 15 sub-provincial cities.

According to the Development Report on Shenzhen's Health and Family Planning Cause During the "Eleventh Five-Year Plan" Period (http://www.szhpfpc.gov.cn:8080/wsj/news/17228.htm), in 2010, the per capita medical expense for outpatients in public hospitals is 121.2 yuan (that for outpatients in hospital headquarters is 173.7 yuan, up 4.3%), up 3.1% over the previous year; the per capita medical expense for hospitalized patients is 6403.4 yuan, up 6.1% over the previous year. The per capita medical expense for outpatients in private hospitals is 184.7 yuan (that for outpatients in hospital headquarters is 223.6 yuan, up 23.5%), up 17.2% over the previous year; the per capita medical expense for hospitalized patients in private hospitals is 4816.1 yuan, up 17.3%. Given factors such as severity of disease, medical conditions, medical technologies and charging levels, the medical expenses at different levels of general hospitals are still evidently different. The per capita medical expense for outpatients in city, district and sub-district level general hospitals are respectively 217.8 yuan, 130.2 yuan and 80.8 yuan, up 6.6%, 4.4% and 0.5% respectively over the previous year. The per capita medical expense for hospitalized patients are respectively 11,257.9 yuan, 6,752.2 yuan and 3,859.5 yuan, up 5.5%, 6.9% and 7.3% respectively over the previous year.

(5) Competition in the medical industry in Shenzhen. According to investigation, competitors of The University of Hong Kong-Shenzhen Hospital mainly include Shenzhen People's Hospital, Shenzhen No.2 People's Hospital, Peking University Shenzhen Hospital, Shenzhen Sun Yat-Sen Cardiovascular Hospital, Shenzhen Maternity and Child Healthcare Hospital, Shenzhen Children's Hospital, Shenzhen No.3 People's Hospital and major district-level hospitals such as Luohu District People's Hospital, Futian District People's Hospital, Nanshan District People's Hospital and Bao'an District People's Hospital. Due to implementation of the medical institution classification management system, there has been an increase in the number of private medical institutions, some of which are also competitive such as Shenzhen Huansheng Hospital, Shenlian Hospital, Baotian Hospital and Longcheng Hospital. It is predictable that in the near future, competition in the medical industry in Shenzhen will be increasingly fierce.

4.2 The Status Quo and Problems of Outpatient Service Process in the University of Hong Kong-Shenzhen Hospital

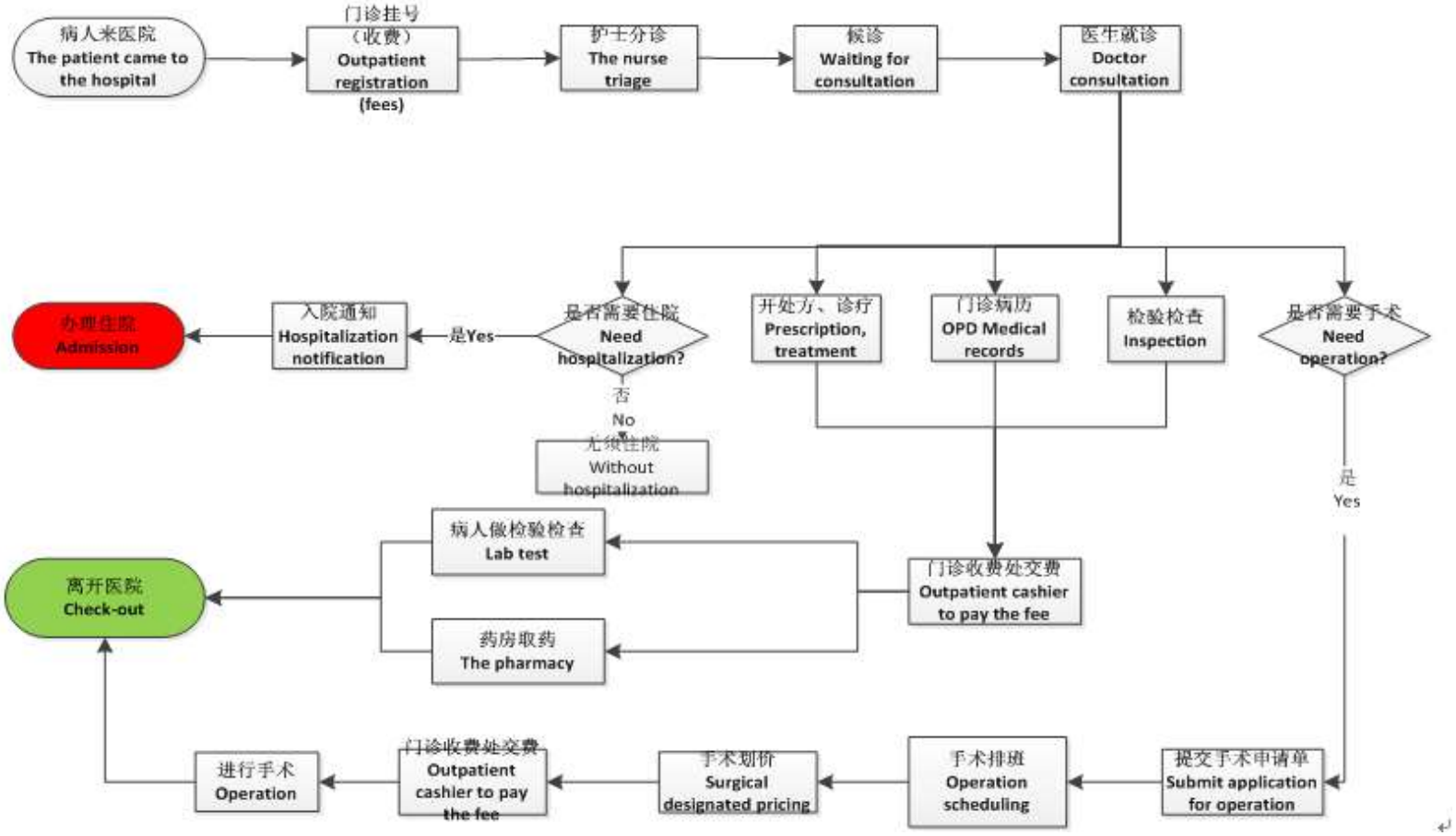
4.2.1 Introduction to the Process of Outpatient Service Appointment

In the University of Hong Kong-Shenzhen Hospital, the outpatient department has entirely adopted appointment registration. At present, there are three ways of appointment, including online appointment, telephone appointment and walk-in appointment at the hospital's service desk. New patients do not need to choose a doctor. They can make an appointment for further consultation at the hospital immediately after treatment. Once the appointment is made, the hospital will try to arrange the same doctor for further consultation in order to provide continuous care to patients. Of course, patients can select different doctors by informing the hospital in advance.

Appointment registration can help patients avoid waiting in the hospital for a long time. At the same time, patients can have sufficient time to communicate with their doctors, which helps create a well-ordered medical environment. At present, the

medical resources in Shenzhen are limited so that patients flood into large hospitals in the urban area. In this case, making an appointment helps distribute resources, effectively classify patients and reasonably allocate medical resources. The University of Hong Kong-Shenzhen Hospital is patient-centered. Taking full advantage of the modern means of communication and network technology, the hospital extends the appointment system within the hospital to patients and reconstructs the outpatient service system, which has fundamentally changed the traditional treatment process (The flow chart below shows the traditional treatment process).

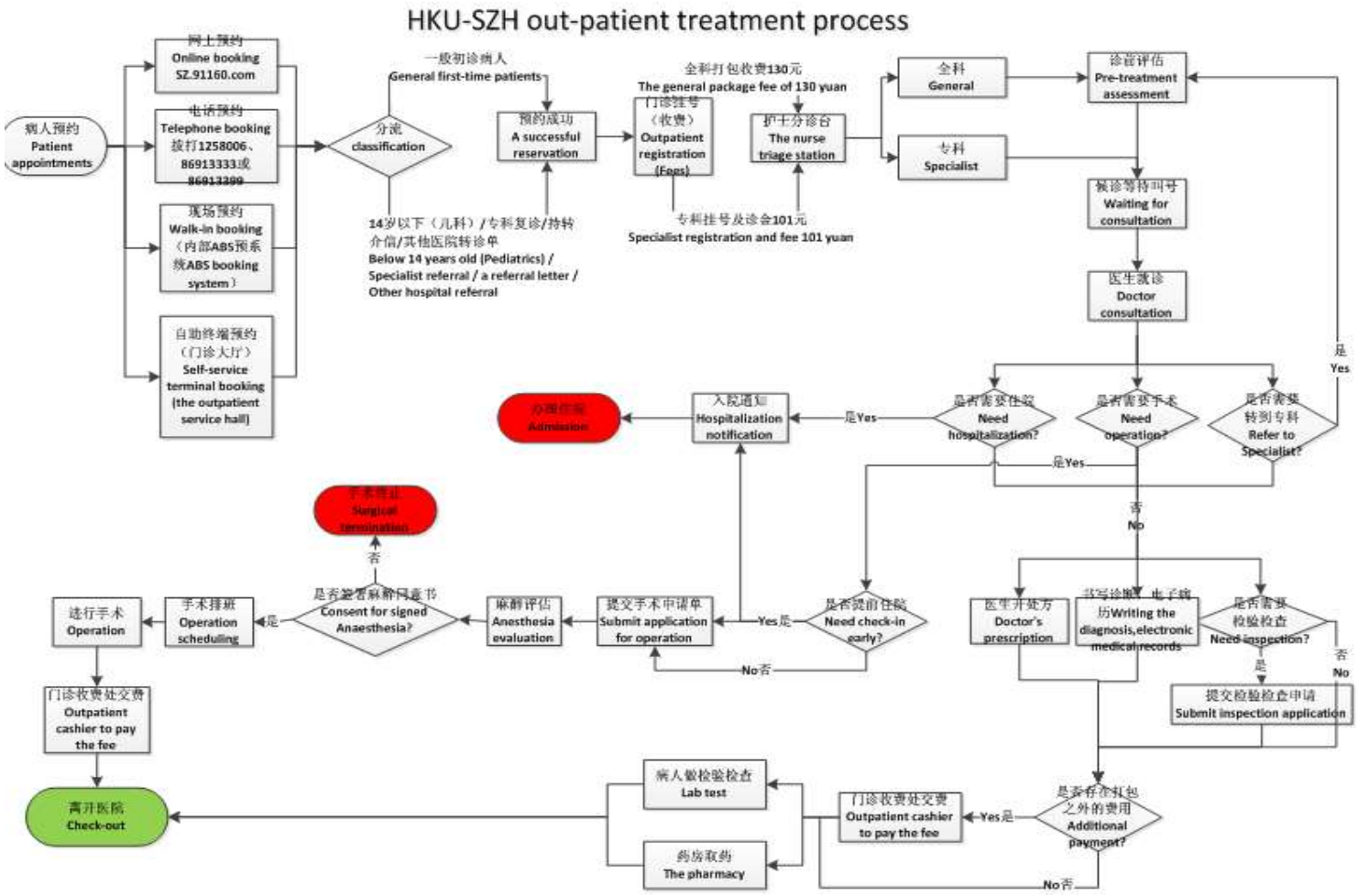
Figure 4-5 The Traditional Hospital Outpatient Process



Source: The author

To distribute medical resources of the hospital at an optimum state is conducive to greatly improving its operation efficiency and reducing medical cost. The University of Hong Kong-Shenzhen Hospital opens up a new health care model, ensuring the quality of medical services at the same time. The University of Hong Kong-Shenzhen Hospital outpatient appointment flow chart is shown below.

Figure 4-6 HKU-SZH Out-patient Treatment Process



Source: The author

The University of Hong Kong-Shenzhen Hospital started to use its self-developed appointment registration system from April 1, 2013. This system is closely linked with the systems installed in each clinical department. Therefore, clinical departments can not only make a plan for the time and number of appointments following their own work plan and schedule, but also make adjustments at any time if the actual appointments are less than expected. This system is closely combined with the practical work. The interval of the time for appointment is 30 minutes. Current appointment methods provided by the hospital include:

(1) Give part of appointments to China Mobile so that citizens can make an appointment on China Mobile's appointment platform.

(2) Make a self-service appointment through the appointment system on the hospital's website.

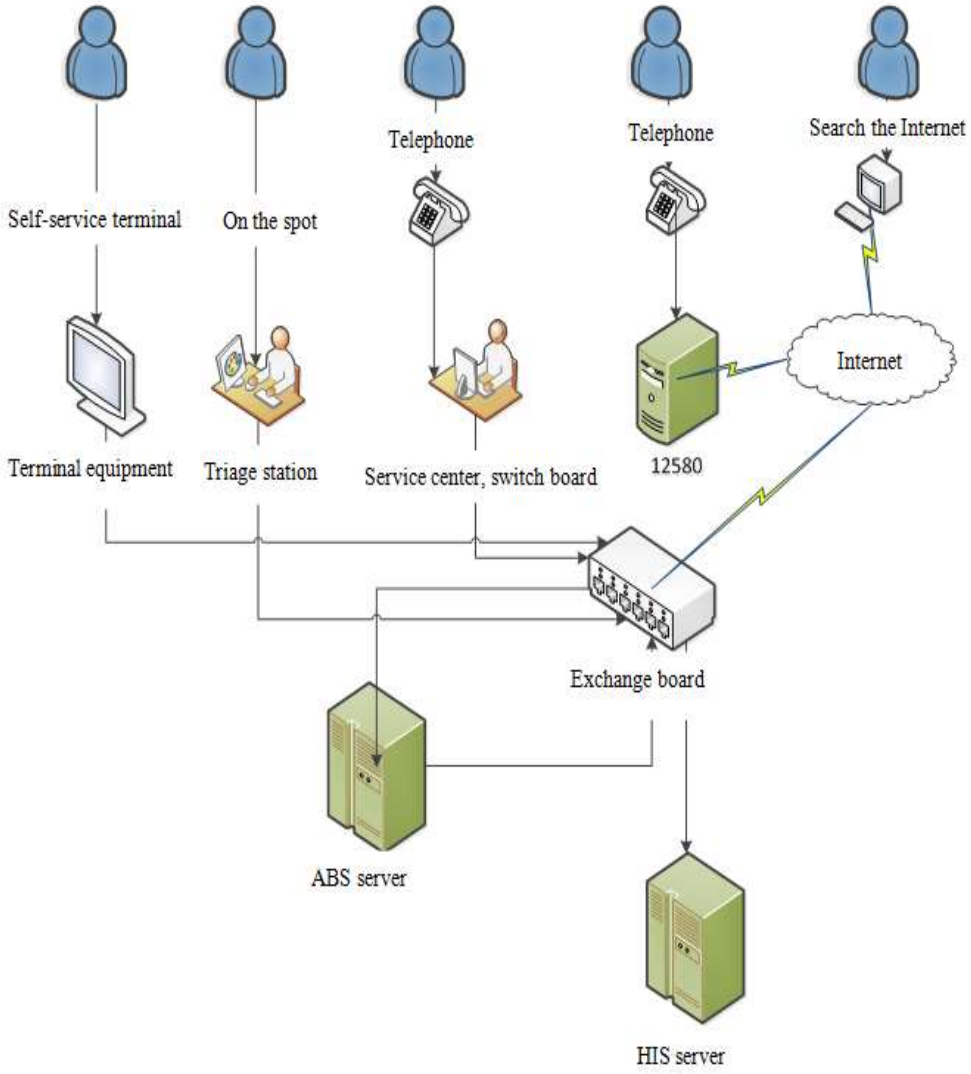
(3) Make an appointment by calling the hospital appointment center.

(4) Walk-in appointment. Go to the medical technology building in the outpatient clinic on first floor, find the help desk and make an appointment directly with the help of the medical guide nurses.

The four appointment methods use the same software with the same data source.

The physical structure diagram of outpatient appointment and registration is shown below.

Figure 4-7 The Physical Structure Diagram of Outpatient Appointment and Registration



Source: The author

China Mobile's appointment system obtains from the University of Hong Kong-Shenzhen Hospital the appointment numbers, the amount of which is controlled by the hospital. Currently, three major communications companies, including Company A, B and C, are able to undertake the appointment task. Company A, a third-party professional communications company, undertakes the task of running registration software on the platform, where the entire appointment resources of the whole city are shared. However, there still exist following problems:

(1) Text messages from the appointment platform of Company A cannot be sent to those of Company B and Company C, and vice versa. If a patient makes an appointment on the website of Company A, he must use the phone of Company A to receive the appointment information. However, since all the appointment numbers are stored in the data platform of Company A, appointment platforms of other companies sometimes face data disorder. In other words, there are appointment numbers on the Company A's website, however, no appointment number is shown on the appointment platforms of other companies. It may be a means of commercial competition adopted by Company A.

(2) Hospitals, as the providers of medical and health care services, even cannot get information of patients from Company A. Functions such as direct telephone appointment and text messages can only be used by China Mobile subscribers.

(3) The function of appointing further consultation is yet to be developed. In addition, the appointment system and HIS are not synchronized, which has brought about chaos.

(4) In all the appointment channels, appointment rules and patterns of hospitals are violated, appointment procedures are overlooked and misleading information is disseminated.

(5) There exist data security risks while the system functions improve slowly.

As for the appointment systems of external companies, there are also so many flaws that they cannot meet the long-term development of the hospital. Therefore, the University of Hong Kong-Shenzhen Hospital decides to develop its own system for appointment registration. The advantages of the appointment systems developed by the hospital are as follows:

(1) All users can make an appointment via the Internet and telephone.

(2) All operators can accurately work following business model and process of the hospital.

(3) Medical staff can flexibly make an appointment for further consultation for patients.

(4) It does not affect the existing appointment platform and can also improve and optimize appointment service.

(5) It can accurately convey appointment information and reduce doctor-patient conflicts.

In the future, the hospital prepares to open online payment so that patients do not need to pay again in the hospital after their appointment and registration, which will bring convenience to patients. At first, the University of Hong Kong-Shenzhen Hospital used OMMDB Platform to develop system which was later found very slow as usage increases, and is not suitable for the future development of the hospital. So, after test, the hospital tried to use Hibernate Platform to develop system which is 10 times faster than using the OMMDB Platform. Thus, the hospital decided to use Hibernate again to develop appointment system in December, 2013.

Since July 1, 2012, patients have been able to make an appointment in the University of Hong Kong-Shenzhen Hospital by visiting www.91160.com, calling China Mobile's appointment hot-line on 1258006 or making an appointment on the spot. But there is no hospital staff specifically designated for patient appointments.

Since October 23, 2012, the University of Hong Kong-Shenzhen Hospital has started to adopt ABS appointment platform. At first, this system was only used in the nurse station and was not open to the public outside the hospital. It was not until December 6, 2012 that hot-line (86913333) takers of the hospital switchboard were allowed to help people in need to make an appointment. But staff had not received relevant training on medical knowledge. As a result, many phone calls for consultation have to be transferred to nurse stations where ABS system was used to help patients make an appointment. Then, the Hospital Appointments Call Center was established on April 1, 2013 when the hospital decided to use appointment hot-line on 86913399. In the beginning, there were only six operators in the center. With increasing patients appointing and consulting, now there are 16 operators specifically designated to answer the appointment hot-line on 86913399.

The responsibilities of the Hospital Appointments Call Center are as follows. From time to time, the center has an exchange with the medical departments about the

illnesses that each department can treat so that 16 operators can be trained in time once new changes has been made by any department. In this way, the operators know more about the departments. The center has set up in the computer a shared folder which shares the hospital's medical treatment processes, the medical package cost of related sections departments, and medical projects, which are useful for the operators during the consultation for the patients' appointment and registration.

In the Telephone Appointment System, there is a call center system specifically designed to answer calls. There are different operators in the center who understand Mandarin, Cantonese or English. After dialing the appointment hot-line, patients can follow voice guidance which will enable them to select the corresponding language to consult relevant issues. Besides, there is queuing reminder function in the center. With this function, the user can choose to wait or leave his contact information when operators are answering other calls. And the center will send personnel to re-call these users later. This avoids too many people calling at the same time when the lines are busy during peak hours.

Statistical report on the outpatients of the University of Hong Kong-Shenzhen Hospital is shown as follows (from January, 2013 to April, 2014)

Table 4-4 Statistical Report on the Outpatients of the University of Hong Kong-Shenzhen Hospital

Date	Outpatient Amount	Emergency Amount	Examination Amount	Appointment Amount	Missing Appointment Amount	Missing Appointment Rate	Day Appointment Amount	Day Appointment Rate
2014/4/30	2042	283	91	2108	256	17.0%	602	29.5%
2014/4/29	2006	273	85	2090	233	15.0%	540	26.9%
per day in April,2014	1950	244	92	2029	230	16.4%	627	32.2%
per day in March,2014	1853	192	71	1928	214	16.6%	636	34.3%
per day in February,2014	1560	148	63	1542	174	17.6%	549	35.2%
per day in January,2014	1471	176	61	1436	182	20.0%	526	36.0%
per day in Dec., 2013	1523	146	70	1500	206	22.6%	588	38.6%
per day in Nov.,2013	1467	130	52	1454	206	21.2%	482	32.9%
per day in October,2013	1256	113	56	1252	192	**15.4%**		
per day in Sept.,2013	1109	105	57	1121	189	**16.9%**		
per day in August,2013	1024	75	45	1037	180	**17.4%**		
per day in July,2013	958	9	37	975	176	**18.0%**		
per day in June,2013	905	47	35	910	162	**17.8%**		
per day in May,2013	723	20	14	694	144	**20.7%**		
per day in April,2013	634	3	15	574	89	**15.5%**		
per day in March,2013	633	4	4	569	84	**14.8%**		
per day in February,2013	466	2	0	393	55	**14.1%**		
per day in January,2013	476	2	0	442	68	**15.4%**		

Note: Since November, 2013, the formula of missing appointment rate has been revised: missing appointment rate = missing appointment amount / (appointment amount - day appointment amount)

Source: The author.

Because there are a lot of people rushing to the hospital every day, hoping to directly see a doctor without an appointment, the hospital has started to open walk-in

appointment and registration service in the help desk in the outpatient medical technology building since November, 2013.

It can be seen from the table that every day a lot of people miss appointments, accounting for 17% of the entire hospital outpatient amount, which is bound to affect the allocation of resources of the hospital. On the other hand, each day a large amount of people come to the hospital for treatment through walk-in appointment, accounting for more than 30 percent of total outpatient amount, clearly demonstrating that many Shenzhen citizens are still not accustomed to medical appointments.

We believe that the characteristics of appointment registration can be summarized in the following aspects:

(1) Adopting the appointment mode, the hospital is able to set and arrange medical resources for each time period accurately, clearly and orderly.

(2) Appointment is the integration of internal resources of the hospital, which can effectively capture data, and rationally allocate medical resources.

(3) Appointment can be planned according to the development of the hospital at different stages so that the hospital can better control the speed and pace of its development, and find its own way of development according to their own plan and pace of development.

(4) Appointment helps rationally allocate resources, allows the hospital to control its pace of development, and guarantees the medical and treatment quality of the hospital. On the other hand, the appointment will restrict the scale and speed of the hospital's development and have a direct influence on its the economic effects.

4.2.2 Introduction to the General Clinic

As a pilot of China's medical system reform, The University of Hong Kong-Shenzhen Hospital has been the first in China to establish a general clinic, a new, efficient and cost-effective medical service model in order to support strategies of the reform. It is also the only one in China to adopt an overall pre-registration model for outpatients. Taking patients as the first priority, the hospital makes full use of modern telecommunication and Internet technology, making registration closer to

patients and reengineering the outpatient system of the hospital. By doing so, it has altered the traditional doctor-seeing process fundamentally and allocated medical resources of the hospital in an optimal manner, greatly improving efficiency of the hospital and reducing costs for patients.

The hospital mainly implements a treatment model featuring "Generalist First, Specialist Next"; namely, if illness of a patient is unclear to be confirmed, s/he would go to the general clinic first. The advantage is that with comprehensive medical knowledge and clinical experience, a general practitioner is able to make a clinical diagnosis and treatment for most patients immediately. And if a general practitioner determines that the illness shall be further diagnosed in special clinics, the patient can be transferred to the specific special clinic precisely, avoiding a waste of time and the trouble that a patient is transferred among different special clinics. To ensure quality of treatment, the hospital has stipulated that each patient will receive diagnosis and treatment for a reasonable period of time (no less than 10 minutes).If a patient needs to be transferred to special clinics due to an emergency, the general practitioner shall arrange for transfer immediately.

Package charging for the general clinic: package charging is adopted in the general clinic. A patient should pay a package charge of 130 yuan, among which expenses of registration, diagnosis, medicines for 7 days or less, a type-B ultrasonic check for one body part, an X-ray check for one body part, blood routine examinations, urine routine examinations and minor wound treatments are included. Patients do not have to pay extra money for medicines or examinations (except for particular medicines and examinations). Through package charging, unnecessary examinations and charges are reduced and patients are spared from the trouble of queuing to pay different charges.

Time duration for treatment in the general clinic: at least 10 minutes for each patient should be guaranteed to provide sufficient time for communication between patients and doctors;

Time duration for treatment in special clinics: at least 20 minutes for each patient should be guaranteed. The registration fee for special clinics is 100 yuan, with other

expenses calculated separately.

Like other public hospitals, The University of Hong Kong-Shenzhen Hospital is available for social security cards and implements same charging standards with other hospitals in Shenzhen.

4.2.3 Existing Problems

Currently, The University of Hong Kong-Shenzhen Hospital uses medical records common in Shenzhen City. Without magcards or IC cards, the hospital identifies patients by sticking QR codes (for free) on the cover of medical records. Related information of patients is saved through QR codes. So medical staff is spared from typing in basic information of patients since information stored through QR codes can be read directly, reducing the time of queuing up of patients and improving the efficiency of medical staff. The following problems are found in the outpatient process of the hospital through field survey and interview:

(1) Since it is newly-established and its hardware and software facilities are under constant improvement, the hospital is occasionally overloaded due to excessive outpatients. And it is mainly because that sometimes a doctor spends too much time on one patient. For instance, at times it takes a doctor about an hour to diagnose for one patient (such as in Dermatology Department);

(2) After implementation of the overall pre-registration system, the number of outpatients decreased because patients without pre-registration would not go to the hospital in case they cannot see a doctor.

(3) Since no expense is charged for pre-registration, it is common that patients do not go to the hospital after pre-registering. Presently, over 200 patients with pre-registration, 16% of the total number of outpatients do not go to the hospital, causing a slight waste of hospital resources. And no countermeasure is taken by the hospital. In fact, on-spot pre-registration can be made in the hospital as long as any department is available. If a department is fully booked, patients can only pre-register for diagnosis and treatment in the following days. At present, over 500 patients choose on-spot registration for the day, taking up approximately 30% of the total

number of outpatients.

(4) Peak hours in the hospital are from 9:00 to 11:00 in the morning when most patients of the day come for diagnosis and treatment. For Orthopedics Department, Tuesday and Thursday usually witness the most outpatients; and for Dentistry Department, Obstetrics and Gynecology Department, B-Ultrasound Room, MRI Room, Pediatrics Department, Cardiology Department, Otolaryngology Department and Dermatology Department, the number of outpatients is huge and it requires more reasonable allocation of medical resources. From 12:00 to 13:00 pm, it is peak hours for payment. As a result, staff has to be on duty at noon at the Cashier and Dispensary for outpatients.

(5) Concierge medical advisors are not professional and do not know enough about types of disease. Logos in Medical Technology Building are two-dimensional and with small characters, far from being clear. Besides, since some departments are relocated and no sign or notice is provided for such relocation in the original site, patients have to look for the new site blindly. Currently, there were only 2 to 3 concierge medical advisors in the lobby of Medical Technology Building. And they are unable to handle occasions when there are too many outpatients. Besides, there is no clear distinction among Area 1, 2, 3 and 4 in the hospital, including the basement. Consequently, it takes patients great efforts in finding different departments.

(6) In July 2014, the government started tender-calling for new medicines, so that 200 to 300 kinds of medicines will be replaced. During the replacement process between old and new medicines, a problem of disconnection may occur in stock control. For example, if there are only 10 boxes of medicines left in stock, when 3 doctors pre-read the inventory, the total amount of demand from the three doctors are larger than the physical inventory. As the past inventory was a virtual one, it takes time to connect it with the actual one. And the inventory has not been synchronized due to the large scale of the hospital; it is also difficult for real-time synchronization due to excessive statistics. Under the current set-up of medical software, the computer should be restarted and software will re-loaded automatically to synchronize the medicine inventory.

(7) Pre-registration is required for B ultrasound, CT and X-ray examination and it takes 3 days to generate examination reports. It is a long time and it is inconvenient for patients to pre-register for diagnosis and treatment for a second time due to inconvenience in time and transportation. It takes 20 minutes to get examination results in traditional hospitals while it takes at least 30 minutes in The University of Hong Kong-Shenzhen Hospital. In other hospitals, image examination reports can be got on the same day of examination. Currently, clinical inspectors conduct tests in batches in laboratories, reducing some workload. And the hospital is about to launch a patients self-service enquiry system and self-service printers to improve a centralized report printing process.

(8) It takes long time to queue up for payment in front of Cashier in the University of Hong Kong-Shenzhen Hospital even with a pre-registration system. And that is contradictory to service requirements of the hospital. It is suggested that the charging process should be optimized and business skill trainings should be provided for charging staff.

(9) For the layout of buildings, special conditions in Orthopedics Department, Obstetrical Department and departments for diseases of the elderly have not been taken into consideration. Presently, Orthopedics Department is on the second floor and Obstetrical Department is on the third, making it inconvenient for fracture patients and pregnant women. Furthermore, a special track is suggested to be installed for orthopedic patients.

4.3 Principles of Outpatient Process Reengineering

1. Put people first: design of outpatient process of the hospital shall be guided by customer-serving and be patients-oriented. Efficiency should be improved, making it convenient for patients to see a doctor and minimizing time of waiting. Meanwhile, efforts should be made to improve efficiency of medical staff and reduce their workload. Besides, the traditional function management model shall be transformed to put the process at the core and take business process management as one of the

priorities.

2. Identify the bottleneck and solve major problems: during information building process of the hospital, BPR (Business Process Reengineering) should first identify bottleneck problems that affect key business process effects and work out detailed solutions. Then it should design an appropriate organizational architecture and personnel structure, determining posts and the architecture in a reasonable way and working out job descriptions for different posts. Besides, it should allocate personnel with required abilities and qualities according to job descriptions, giving full play to their potential and developing human resources to the utmost.

3. Combine overall planning with partial improving: when designing outpatient process for the hospital, importance should be attached to overall planning and connection, combination as well as optimization of business process; and effective integration of business resources should be taken into consideration from a general perspective, optimizing and allocating medical resources and processes for the hospital as a whole.

4. Base on a concept of optimal overall KPI: hospital business improvements should focus on function optimization of the hospital as a whole rather than paying attention to one organization, department or function. Importance should be attached particularly to improvement of overall KPI (Key Performance Indicator), which should be used to evaluate whether the overall system is optimal or not.

5. Build an organizational climate: the bureaucracy system should be weakened and a horizontal organization should be established gradually, giving full play to autonomous participation and decision-making of staff. The top management should set as an example to build a high-performance team with a patient-serving concept, emphasizing on a specialized division of labor and more on cross-function team work.

6. Make use of IT support: transfer of business information is closely linked to whether business processes are smooth or not. An efficient information-based system can ensure an immediate collection, analysis and transfer of business information, improving sharing of various business information and quick responses to external urgent business of the hospital. Besides, apart from the hardware system, when

conducting information building, design, upgrading and transformation of supporting software of various kinds shall be taken into full consideration, including achieving seamless links to other business modules, such as the office information system, financial system and LIS system.

4.4 Goals of Outpatient Process Reengineering

It is believed that the most important goal of restructuring of hospital outpatient business process is to make breakthroughs in organization, technology and business, namely to realize an orderly flow and management of capital, material, personnel and information. For one thing, it should reduce the time of queuing and waiting of patients as much as possible, ensuring the efficiency of diagnosis and treatment and improving overall satisfaction of patients with the hospital. For another, it should enhance medical service and technology level of the hospital, improving external comprehensive competitive strength of the hospital, building high-quality hardware and software facilities for medical services and core competence for the hospital. Details are as follows:

1. From the viewpoint of patients: the business model that functional departments are set up based on internal needs should be changed fundamentally. Under the past hospital management model, diagnosis and treatment tasks are generally divided to many specific posts, such as registration, waiting, diagnosis, examination, payment, dispensary and treatment; and business departments are formed according to positioning of functions of corresponding posts. As a result, horizontally, departments based on function division are independent from one another and an efficient link among various departments is absent; and demands of patients are disintegrated to different business links of internal management of the hospital, at the cost of consumption of time, physical strength and vigor of patients. Vertically, due to a lack of timely and effective communication and coordination among functional departments, when patients run into problems during the service process, related departments fail to handle or transfer such problems immediately to

other departments, wasting time and causing troubles to patients. Instead of improving efficiency, it leaves unpleasant impression on patients. Such a lengthy business process will bring about low management efficiency and a lack of human-based and scientific management to the hospital. Business process restructuring is aimed at reducing waiting time of patients, saving costs and operation expenses for the hospital and improving social reputation and patient satisfaction of the hospital.

2. From the viewpoint of medical staff: the hospital has to build up a zero-distance service environment where medical staff and patients conduct heartfelt exchanges. Through business process restructuring, it is to improve service awareness of medical staff and establish a service attitude that putting patients first. It is to improve work of medical staff as much as possible, optimizing and enhancing their efficiency and reducing mistakes and errors to the maximum degree. While understanding medical businesses well, medical staff has to learn and draw experience of etiquette from excellent service enterprises. Furthermore, the hospital has to provide systematic and standard trainings for staff to build a distinctive service team and build up a sound service climate.

3. From the viewpoint of economic calculation: as a social-economic operating organization, the hospital is to maximize optimization and design of each and every link in its outpatient process, simplifying complicated and repetitive business processes and reducing operation costs, including cost of human and material resources. On the basis of information technology, the hospital is to implement a quantitative assessment and individual responsibility-seeking system for different levels of staff within the organization. And it is to analyze and determine the ratio between investment and turnover of various links, monitoring such daily basic data in a dynamic manner to realize sound operation and management in the hospital.

4. From the viewpoint of managers: the ultimate goal of business process restructuring is to change the common phenomenon of “three longs and one short”, namely, a long time for registration, payment and medicines, but a short time for diagnosis by doctors. Through taking advantage of existing resources of the hospital appropriately, it is to achieve optimal costs both for patients and for operation of the

hospital. By solidifying BPR program with computer network technology, it is to re-design the current business process and work out a new flowchart. And it is to develop and design software in accordance with the new business process and achieve seamless connection among different links of process management. Besides, it is to process various data concerning human, materials and capital flow, providing a quantitative basis for decision-making of the management.

4.5 Summary

This chapter focuses on introduction to the status quo of outpatient process of The University of Hong Kong-Shenzhen Hospital as well as goals of its future process restructuring. It includes an analysis of internal and external environment of the hospital, including an overview of the hospital, introduction to its assets, its human resource structure, health resources in Shenzhen City, the competition landscape and medical system reform and an introduction to the current outpatient process such as the general clinic and existing problems; and it also includes principles and goals of the outpatient process restructuring. The purpose of this chapter is to make it clear the general situation of the target hospital as well as goals of its restructuring.

Firstly, this chapter introduces internal and external environment of the hospital. Introduction to the internal environment includes an overview of the hospital, its fixed asset, the organizational architecture, the establishment and operation status of special clinics, its communication and cooperation and future development goals; while introduction to the external environment contains the current situation of health resources in Shenzhen, the medical system and health care reform, the information building, the medical expenses control as well as competition in the medical and health industry.

Secondly, this chapter analyzes and outlines the current status as well as existing problems of the outpatient process of The University of Hong Kong-Shenzhen Hospital. It introduces the current diagnosis and treatment process for outpatients of the hospital and focuses on an introduction to diagnosis and treatment model in the

general clinic. It also analyzes problems existing in the current process.

Finally, this chapter discusses principles and goals of outpatient process restructuring of The University of Hong Kong-Shenzhen Hospital from the perspective of theoretical analysis. Specifically, the principles should be patients-oriented, identifying major problems, working out overall planning, building up a sound restricting climate and taking full advantage of the guiding role of information technology. The goals are to achieve common development of organization, technology and businesses, to realize a win-win situation among patients, medical staff and the hospital management, and to improve efficiency of the outpatient process in a comprehensive manner.

Chapter 5 Diagnosis and Analysis of the Outpatient Process

This chapter consists of two parts. In the first part, the data source and the statistical approach are introduced while measuring the satisfaction rate of patients for the outpatient process in the University of Hong Kong-Shenzhen Hospital. We adopt on-the-spot random sampling to conduct an on-the-spot questionnaire survey which lasted for a month in the hospital. The survey collects patients' basic information, their overall satisfaction with the outpatient process and scores of evaluating each survey item. The professional statistical analysis software SPSS 15.0 is used for data analysis so as to master the basic distribution of survey items. In the second part, the structural equation modeling is established to analyze the effects of basic factors on the degree of satisfaction of patients for the outpatient process. AMOS7.0 (Analysis of Moment Structures 7.0) is used to establish the structural equation modeling, on the basis of which the parameter estimation and related test analysis are carried out. AMOS7.0 is a professional structural equation modeling to explore the relationship among variables. To ensure that the model can better fit data, we optimize and revise the model and draw standardized coefficient path graph. Through the analysis of the direct and indirect effect of key variables on the satisfaction degree, the current "bottleneck problem" in the hospital's outpatient process is found finally and reasons for the obstacles in the present outpatient process are summarized.

5.1 Satisfaction Degree Measurement for the Outpatient Service in the University of Hong Kong-Shenzhen Hospital

5.1.1 Data Source and Statistical Approach

(1) Purpose and Object of the Survey

In order to know the needs of patients and the status quo of the process of outpatient business, we conducted a random sampling of questionnaires from April to May in 2014 among patients who went to the hospital for treatment. The survey is an

on-the-spot questionnaire survey, meaning that the patients will anonymously have a self-administered questionnaire survey on the spot. Clerks of the IT department gave questionnaires to the patients who had finished treatment, who were ready to leave the hospital and who were waiting in the waiting room, the injection room, and the clinical laboratory. Questionnaires were collected when patients finished them.

Out of 1500 sending questionnaires, 1322 have been collected, with an effective rate of 88.3%. According to the statistical validity and reliability tests, the survey data is valid. Therein to, the reliability coefficient of questionnaires is 0.917, greater than 0.8, thus they are of high validity and reliability.

(2) Content and Approach of the Survey

The questionnaire is designed by our own. After a pre-survey test, the questionnaire is proved to be of relatively high reliability and validity. The questionnaire consists of three parts. In the first part patients' basic information is introduced, including their gender, age, marital status, profession, education degree, place of residence, category of payment and their family's monthly income, which is designed for collecting basic information of patients so as to classify and compare;. The second part includes 24 items, including appointment registration, communication between doctors and patients, medical cost, medical effect, hospital signs, service attitude, hospital environment, hospital hygiene and waiting time in each link of treatment. Based on variables of satisfaction survey, this part aims to let patients respond to each item and get score of each patient's attitude with cumulating method. The average score of all the patients can indicate the overall attitude of investigators. Each item adopts Likert-type six-level scale method. From the negative to the positive, number 1, 2, 3, 4, 5 and 6 respectively correspond to very dissatisfied, not very satisfied, a little dissatisfied, a little satisfied, quite satisfied and very satisfied. The answer of each item will no longer be confined to "Yes" or "No", instead, it will be divided into several types, ranging from "satisfied" to "dissatisfied" and the medium term of which is neutral. Owing to increasing types, it can fully embody the difference of patients' attitude. The third part contains open questions which patients need to answer to make suggestions for the hospital's outpatient work

and to give recommendations for improvement.

A total of 1322 questionnaires are distributed in this survey. After statistical validity test and reliability test, the data proves to be valid. Since the reliability coefficient of the scale is 0.917, which is greater than 0.8, the questionnaire is considered to be of relatively high validity. After calculating statistics, the overall degree of patients' satisfaction of the hospital is 83.13 points.

(3) Statistical Approach

The data from the collected questionnaires are entered through Epidata platform, issued by EpiData Association from Denmark, analyzed by SPSS 15.0 and AMOS7.0 is used to analyze variables through structural equation modeling. Besides, statistical approach such as descriptive statistics analysis and Wilcoxon rank sum test are also used.

Generally, questionnaires are analyzed by the following methods:

a. Descriptive Statistics Analysis

The description of samples' basic information is included as well as the frequency distribution and percentage analysis so as to understand the distribution of sample. Generally, a descriptive analysis of the data is conducted at first to find the inner law and then further analysis approach is adopted. Descriptive analysis can be used to analyze all the relevant data of variables in the survey population, mainly including frequency analysis, central tendency analysis, dispersion degree analysis and distribution of the data as well as statistical graphics. Common indicators include mean value, median, mode, variance and standard deviation.

b. Cronbach's Reliability Coefficient Analysis

Reliability refers to the consistency, stability and dependability of test results. Generally the level of reliability is indicated by inner consistency. The higher the reliability coefficient, the more consistent, stable and dependable the result is. Besides, analyzing measured items of variables can shed light on the inner consistency of the measurement dimension. In addition, when Cronbach's is higher than 0.7, its reliability is high and when Cronbach's is lower than 0.7, its reliability is low. And the

lowest acceptable reliability level is 0.5.

c. Exploratory Factor Analysis and Confirmatory Factor Analysis

Exploratory factor analysis and confirmatory factor analysis is used to test the convergent validity and discriminant validity of measured items in each dimension. Reliability alone is not enough because a high reliable measurement may probably turn out to be completely invalid or invalid to some degree. Therefore, taking a validity test is necessary. Validity refers to whether tools can get the expected result when they are designed. The convergent validity test is decided by the capacity of each item and measured concept factors. And discriminant validity test is to calculate the correlation index of related concepts according to confirmatory factor analysis to test whether 95% of confidence interval of correlation index includes 1.0. If not, it can be regarded to be discriminant valid.

d. Structural Equation Modeling Analysis

Structural equation modeling combines factor analysis with path analysis and incorporates simultaneous equations in econometrics. Therefore, several variables can be dealt with simultaneously. Moreover, measurement errors of independent and dependent variables are allowed and the factor structure and the factor relation can be estimated at the same time. Measurement model of greater flexibility is allowed and the fit degree of the overall model can be estimated so that it can be applied to the causal relationship of the overall model. In the estimation of the model parameter, maximum likelihood (ML) estimation is adopted. While testing the fit degree, indicators of preliminary fit criteria, overall model fit and fit of the model's internal structure are used as criteria. As for the criteria of overall model fit, chi-square/df value, GFI, RMSR, and RMSEA are used as indicators to study whether the estimated parameters reach a significant level.

5.1.2 Analysis of Statistical Results

(1) The basic information of patients (Note: This part is mainly to have a descriptive statistical analysis for A1-A11 of the first part in order to make readers get an overall understanding of the basic information of the present treatment in the

University of Hong Kong-Shenzhen Hospital. And the distribution of scores of each sub item is also been shown. For example, a preliminary judgment is arrived at, saying that the main reason for patients to choose this hospital is its reputation and the advanced medical skill of doctors while other factors are minor reasons.)

The basic information of the surveyed patients is shown in Table 5-1. According to the data of A9, we found that 34.3% patients go to the University of Hong Kong-Shenzhen Hospital for the first time and 65.7% patients go there for more than two times. Therefore it can be seen that the surveyed objects are mainly patients who go to the hospital repeatedly. Therefore, their evaluation of the hospital is stable and there is less error in data. According to questionnaires, the main reason for patients to choose the hospital is its reputation and the advanced medical skills of doctors, respectively accounting for 53.8% and 33.7% in all reasons, followed by simplified treatment process, advanced medical technology and equipment and good service attitude, respectively accounting for 22.4%, 16.5% and 12.7%.

Table 5-1 Basic Information of Surveyed Outpatients

Item	**Percentage (%)**	**Item**	**Percentage (%)**
A2. Gender		**A6. Education degree**	
Male	43.8	Master and above	9.6
Female	56.2	University and College diploma	58.3
A3. Age		Technical Secondary School, Secondary Technical School and Senior High School	10.9
Under 18	13.8	Junior High School	7.2
Between 18 and 25	10.9	Primary School and below	14
Between 26 and 35	14.1	**A7. Place of residence**	
Between 36 and 45	42.6	Districts Inside Shenzhen Special Economic Zone	68.2
Between 46 and 55	7.4	Districts Outside Shenzhen Special Economic Zone	26.4
Between 56 and 65	6.8	Districts Outside Shenzhen	5.4
66 and above	4.4	**A1. Clinical Departments**	
A4.Marital Status		General Practice Outpatient	21.7
Single	22.3	Internal Medicine Department	15.3
Married	74.8	Surgical Department	5.1
Divorced or Separated	2	Obstetrics and Gynecology Department	3.5
Widowed	0.9	Department of Pediatrics	19.4

Source: The author

Table 5-2 Basic Information of Surveyed Outpatients

Item	**Percentage (%)**	**Item**	**Percentage (%)**
A5.Profession		**A1. Clinical Departments**	
Civil Servants/Administrative Staff/Staff Member	32.3	Department of Orthopaedics	2.9
Worker/Service Staff	13.2	Department of Ophthalmology	4.1
Teaching/Research/Doctor /Lawyer and other Professionals	9.8	Department of Stomatology	1.9
Farmer	4.3	Department of Rheumatism	2.2
Private Owner	8.7	Department of Dermatology	11.9
Housewife	13.5	Department of Urology	2.7
Student	6.6	Physical Examination Center	9.3
Retirement Personnel	7.4		
Unemployed	4.2		
A8.Payment method		**A11. Family's monthly income**	
At one's own expense	55.6	Below 1000 yuan	4.2
At public expense	19.5	Between 1000 to 1999 yuan	10.3
Partially at one's own expense and partially reimbursing	24.9	Between 2000 and 2999 yuan	11.1
		Between 3000 and 3999 yuan	25.3
		Between 4000 and 4999 yuan	24.7
		5000 yuan and above	24.4

Source: The author

(2) Overall satisfaction (Note: This part is mainly to give a statistical analysis for B24 of the second part so that readers can comprehensively understand the current scores of overall satisfaction with the University of Hong Kong-Shenzhen Hospital and the percentage which the score of each dimension occupies can be seen clearly in the six-point scale.)

From the statistical data of the medical service, we can find that according to scores of the overall assessment, currently scores given by patients for outpatient services range from 50 to 100. The average score is 83.13. Table 5-2 gives the specific information. Patients who are satisfied with the outpatient service account for 77% and patients who are a little dissatisfied account for 23%.

Table 5-3 Overall Satisfaction with the Outpatient Service

Degree of Satisfaction	**Number of People**	**Percentage (%)**
Very satisfied	216	19%
Quite satisfied	303	27%
A little satisfied	362	32%
A little dissatisfied	153	13%
Not very satisfied	67	6%
Very dissatisfied	34	3%
Σ =	1135	100%

Source: The author

(3) Evaluation of each medical service item (Note: This part is mainly to analyze the mean and variance for B1-B23 in the second part. From the mean value of each sub item, the present deficiency of outpatient service can be known. The value of variance represents the degree of dispersion of the scores of each sub item. The bigger the value is, the higher the dispersion degree is. The smaller the value is, the more centralized the data is. The conclusion drawn from data in this part fairly coincides

with outpatient services' problems which are mentioned by interviewees in the previous interviews.)

We rank the scores from high to low, as is shown in Table 5-3. From the table, it can be seen that patients' faith in the hospital rank the highest (B23 gets an average score of 4.52), followed by the evaluation of the hospital's environment (B20 gets an average score of 4.47). The evaluation of medical personnel's service attitude is at an average level while the evaluation of waiting time for having laboratory test and obtaining medicine gets the lowest score.

Table 5-4 Scores of the Outpatient Service Items

No.	Name for Variables	Items of Satisfaction Survey	Mean	Variance
1	B23	Will you choose our hospital for treatment again?	4.56	0.86
2	B20	Are you satisfied with the environment of the hospital and feel comfortable in the hospital?	4.48	0.66
3	B19	Are you satisfied with the sanitary conditions of the hospital?	4.31	0.74
4	B5	Are you satisfied with the technical level for general practitioners in our hospital?	4.21	0.62
5	B6	Are you satisfied with the diagnosis and treatment of the attending doctor?	4.09	0.71
6	B2	Are you satisfied with the patience shown by medical guidance personnel when they answer your questions?	3.96	0.79
7	B21	Are you satisfied with the sign and guidance system of our hospital?	3.91	0.78
8	B7	Are you satisfied with the attitude when the attending doctor asks about your illness, examines and treats you?	3.78	0.73
9	B1	Are you satisfied with the service of the registration system of our hospital?	3.72	0.6
10	B15	What do you think of the one-time charge which contains the entire fee for general practice?	3.69	0.91
11	B12	Are you satisfied with the service of the personnel in the clinical laboratory?	3.64	0.72
12	B14	Are you satisfied with the service of the personnel in the pharmacy?	3.58	0.65
13	B9	Are you satisfied with the privacy protection of our hospital for you?	3.52	0.77
14	B16	Are you satisfied with the waiting time to go to the dispensary?	3.47	0.64
15	B3	Are you satisfied with the waiting time n front of the triage station?	3.36	0.74
16	B18	Are you satisfied with the treatment outcome?	3.24	0.8
17	B4	Can you choose your doctor according to your own will?	3.16	0.79
18	B8	Does the doctor respect your opinion when choosing the therapeutic schedule?	3.05	0.67
19	B22	Do you think that the cost you paid can do justice to the medical treatment you get?	2.94	0.84
20	B17	Are you satisfied with the service of the personnel in the cashier?	2.92	0.91
21	B10	Are you satisfied with the waiting time to have a test (such as routine urine test and blood routine examination)?	2.9	0.83
22	B11	Are you satisfied with the waiting time to have a test (such as B ultrasonic and CT)?	2.72	1.09
23	B13	Are you satisfied with the waiting time to take medicine?	2.51	1.16

Source: The author

5.2 Model Establishment to Analyze Factors Influencing Patients' Satisfaction with the Outpatient Service

5.2.1 Comparison among Traditional Data Analysis Methods

Traditional data analysis method includes linear correlation analysis, linear regression analysis and structural equation modeling analysis. Their differences are described as follow:

Linear correlation analysis: Linear correlation analysis indicates the statistical relation between two random variables. Both variables are equal, and there is no difference between dependent variables and independent variables. Therefore, correlation coefficient can not reflect the causal relationship between the single index and the totality. In linear regression, correlation coefficient only indicates the degree of correlation. However, when the significance of the independent variable towards the dependent variable is not obvious, this shows that the independent variable has little effect on the dependent variable so that a new variable which is more closely related to the dependent variable can be considered to replace the previous one. Or when there are several independent variables, stepwise regression can be used to extract the independent variable which is most correlated with the dependent variable.

Linear regression analysis: Linear regression analysis is more complex than linear correlation analysis because it defines the independent variable and the dependent variable in the model. However, it can only provide the direct effect among variables but cannot show the indirect effect. And co linearity can lead to unexplainable data and result. For example, negative correlation appears between the single index and the totality. Unitary linear recursive analysis is to establish the linear regression equation of X and Y based on the correlativity between the independent variable X and the dependent variable Y and to make predictions. Because a phenomenon is often related with multiple factors, the optimal combination of multiple independent variables is thus used to jointly predict or estimate dependent variables for it is more effective and practical than using only one variable. As a result, multivariate linear regression is

more practical than unary linear regression. In the multivariate linear regression, those variables which are not significant to dependent variables will be eliminated automatically. If the simple correlation analysis is not accurate, it is possibly because that there is colinearity among variables so that single variables correlate. But in multivariate regression analysis, some variables are eliminated, the regression equation can be used and those variables which are not significant cannot be used.

Structural equation modeling analysis: Structural equation modeling is a method which is used to build, estimate and test the causal model. The model not only contains overt variables which are observable, but also latent variables which are not observable. Structural equation modeling analysis can replace multiple linear regression, path analysis, factor analysis method, and analysis of covariance. It can clearly analyze the effect of single index on the whole and the correlation among single indexes.

Put it simply, different from traditional regression analysis, structural equation analysis can deal with multiple dependent variables simultaneously and can compare and evaluate different theoretical models. Different from the traditional exploratory factor analysis, in structural equation modeling we can come up with a specific factor structure and examine whether it fits data. Through the multiple-group analysis of structural equation, we can find whether variables in different groups remain unchanged and whether there is a significant difference in the mean value of each factor.

At present, there are several kinds of software that can deal with SEM including LISREL, AMOS, EQS and Mplus.

5.2.2 The Features and Advantages of Structural Equation Modeling

Structural Equation Modeling (SEM), one form of multivariate statistic technology, combines the statistic technologies of factor analysis and path analysis to comprehensively analyze the relationship and strength between different variables on the basis of covariance matrix of variables (Schumacker, Lomax, 2004). The advantage of SEM is that it can effectively study the interactive relationship between

different variables and it can be used to verify the interactive relationship between one or multiple variables and another or other variables. In the past decade, SEM was widely applied in many areas and has become a useful quantitative tool in social science research. When the relationship between various reasons and results needs to be analyzed, or when latent variables need to be processed, SEM serves as an effective method, because in social science there exist a lot of variables which cannot be observed or measured directly. Most of these variables are hypothetical concepts and notions which are used to understand or study issues. Therefore there are no effective measurements for these variables. However, some observable variables can be found and used as substitutes for latent variables, for there exist a lot of observational errors in the observation and signs of latent variables. Compared with traditional multivariate statistic technologies, SEM has the following advantages:

(1) Multiple dependent variables can be taken into consideration and processed simultaneously

SEM can take multiple dependent variables into consideration and process them at the same time. In regression analysis or path analysis, multiple dependent variables are displayed in statistical charts, but all dependent variables are calculated individually in the calculation of regression coefficient or path coefficient. Therefore, even though statistical charts can show multiple variables, the existence and influence of other dependent variables are often ignored in the calculation of the influence and correlation between variables.

(2) Measurement errors in independent variables and dependent variables are allowed.

Some variables which have errors cannot be simply measured by only one indicator, but SEM allows for certain measurement errors in all variables. The correlation coefficients calculated by traditional statistical methods vary a lot from those calculated by SEM.

(3) Factor structure and factor relationship can be estimated simultaneously

To figure out the relationship among latent variables, the traditional statistical

method is carried out in two separate steps: first use factor analysis to calculate the factor score of every latent variable, which serve as the observed value of latent variables, and then the correlation coefficient is calculated. While in SEM, factors and the relationship among factors can be considered and calculated simultaneously.

(4) More flexible measuring modeling is allowed.

SEM is more flexible than traditional methods because its indicator variable can belong to or reflect multiple latent variables, while traditional factor analysis method cannot handle such a complex affiliated relationship.

(5) The fitting of the entire model can be estimated

In the traditional path analysis, the relationship among variables can be defined clearly. While in SEM, besides estimating the relationship, the overall fitting of different models for the same sample data can also be calculated so as to judge which model has a better fitting.

Due to the above mentioned advantages of SEM, the measurement errors of latent variables can be allowed. As a result, SEM has certain advantages if it is applied to studying satisfaction factors.

5.2.3 Constructing Structural Equation Modeling

SEM can be divided into two models: Measurement Equation and Structural Equation. The expression is as follows:

(1) Measurement Modeling: it is used to describe the relationship between measurement variables and latent variables. The mathematical expression is as follows:

$$\mathbf{X=U_x\xi+\delta}$$

$$\mathbf{Y= U_y\eta+\varepsilon} \qquad (5.1)$$

The meanings for the above mentioned mathematical expressions are as follows:

ξ represents exogenous latent variables. They serve as independent variables and remain unchanged regardless of influences from other variables in the model.

η represents endogenous latent variables. They change accordingly with the

change of other variables in the model.

X represents vectors made up of exogenous measurement variables.

Y represents vectors made up of endogenous measurement variables.

U_x represents the rotated component matrix of exogenous measurement variables in exogenous latent variables.

U_y represents the rotated component matrix of endogenous measurement variables in endogenous latent variables.

δ is the error item, which is caused by exogenous measurement variable X.

ε is the error term, which is caused by endogenous measurement variable Y.

(2) Structural Modeling: it is used to reflect the relationship between latent variables. The mathematical expression is $\boldsymbol{\eta=B\eta+\Gamma\xi+\zeta}$.

(5.2)

The meanings for above mentioned mathematical expressions are as follows:

B represents the interaction among endogenous latent variables.

Γ represents the effect and influence of exogenous latent variables upon endogenous latent variables.

ζ is the error term of structural equation.

Coefficient matrix composed of B and Γ as well as error vector ζ serve as the link between endogenous latent variables and exogenous latent variables,

In this research, AMOS7.0 (Analysis of Moment Structures) is used to construct structural equation modeling and to carry out parameter estimation and relevant test analysis. This software can utilize path graph to customize models and use mapping tools to change path graph so as to change models. It can also graphically display parameter estimation and fitting measurement as well as display the degree of freedom at any time of mapping in the path graph. In this software, the rectangle represents measurement indicators. The oval represents latent variables, which cannot be measured directly. The circle represents residual error. Double arrow indicates correlation and single arrow represents cause and effect. Exogenous latent variables do not have residual errors while endogenous latent variables have these errors.

The graphic interface provided by AMOS is used to map out the causal relationship path graph. In mapping, it is supposed that the corresponding factor for every latent variable in the measure indicator is 1. That is to say, the unit of measurement for latent variables and the corresponding measure indicators are the same. It is also supposed that the default value for system error of observed variables is 1 and at least one path coefficient for measure indicators has 1 as its initial value. Moreover, AMOS7.0 will automatically set 1 as the value for the path coefficient, which is one measure indicator of the same latent variables. After the parameters of causal relationship path graph are set, the result can be obtained through the following steps:

Step 1: Choose the data file and connect the model with data. Under the File menu, choose "Data File" and name the file which needs to be analyzed;

Step 2: Find the data file. Through this button find the data which is already edited;

Step 3: List the variables. Find a series of variables though the button, such as service attitude, service value, waiting time and patient satisfaction which is mentioned in the study; variable summary can show the number and content of endogenous variables, exogenous variables, and unobserved, exogenous variables. Click Variable Counts then the number of each variable can be seen.

Step 4: Analyze attributes. Before calculating the needed parameters through AMOS, the parameters must be designed beforehand.

Step 5: Calculate, estimate and map out path graph. Click this button and then the needed parameters can be calculated. Under the Diagram menu, choose "Draw Observed" to map out observed variables and choose Draw Unobserved to map out unobserved variables (which are referred to as residual error terms in the path graph). Choose Draw Path to map out the cause and effect relationship between these two variables. Choose "Draw Covariance" to map out the correlation between them.

Step 6: View model. Click this button, and the path parameter and covariance for each variable can be viewed. After the residual term is chosen, click the right button to choose "Object Properties" and set 1 as the variance in "Parameters". Then choose

Analysis Properties in the View/Set menu. Choose "Scale-free Least Square" as the estimation method on the Estimation page. Click "Calculate Estimates" in the Model-Fit menu to calculate path parameters. But the result has not been standardized in this step. Click on View Text to get statistical results.

It is estimated that there exist four latent variables in this model, namely, service attitude, service value, waiting time and patient satisfaction. Explanation and definition for the four variables are as follows:

a. Service attitude: it is defined as the level of patience, conscientiousness and respect of outpatient medical staff for patients

b. Service value: it is defined as the expertise of medical workers, the curative effects, the rationality of medical service charge, and the sanitary environment of hospitals.

c. Waiting time：it is defined as the queue time and order of patients throughout the outpatient process.

d. Patient satisfaction: it is defined as the overall satisfaction rate of patients towards the outpatient service in the hospital. The satisfaction rate is influenced by the above-mentioned three variables.

The author used 24 constructs from B1 to B24 to measure the above mentioned four variables. Among them, the corresponding variables for patient satisfaction are patient loyalty and overall evaluation score. Variables from e1 to e24 represent the measurement errors caused by measurement variables. Variables from zate1 to zate3 represent the error for endogenous latent variables.

The fitting situation for the model is shown in Table 5-5. The indicators of the fitting effect show that P value which is corresponded by chi-square has certain statistical significance. Click "Notes for Model" in the left catalogue of software, computation of degrees of freedom can be checked and the result is 1. Besides, the result of chi-square can be calculated. The degree of freedom is 1 and the probability value is 0.672, which is higher than the threshold value 0.05. As a result, null hypothesis is accepted and the model is considered to be appropriate. The ratio of

chi-square to the degree of freedom is more than 2. The values for GFI, AGFI and CFI are all less than 0.9. The value for RMSEA is more than 0.08. Generally speaking, GFI value should be more than 0.9 while RMR value and RMSEA value should be less than 0.05 and the smaller the value the better. Therefore this indicates the fitting between data and model is not ideal and this model should be revised. Usually fitting indicator RMSEA (root mean square error of approximation), which is very sensitive to error model, is a relatively ideal indicator and the smaller its value is, the better. When its value is less than 0.08, it shows good fitting. By comparison, it is better for the values of GFI (goodness of fit index) and AGFI (adjusted goodness of fit index) to be large. The value of NFI (normed fit index) ranges from 0 to 1. When it surpasses 0.9 the model is acceptable and the nearer the value is towards 1, the better.

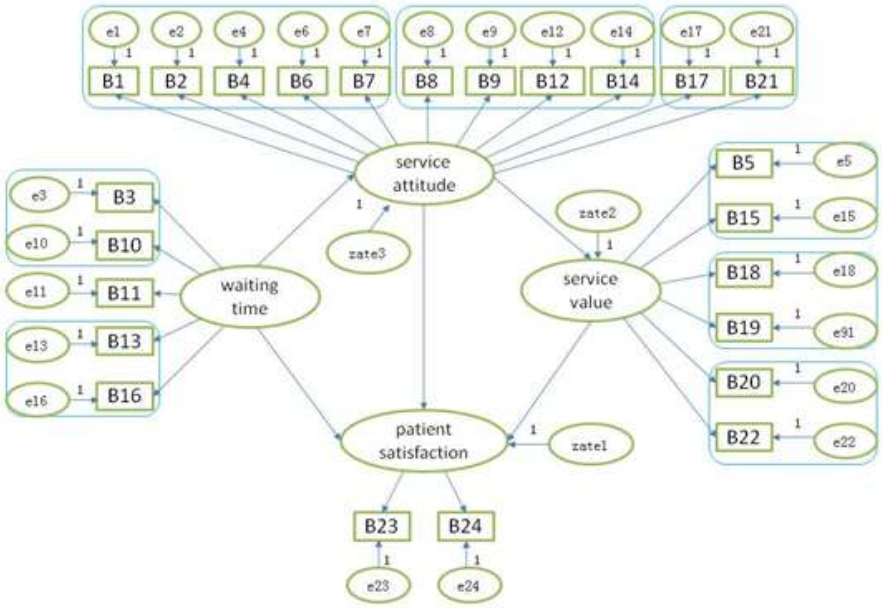
In the estimation of regression coefficient, except that the regression coefficient P value for wait-＞satisfaction，attitude-＞B4，wait-＞B3 does not have statistical significance, other regression coefficient reaches more than 95% in the hypothesis testing of significance. Click estimates-scalars-regression weights in the software, non-standardized regression coefficient can be estimated and its test of significance can be carried out. Besides, the estimated value, standard error, cr value (critical ratio) and statistical significance can also be shown. Whether non-standardized regression coefficient is meaningful is determined by whether P value is significant (three asterisks indicate that the value is significant). Insignificant path needs to be removed in the model revising process afterwards.

Table 5-5 Fit Measures

	CMIN	DF	P	RMR	GFI	AGFI	NFI	RFI	CFI	RMSEA
Default Model	367.194	149	0.000	0.079	0.81	0.786	0.859	0.832	0.897	0.105

Source: The author

Figure 5-1 Causal Relationship Path Graph



Source: The author

5.2.4 Revision of Structural Equation Model

After an analysis of the theoretical model, the relationship between measured variables and latent variables is found to be clear. After a check on correction factors, the M.I value between e7 and e15 is found to be the largest, namely 15.426. If the correlation between the two variables is strengthened, Chi-square value will at least decrease to 15.426. Therefore, it can be concluded that there is a strong relationship between these two variables. In the path diagram of causal relationship, if we strengthen the correlation of measurement errors between e7 and e15, we can get a revised model.

Since the path coefficient often is often greater than 1 before standardization, a standard estimation must be carried out. Click on and check Model Estimation Value, we can see the coefficient for the model. Click on “Standard Estimate Value” in the software, the standardized estimation value will appear. The standardized regression coefficient can be found in the path diagram and the number above the arrow is the relevant coefficient. Click on Estimates→Scalars→Standardized Regression Weights,

the estimated value for standardized regression coefficient can be found. If there is nothing wrong with this model, all the values should be between -1 and 1. Click on Estimates→Scalars→Covariance, we will see a figure. This figure shows the covariance and the significance testing of the three exogenous variables. If the P value is smaller than 0.001, there will appear three asterisks.

The fitting situation of the revised model is shown in table 5-6, from which we can see that the new model is better matched with the data. Besides, the revised Chi-square value of significance is p=0.00. The ratio of Chi-square to the degree of freedom is 2.06, slightly larger than 2.0. But the RMSEA value is 0.057, far less than 0.08. The values for GFI, NFI, and CFI are all greater than 0.9 while the values for AGFI and RFI are all smaller than 0.9. This proves that the revised model are better matched with its data compared with the previous one. The reason why the Chi-square value of significance is 0 is probably connected with the abnormal distribution of the data. After an analysis of regression coefficient, it is found that, except the P value for attitude- ＞ B4, which does not have statistics significance, other regression coefficients are all greater than 95% in the hypothesis testing of significance.

Table 5-6 Fit Measures

	CMIN	DF	P	RMR	GFI	AGFI	NFI	RFI	CFI	RMSEA
Default Model	288.163	128	0.00	0.067	0.903	0.853	0.914	0.856	0.909	0.057

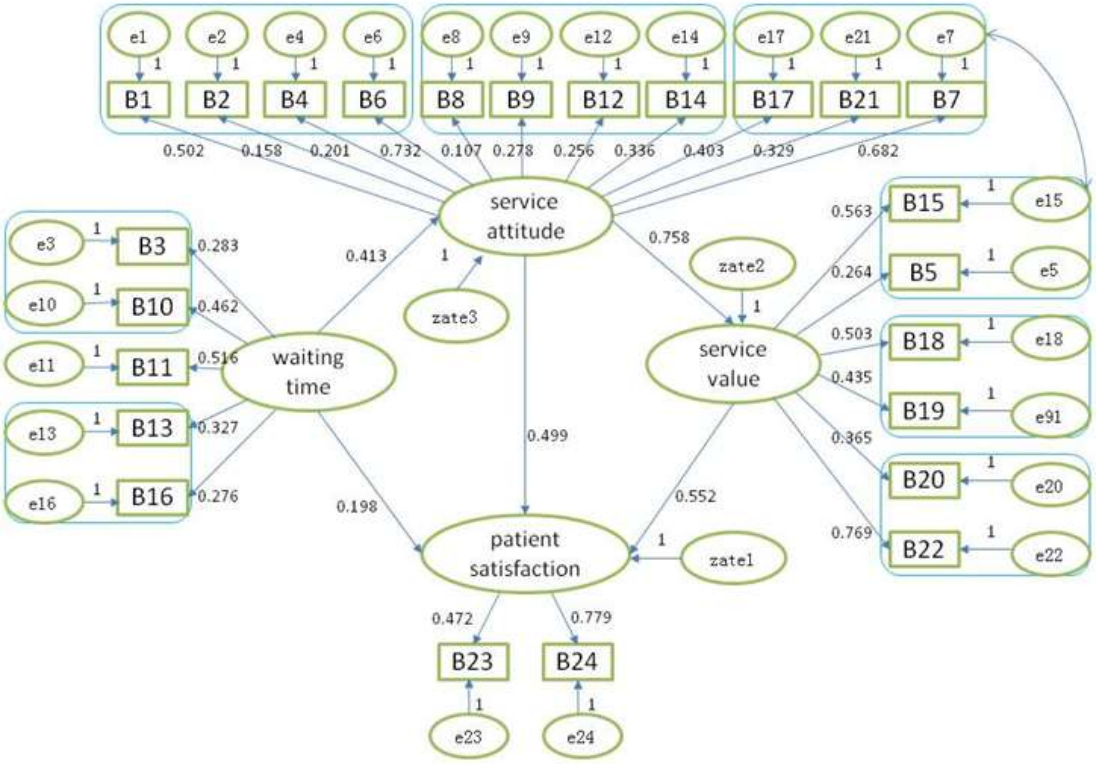
Source: The author

5.2.5 Analysis of the Correlation between Variables

Through the standardized coefficients of variables in the output model of AMOS7.0, the correction and the degree of correlation between different variables can be found out. In this way, it is easier to figure out which factors are the bottleneck that influences patients' satisfaction and then help to make efficient improvement plans. In the software, the covariance between two variables can be shown in sample moments. Click on it then the relevant coefficient matrix can be checked, such as the

correlation coefficient between service value and patient satisfaction rate, correlation between service attitude and patient satisfaction and correlation between waiting time and patient satisfaction. Click on Estimates → Scalars → Correlations, the estimation for relevant coefficients can be seen. The coefficients between different latent variables can be shown in Figure 5-2. The standardized coefficient distribution in the revised model is also shown in Figure 5-2.

Figure 5-2 The Standardized Coefficient Distribution Map after Revision



Source: The author

(1) Correlation Analysis of Latent Variables

The coefficient between latent variables means that the change of one variable will cause the change of another variable. This degree of the influence is reflected in the correlation coefficient. From figure 5-2 we can see that:

a. The coefficient of influence between service value and patient satisfaction is 0.552. This shows that an addition or improvement of 1% in service value will

directly lead to an increase of 0.552% in patient satisfaction.

b. The direct influence coefficient between service attitude and patient satisfaction is 0.499. The indirect influence coefficient which is caused by service value is 0.758×0.552=0.418. Therefore the total influence coefficient is 0.499+0.418=0.917.

c. The direct influence coefficient between waiting time and patient satisfaction is 0.198. The indirect influence coefficient caused by service attitude is 0.413×0.917=0.379. Therefore the total influence coefficient is 0.198+0.379=0.577.

As a result, the three variables of service attitude, service value and waiting time have a huge influence on patient satisfaction, especially service attitude, for its coefficient of influence reaches 0.917. Waiting time alone does not have a significant influence on patient satisfaction (its direct influence coefficient is only 0.198). But if the indirect influence caused by service attitude is also taken into consideration, the influence coefficient will become 0.577, which deserves the attention of the hospital.

The scores for latent variables are shown in Table 5-7. It can be seen that patients give the highest score for service attitude and the next highest score for service value while give the lowest score for waiting time. Therefore, reducing the waiting time is the key to making patients more satisfied.

Table 5-7 Scores for Latent Variables

Latent Variables	**Measurement Variables**	**MEAN**	**SD**
Service value	B5、B15、B18、B19、B20、B22	3.45	0.43
Service attitude	B1、B2、B4、B6、B7、B8、B9、B12、B14、B17、B21	3.68	0.40
Waiting time	B3、B10、B11、B13、B16	2.91	0.52

Source: The author

(2) Analyzing the Correlation between Measurement Variables and Latent Variables

The correlation between "service value" and the price/performance ratio of

medical service is the closest, with the correlation coefficient reaching 0.769. The next closest correlation is between inspection fees and therapy effectiveness. Although service value is also related to general doctors' medical expertise as well as hospitals' environment, comfortableness and sanitary conditions, the degree of correlation is not significant.

The correlation between service attitude and physicians' diagnosis and treatment is the closest, with the correlation coefficient reaching 0.732. The degree of conscientiousness of doctors, namely their work attitude while examining and treating patients, has the second closest correlation with service attitude, with the correlation coefficient reaching 0.682 What's more, patients' satisfaction level towards appointment service, pharmacy staff's service, hospital cashiers' service and hospital guidance system have the third closest correlation with service attitude, with each correlation coefficient reaching more than 0.3. Data shows that the attitude of hospital patient guide while answering questions, patients' choice of doctors according to their own will, doctors' respect for patients while choosing treatment protocols, protection of patients' privacy, the attitude of staff in the Medical Examination Department are also correlated with service attitude. But the degree of such correlation is not significant, with the correlation coefficients all below 0.3.

Waiting time is most closely related to medical examination, laboratory test and medicine dispensing wait, with the correlation coefficients reaching 0.516, 0.462 and 0.327 respectively. But waiting time has a weak correlation with queuing and waiting for triage and waiting to pay fees, with the correlation coefficients both below 0.3. After a comparison of all correlation coefficients' values, it can be known that the waiting time for medical examination, laboratory test and medicine dispensing is relatively long and can significantly influence patients' satisfaction. This should be given priority in process optimization. Though patients have to wait for a long time to get treatment, it does not have a huge influence on patients' satisfaction, which is probably because patients have the lowest expected value or the highest degree of tolerance towards waiting to be treated.

5.2.6 The Influence of Basic Factors on Outpatient Service Satisfaction

Given that the normality of the survey data could not be guaranteed, we decided to conduct Wilcoxon rank sum test to analyze the influence of some basic factors, such as gender, occupation and age on outpatient service satisfaction. As a result, it is found that factors such as gender, age, payment method and clinic department will significantly influence outpatient service satisfaction. The conclusions are as follows:

a. Male and female have quite different comments on service attitude and waiting time. To be specific, comments from male are much higher than that of female.

b. Age also has certain influence on the satisfaction of service attitude and waiting time. Specifically, people at the age of 36 to 45 give the highest comments while people who are 46 to 55 years old produce the most negative comments. Furthermore, the older people give the higher comments on waiting time.

c. Payment method also has certain influence on customer loyalty. To be specific, patients with medical insurance that covers part of their medical costs rank the first in terms of loyalty, while patients enjoying free treatment or medical insurance that covers all the costs rank the second, with patients who seek for medical treatment at their own expense ranking the last.

d. Clinic department is also a factor that influences the length of waiting time. We found that the waiting time for treatment in Departments of Gynecology, Obstetrics and Pediatrics is much longer than that in other departments. Therefore, the hospital should focus on the Departments of Gynecology, Obstetrics and Pediatrics while improving its process.

5.3 Analysis of Problems in Outpatient Service Process

In terms of improving hospital outpatient service process in the interests of patients, we hold that there are mainly three medical service processes closely related to the interests of patients, including departmental treatment, test and examination and diagnosis and treatment. Since the improvement of other processes such as

registration, triage of treatment, payment and drug dispensing cannot bring significant benefits to patients, they are defined as non-value-added process. Therefore, the optimization of process can be carried out by reducing, integrating and simplifying the non-value-added processes while ensuring the normal operation of the above-mentioned three processes.

According to the revised Figure 5-2 of standardized coefficients distribution, the waiting time required in different processes has different effects on patient satisfaction, which can be ranked from large to small as follows: examination (B11), testing (B10), drug dispensing (B13), triage of treatment (B3) and payment (B16). Their corresponding coefficients of relationship are 0.516, 0.462, 0.327, 0.283 and 0.276. Hence, reducing the waiting time of examination, testing and drug dispensing can efficiently improve patient satisfaction.

After an analysis of the current outpatient service process, the source of inefficiency has been found, and can be summed up into the following aspects:

(1) The overly subdivided departments and the lack of medical information sharing result in a poorly-organized and discontinuous outpatient process. Due to the over-subdivision of functions, patients have to go back and forth between different departments, leading to the great mobility of patients within the hospital. Currently, some consulting rooms, pharmacy, examination department and testing department are even located in different floors. When a doctor ask his or her patient to have a laboratory test, the patient has to go out of the consulting room, find the medical laboratory with the test report, and then receive the testing. After the test, the patient has to wait for the result, go back to the consulting room again, ask the doctor to prescribe medication and pay for the fee. Only after the above processes are finished can the patient get the medicine. The outpatient process is even more complicated when the patient needs to be transferred to another hospital or the patient needs to visit different departments. Besides, the lack of information sharing will also result in poor coordination and connection between different departments in their business. For example, since a doctor knows nothing about the inventory of medicine when he or

she prescribes, only when the patient goes to the cashier does he or she know that the medicine in the prescription has been sold out. Then the patient has to return to the consulting room to ask the doctor to change the prescription. Such situation occurs from time to time in the hospital, not only increasing the mobility of patients between the consulting room and cashier, but also affecting the orderliness and continuousness of the process.

(2) The unreasonable architectural layout of the outpatient service leads to the increase of patients' mobility and waiting time. In fact, the layout of medical technology building and departments will directly influence the efficiency of process. For example, the lack of signs in hospital or the overly small font size of characters on signs will further increase patients' mobility and waiting time in different service processes. Besides, nurses for medical guidance, knowing little about the categories of diseases due to the lack of training, cannot provide efficient service for patients. Furthermore, the location of some departments such as Orthopedics Department and Obstetrical Department are not well-designed in the architectural layout. The Orthopedics Department is located on the second floor while obstetrical department on the third floor, posing great difficulties for patients to move around.

(3) Medical and health resources are insufficient and unevenly distributed. Although a comprehensive outpatient appointment system has been established in the hospital for the consultation process, the number of medical staff and examination equipments still cannot meet the needs of patients, since the hospital has been opened only for a short time. In light with the increasing number of outpatients, a further expansion of the hospital must be carried out. Besides, the comparatively uneven distribution of medical resources also leads to the uneven mobility of patients in different departments to some extent. As analyzed in the last chapter, Gynecology and Obstetrics Department, Dermatological Department and Pediatrics Department of the hospital receive most patients. However, doctors in Dermatological Department are comparatively insufficient.

5.4 Summary

This chapter studies and analyzes the current situation of outpatient service process of HKU-SZH. What's more, the patient satisfaction of this hospital is also measured through field questionnaire and interviews. Totally, there were 250 patients of the hospital taking part in the survey anonymously. In this survey, patient satisfaction was evaluated according to the 6 grade scale. A validity test has also been carried out on the reliability coefficient. The analysis of this survey mainly focuses on patients' basic situation, percentage of overall satisfaction evaluation and the scores of all outpatient service items, covering 24 factors totally, including gender, age, marital status, occupation, degree of education, address, payment category, monthly income of family, reservation and registration, communication between doctors and patients, treatment effect, hospital sign, service attitude, hospital environment, hospital hygienic conditions, waiting time of each process .

In order to figure out the specific process that has the greatest impact on patient satisfaction through quantitative analysis method, which is also the bottleneck for outpatient process of the hospital, we adopted structural equation model. With this model, interactive relationship between multiple variables and relationship between multiple reasons and results, including some unobservable variables (latent variables) can be studied. We assumed that there were 4 latent variables in the established model, including service attitude, service value, waiting time and patient satisfaction.

Through regression analysis and parameter estimation, we added the relationship between e7 and e15, the two measuring errors, into Figure 5-2 Path Diagram of Causal Relationship. After revision, Figure 5-2 Standardized Coefficients Distribution was formulated, based on which we found that service attitude, service value and waiting time have significant influence on patient satisfaction. Especially, the influence coefficient of service attitude reached 0.917. Meanwhile, the direct and indirect influence of waiting time on patient satisfaction cannot be neglected either, since these factors might be the key to improving patient satisfaction.

Chapter 6 Redesign and Implementation of the Outpatient Procedure

This chapter is consisted of two parts: the first one is about major problems in the current outpatient process concluded through an analysis with the structural equation model in the previous chapter, such as concentrated time periods of patient visits, the incomplete appointment mechanism and insufficient information sharing. For those problems, on the one hand, on the basis of consulting relevant literature as well as field research and interviews, it is proposed to optimize and complete the existing appointment mechanism by drawing from best practices of hospitals home and abroad; on the other hand, it is suggested to optimize the outpatient procedure with an all-in-one card program, implementing and consolidating the optimized outpatient procedure by virtue of an outpatient information system. The second part will mainly discuss detailed implementation plans and steps after outpatient procedure optimization. It is suggested that a leadership team that is consisted of Board of Directors (hereinafter referred to as BOD) of the hospital, department directors and executives of banks should be established to organize, coordinate and advance implementation of the project. The smooth transition from the old procedure to the new one is to be achieved through steps including preparation, promotion among and training of hospital staff, social publicity, trial operation and procedure improvement. Furthermore, comprehensive assessment indexes should be established on effects of the reengineered procedure; and improvement is to be made on deficiencies to lay a solid foundation for an overall promotion.

6.1 Overview of the Procedure Optimization Plan

6.1.1 Optimization of the Appointment Mechanism

According to results of the survey on the existing outpatient procedure, it is suggested to effectively segment the visit periods of patients during a day, especially

for tests and diagnosis that require a long time of waiting.

(1) Short message appointment can be added mainly for patients that are of no emergency and cannot be tested on the same day due to limited test facilities. Appointment can be made 24 hours a day without being restricted by time and location. In this way potential patient customers can be increased to the maximum.

The hospital can cooperate with China Telecom and China Mobile, so that patients can make appointments for registration through short messages with fixed contents including the all-in-one card account number, department code and appointed date and time period. Upon sending appointment messages to given service telephone number, information of successful registration will be sent back to patients for confirmation automatically by the system. (For instance: you have successfully registered for expert outpatient services on MM/DD/YY. Please make payment for general outpatient services at the Outpatient Hall of the hospital with this appointment number XX between 9:00 and 9:30. If you are late for personal reasons, your appointment will be delayed and you will receive treatment at the last period of time of the day.) Registration is effective when patients confirm the message and registration fee will be added to the telephone bill. If patients have to cancel the registration for personal reasons, they can cancel with short messages before 16:00 on the day before the appointed date. And registration fee will be returned to the telephone account of patients. In this way it can be avoided that patients fail to keep an appointment.

(2) Registration at differentiated time periods: after successful registration, patients can set the time for treatment at the hospital automatically on the registration sheet. Dividing treatment time of patients into different periods with each lasting for half an hour (such as 9:00 to 9:30 and 9:30 to 10:00) can effectively distribute the number of patients evenly at different time periods. For one thing, it can contribute to the efficient use of outpatient resources; for another, it helps to reduce time for patients to stay at the hospital and contributes to a better order of treatment.

(3) Online registration: currently, the hospital has been included in the unified registration appointment platform established by Health and Family Planning

Commission of Shenzhen Municipality. In the future, it is possible to develop an independent online registration appointment system for the hospital based on the amount of patient visits, so as to meet demands of patients and avoid network congestion.

6.1.2 Improvement of Outpatient Procedure

The structural equation model analysis together with field interviews show that problems mainly exist in tests and drug dispensing along the outpatient procedure. Currently, the four drug dispensing windows are far from being enough in rush hours and the number of payment service personnel is rather limited. Besides, test reports have to be got in the treatment area. It not only adds to the workload in the treatment area, but also results in that patients would consult doctors in the treatment area due to convenience. Thus the workload of doctors is increased and treatment time of doctors will be reduced. Under such a context, it is suggested that:

(1) Test reports should be issued by Test Department. For one thing, it will avoid imperceptible missing of information and make it easier to improve the outpatient procedure. For another, it is beneficial to privacy protection for patients;

(2) Test reports should be printed in a concentrated way. It is suggested to establish an outpatient service station near Test Department for report printing, so that patients can resort to self-service query and printing.

(3) When prescribing, doctors should read real-time inventory, so that patients do not have to return to Doctor Workstation to change the prescription when the prescribed medicine is out of stock. (In case that slow operation of the system may be caused when a large number of outpatient doctors read drug inventory in a real-time manner, under the original medical information system of the hospital, virtual inventory is read every morning when computers at the Doctor Workstation start up. Now server resources purchased by the hospital are enough for real-time inventory reading.)

(4) Concierge medical advisors should be arranged in a dynamic and flexible way. In peak hours of registration appointment, concierge medical advisors should

focus on the Cashier; while in rush hours of drug dispensing, they should be mainly in waiting areas for drug dispensing. To sum up, work of concierge medical advisors should be determined in a reasonable yet flexible way.

(5) The number of test and drug dispensing windows as well as related staff should be adjusted appropriately on the basis of patient-flow. For instance, in rush hours, extra windows and staff should be added properly to reduce time of waiting and queuing up for patients.

6.1.3 All-in-one Card Program

Through field interviews and surveys, it is found out that quite a big proportion of the surveyed think it takes rather long time to queue up for payment. Though the appointment mechanism for registration is adopted, it still takes time for queuing up. It fails to meet service requirements of the hospital and business skill training on personnel at the payment window should be strengthened. However, it is believed that in order to fundamentally resolve the problem of queuing up, to achieve convenient self-service payment and on-site payment with bank cards, to effectively remove the concentration of patients for payment, and to reduce the waiting time for payment, it is worth trying to cooperate with local banks (such as Shenzhen Branch of China Construction Bank) to issue medical cards which read “The University of Hong Kong-Shenzhen Hospital”. For patients coming to The University of Hong Kong-Shenzhen Hospital for the first time without medical cards of China Construction Bank, they can apply for medical cards at the China Construction Bank branch within the hospital. For patients having cards of China Construction Bank, they can directly activate medical payment function of their cards at the Registry, Triage Desk or Cashier as well as other service windows. Medical staff can directly get access to basic information of patients by means of medical cards without typing in, so that queuing time of each patient can be reduced and payment efficiency is to be greatly improved. In departments, doctors can get information on medical records through the all-in-one card. After confirmed diagnosis, doctors can directly make an E-prescription and charge related medical fees through the card. Paid prescription would be delivered to the dispensary automatically via the HIS, so that medicines can

be prepared in advance at the back office. At the same time, the name of patients will be shown on the electronic display screen upon completion of medicine dispensing and voice prompts will be given for patients to get medicines at respective windows. Without confirmed diagnosis, doctors can issue electronic application, so that patients can make payment at the Triage Desk of corresponding medical technology departments and queue up for treatment. While test results are confirmed, prompts will be given to patients on the screen and results will be directly delivered to doctors by HIS simultaneously. After patients go back to the consulting room, doctors can prescribe and charge according to test results. Thus waiting time for payment and redundant payment procedures can be reduced.

At present, there are two types of medical cards in hospitals in China. One is for storage of a large amount of information on medical records while the other is with ID code. Due to technical restrictions, the former one failed to be promoted on a large scale. On the contrary, widely used in optimization of hospital outpatient procedure, the latter one is consisted of two types: one with pre-top-up function and one without. Currently, The University of Hong Kong-Shenzhen Hospital adopts medical records commonly used in Shenzhen City instead of cards. With QR code of the hospital, medical records contain information of patients. Patients with medical insurance can receive treatment with medical insurance cards.

Although such a mode makes the outpatient process convenient to a certain degree, it fails to solve the problem of queuing up fundamentally. Currently, hospitals in China, such as Beijing Tongren Hospital, Peking University Third Hospital, Beijing No.6 Hospital and Anhui Provincial Hospital, adopt medical cards with a pre-top-up and payment function. Patients can pop up for cards in advance and make payment directly at departments, making it convenient for patients and avoiding the trouble of repeated queuing. However, the shortcoming lies in that such cards can only be used within the hospital. Thus it is difficult to achieve outpatient information sharing among hospitals and it is a lack of safety. Besides, when medical cards are issued by and pre-top-up money is managed unilaterally by the hospital, there are disputes on

whether the hospital can manage such a large sum of money in a legal, proper and safe manner.

(1) Three models and functions of all-in-one card

There are three models for the all-in-one card after it starts to be used. First, cards can be applied for directly within the hospital and read The University of Hong Kong-Shenzhen Hospital. Upon card application, basic information of patients can be directly entered into HIS system of the hospital, making it easier to be read. Second, cards can be applied in other branches of China Construction Bank. When patients see a doctor for the first time, their basic information can be read from headquarter of China Construction Bank, in spite of the slow speed. Third, when the host at headquarter is off, cards can only be used for identification of patients without financial functions such as payment. After being enabled, the all-in-one card is at least of following functions:

a. Financial and service functions of China Construction Bank deposit cards;

b. Function of doctor consulting and payment at The University of Hong Kong-Shenzhen Hospital. It can be used for payment and identifying patients. Patients can apply for cards, top up, apply for refund, report loss, and make appointments, payment and inquiries. Besides, data interaction with HIS and LIS systems of the hospital can be achieved.

c. Patients can buy medicines at certain discounts in given drug stores and get bonus points with such cards.

(2) Outpatient service locations and charge items

Back-office billing sites and charge items after swiping cards are listed in the following table:

Table 6-1 Back-office Billing Sites and Charge Items after Swiping Cards

No.	Outpatient Service Location	Charge Item
1	Registry	Registration fee
2	Doctor Workstation	Prescription fee
3	Cashier	All charge items
4	Medical Technology Department	Examination and test fee
5	Intravenous Infusion Room	Infusion fee
6	Outpatient Operating Room	Operation fee, nutrition fee and other related fees
7	Blood Sampling Room	Blood sampling expense

Source: The author

Notes: During the transition period, the Cashier has to be retained while the number of payment windows can be gradually reduced.

(3) Refund application

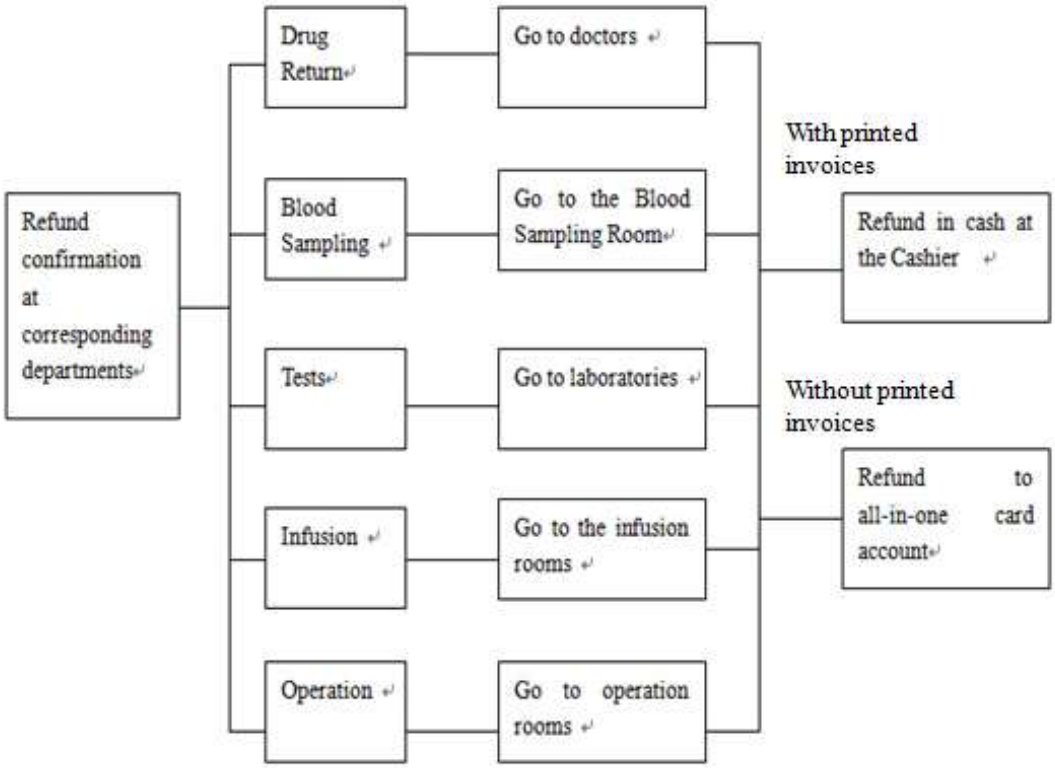
a. Delayed refund application

Application should be filed at the Cahier and refund is made in cash.

b. Intraday refund application

Patients need to confirm for refund at respective departments and ask doctors to issue red written prescriptions. If an invoice has been printed, refund can be applied at the Cashier and made in cash. If no invoice has been printed, refund can be applied at various billing sites and money will be returned to the all-in-one card. The specific process of refund business is as follows:

Figure 6-1 Refund Process



Source: The author

To consolidate the new reengineered process, it is suggested that a leadership team for project implementation that is consisted of hospital executives, COS of major functional departments, consultant doctors and related business directors of China Construction Bank and is responsible for organizing and coordinating the implementation of this project should be established in the hospital. Besides, implementation groups consisted of members from the information center, doctors, nurses as well as major personnel in the Medical Insurance Office and various departments should be set up to offer support to software developers in researching localization demands, to prepare basic data, to receive training on software testing and follow-up tracking and feedback after implementation of software.

6.2 Implementation Steps for the Plan

6.2.1 Preparation before Project Implementation

(1) Preparation of China Construction Bank

Currently, the daily patient visits of the hospital are 2,000. If the number of cards sent is calculated as at least 1,000 cards per day, to ensure a smooth sending process, the hospital has to consult with China Construction Bank to settle the following issues in advance:

a. The card sending process should be optimized. Patients with second-generation ID cards can apply through self-service card sending machines within the hospital while patients carrying other certificates should apply at the branch of China Construction Bank in the hospital. To ensure an efficient and convenient sending process, professionals can be allocated to offer guidance on operation beside the machine;

b. In consideration of the huge demand, a certain number of card sending machines can be set in the Outpatient Hall. And it is suggested to guarantee 24-hour operation of the machine and to realize self-service card sending.

c. Real-time activation of the treatment function of cards should be guaranteed. Namely, while sending cards, China Construction Bank can directly import patient information to HIS system of the hospital, which will automatically generate two-dimensional codes for patients. Thus patients do not have to go to the hospital to open the code.

d. As the time that patients go to the hospital is uncertain, business hours and staff in the card sending branch should be well coordinated.

(2) Preparation of the hospital

As to improvement and import of the new procedure, the hospital should take the following measures:

a. The President should take the lead to set up a hospital procedure improvement committee, which should be consisted of department directors and coordinate among different departments;

b. Demand analysis: demands of outpatient procedure improvement as well as the outpatient information system should be analyzed through outpatient field research and brief meetings;

c. Detailed schemes as well as implementation plans and timetable should be worked out for outpatient procedure improvement;

d. Related outpatient information systems should be developed in exact accordance with demands of the outpatient procedure improvement plan, such as registration payment sub-system, doctor workstation system and dispensary sub-system. Besides, a system of charging through cards should be integrated in billing sites to interconnect with the network of China Construction Bank;

e. Hardware preparation: after the adoption of all-in-one card, the function of the Cashier will be performed separately in various departments, including consulting rooms, the Doctor Workstation, laboratories and the Registry, so as to effectively reduce the phenomenon of queuing up and waiting. To this end, hardware for payment sites such as PC, card readers and thermal printers should be arranged in a unified way at sites of payment with cards.

f. User training: before implementation of the project, simulation exercise should be organized by the hospital for customers who actually use the project such as doctors and nurses. Related technical staff will explain workflow of the system, software functions, basic operation and matters for attention and evaluate on the trained to ensure the effectiveness of training. During the implementation process, appropriate follow-up should be conducted and improvement should be made in accordance with the actual implementation situation.

g. Online testing and perfection of the system;

h. Simulation testing: Related staff will simulate the whole doctor-visiting process and carry out operations including transfer, payment, refund and loss report in each step along the process such as appointment making, card application, registration and triage, doctor consulting, examination and test, drug dispensing and treatment. Any problem or possible problems will be resolved in time.

6.2.2 Card Launching Ceremony

After on-site simulation testing is completed without error, the hospital can take the opportunity to host a launching ceremony of The University of Hong Kong-Shenzhen Hospital all-in-one card to publicize the card and lay a sound foundation for the trial operation. Guests invited to the ceremony could include leaders and experts such as leaders of government departments in the medical and health industry, executives of The University of Hong Kong-Shenzhen Hospital and key members of departments, leaders of China Construction Bank and relevant staff of Social Security Office, together with media in major health systems and financial systems in Shenzhen.

On-site publicity during the ceremony can be conducted from the following aspects: (1) Banner hanged at prominent position in the hospital lobby; (2) Electric signboards at the triage desk; (3) Glass stickers at the Registry; (4) Brochures and posters at elevator entrances within the hospital; (5) Signboards at the Cashier; (6) Publicity notices pasted on the bulletin board; (7) All-in-one Card User Guide issued by China Construction Bank branch within the hospital to explain functions and instructions of the card in detail; (8) Posters and leaflets in other business branches of China Construction Bank.

6.2.3 Trial Operation of the New Procedure

To examine real effects of outpatient procedure improvement, trial operation can be conducted in certain key departments on the basis of the actual situation of the hospital, such as Pediatrics Department and Dermatology Department. Objectives to be achieved during trial operation are as follows: first, to publicize the new outpatient procedure to citizens in Shenzhen; second, to settle the issue of coordination among different departments and help medical staff get familiar with the new procedure; third, to test and complete software functions and system performance; fourth, to accumulate valuable experience for overall operation of the new procedure in other outpatient departments; fifth, to educate all staff with related ideas and provide them with on-the-job training.

During operation of the improved procedure, it is believed that special attention should be paid to the following aspects:

(1) During the transition period, patients can go to see a doctor with all-in-one cards or medical insurance cards. It poses difficulties for medical staff in operation and management and increases the workload of medical staff to some degree.

(2) All-in-one card brings about great convenience for self-paid patients instead of patients with medical insurance. Thus it remains a problem how to negotiate with the Social Security Office to integrate all-in-one cards with medical insurance cards;

(3) As some patients are accustomed to seeing a doctor without ID card yet it requires to present ID cards while applying for all-in-one cards, further publicity and guidance should be conducted and offered for a wide promotion of all-in-one cards;

(4) The new procedure improvement is always concerned with a change of working habits of medical staff and an increase of their job duties. For instance, doctors may complain about their new duty of charging and staff at the Triage Desk may feel unhappy about their added responsibilities of charging and money transfer. As a result, pre-training should be given on medical staff before adjustments on contents of their job duties;

(5) It remains to be further negotiated whether free card application at China Construction Bank branch within the hospital is provided or a cost of card should be charged.

6.2.4 Overall Promotion

After a successful trial operation, operation can be expanded comprehensively in other departments of the hospital with strengthened publicity, which mainly includes:

(1) Promoting all-in-one card program, implementation process and introduction effect via corporate websites and networking platform of Guangdong Medical Treatment and Healthcare;

(2) Conducting brand planning, design and promotion of all-in-one card process through outdoor advertising in Shenzhen;

(3) Posting publicity posters at the forefront of each administrative office as well as the outpatient hall and training as well as arranging concierge medical advisors to

answer questions in the scene;

(4) Delivering lectures about health education knowledge in public place such as Shenzhen Library and arranging free activities of diagnosis and treatment regularly at fixed place.

6.2.5 Communication and Coordination Meeting

During the launching process of the new outpatient procedure, the project leadership team should host coordination meetings regularly among related department heads, software developers and leaders of the Social Security Office, so as to summarize problems existing in the implementation process of the new procedure, to achieve coordination among various departments, to settle such issues as software optimization, procedure improvement and staff guiding and training during the procedure implementation process. In this way the new procedure is to operate in an orderly and reasonable way.

6.2.6 Comparison between the Old Procedure and the New One

Restructuring of the procedure is concerned with common interests of patients, the hospital and China Construction Bank. Through comparison between the new procedure and the old one, it is believed that the new procedure is of following advantages:

(1) For patients

a. Patients with All-in-one cards can finish registration and triage all at once directly at the outpatient nurse triage desk, so that the outpatient treatment process has been simplified;

b. Payment can be made anytime and anywhere through All-in-one cards. Patients can swipe cards and make payment for prescriptions directly at consulting rooms of doctors and for tests and examinations at corresponding departments. It avoids the trouble of queuing up and saves time wasted in going to and fro within the hospital.

c. It is more secure since patients are saved from the trouble of carrying a large sum of cash.

d. The hospital can get access to data information on medical records by swiping All-in-one cards and update and save medical records of patients on line in real time. Thus patients do not have to carry medical records and their health records can be established quickly, significantly boosting medical and treatment efficiency;

e. It is more convenient for receiving treatment since patients can apply for cards in the hospital. Besides, All-in-one card can also be used as bank cards, bringing conveniences for the life of patients.

(2) For the hospital

a. It can relieve pressures of outpatient and avoid the "the three longs and one short" phenomenon;

b. It helps to optimize resource allocation in the hospital and effectively reduce resource pressures at the Registry and Cashier;

c. It makes payment process more convenient, efficient and reliable;

d. It contributes to lasting preservation of patients' medical records and helps to reduce errors and improve medical efficiency and level in an indirect way;

e. It improves overall competitive strength and social influence of the hospital.

(3) For China Construction Bank

a. Greatly increase the number of bank cards issued by China Construction Bank;

b. Directly expand the amount of savings of China Construction Bank as well as its market share;

c. Improve its social reputation and recognition among the general public;

d. Enhance its social influence and external effects.

6.3 Summary

This chapter focuses on major problems existing in the current outpatient procedure analyzed through the structural equation model in chapter five, such as the incomplete appointment mechanism, insufficient sharing of information and relatively long time for examinations and tests as well as queuing up for drug dispensing. Through in-depth visits and research and drawing from management models in

current outstanding hospitals home and abroad, two plans are proposed on the basis of actual features of The University of Hong Kong-Shenzhen Hospital as well as the feasibility and effectiveness of procedure improvement. One is to optimize the current appointment mechanism. For example, short message appointment can be added. For patients without emergent illness that cannot be examined on the same day due to limited resources, differentiated periods for registration or online registration can be provided to ensure the daily outpatient volume of the hospital to a certain degree. The other is to break the old boundary of department functions, adopt a new procedure management model and establish a patient-oriented and optimized management model of outpatient procedure. It is proposed that the hospital should work with banks and the medical insurance system to establish an All-in-one card treatment mode, supporting improvement and function interconnection of outpatient procedure improvement by taking full advantage of modern information technology.

While taking the actual localized operation of the hospital into full consideration, main methods and specific programs and steps of abovementioned plans are discussed. It is considered that it is necessary to set up a leadership team for the project to organize, coordinate and push forward the implementation of the optimization project. To ensure a successful transition from the old procedure to the new one, preparation, staff promotion, social publicity, procedure improvement should be implemented systematically and in an orderly manner as planned. After implementation of each part of the procedure, it is necessary to make an overall assessment on effects of the trial operation. Thus shortcomings can be identified and improved and settled accordingly, setting an example for overall successful promotion of the plans.

Chapter 7 Solidifying the New Procedure with Information Technology

To realize and solidify the new procedure, information technology should be utilized, which includes not only the debit card technology introduced in chapter five, but also the Hospital Outpatient Services Information System. This chapter consists of two parts. The first part is an brief introduction to the informationization process of the University of Hong Kong-Shenzhen Hospital, especially the original seven major information subsystems: the HIS, the Clinical Information System (CIS), the Hospital Resources Planning (HRP), the Picture archiving and communication system (PACS), the Laboratory Information System (LIS), the Clinical Support System (CSS) and the Hospital Decision Support System (DSS). Goals of the building of the Hospital Outpatient Services Information System are also elaborated. The second part discusses potential demands in the optimized Hospital Outpatient Services Information System, which includes six subsystems: the registration subsystem, the billing subsystem, the pharmacy management subsystem, the doctor workstation, the queuing management subsystem and the system management subsystem. The interface relationship among those subsystems is analyzed. To realize the effective functioning of the subsystems, the hospital should collect data such as information of patients, hospital staff, departments, medicines, charging items and diagnostic codes. With such information, the hospital can have better understanding of the system's operating environment and technical requirements, including those for installation, interfaces, environment of running databases, system performance, system stability and data migration.

7.1 Introduction to the Informationization in the University of Hong Kong-Shenzhen Hospital

Up to now, most of the hardware and software in the University of Hong

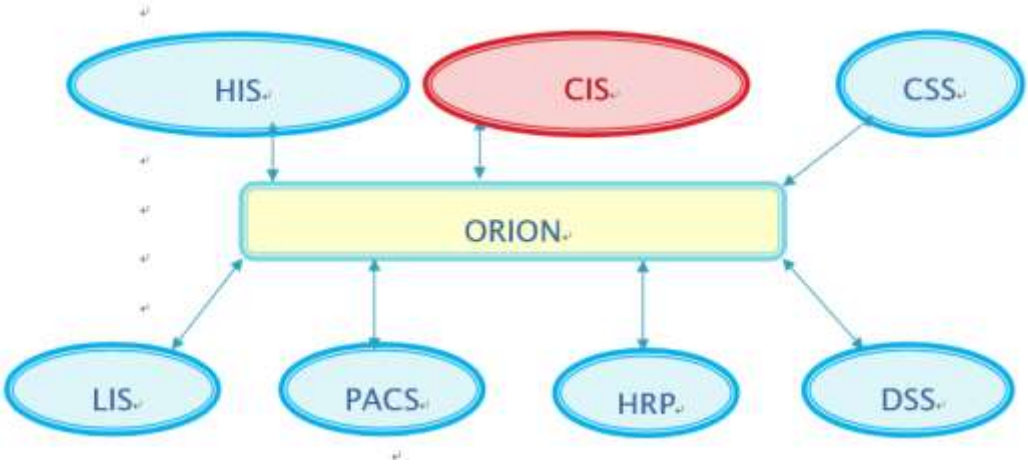
Kong-Shenzhen Hospital are cutting-edge, thus enabling the hospital to base its clinic services on information technology as far as possible. To reduce manual operations, work that can be done by computers is now finished with the help of software.

Currently, Hong Kong- Shenzhen Hospital possesses seven buildings, a Logistic Service Building with seven floors (for the accommodation of canteen staff, interns and operators on duty), a Science and Education Administration Building with seven floors (for scientific and educational business and various trainings), three General Hospital Buildings with seven floors (the charge standard is governed by government), a VIP Hospital Building with five floors (the charge standard is higher and governed by hospital itself) and an Outpatient and Medical Technology Building with four floors (for outpatients and examination of medical laboratories). The two-floor basements of seven buildings are connected (which are mainly parking lots and a portion of warehouses). The hospital has adopted the internationally accepted Hierarchical Internetworking Model, which consists of access, convergence and core layers. Its buildings are connected by ten-gigabit armored fiber cables, which can be used outdoors. The network speed of computer terminals can reach gigabits. Besides, the whole hospital is covered by wireless network. In the four-floor Outpatient Medical Technology Building and the Hospital Building, wireless nursing, wireless ward rounds of doctors and wireless transmission of vital signs data are realized. Buildings and floors are connected by optical fibers. The Operation Room, Medical Imaging Department and Clinical Laboratory are connected to computer rooms through optical fibers. There are altogether three computer rooms in the hospital. The one on the first basement floor is for external lines and CCTV equipment, while those on the third floor of the Outpatient Medical Technology Building and the fourth floor of the Science and Education Administration Building are used to guarantee the operation of the medical software system in the hospital.

Network in the University of Hong Kong-Shenzhen Hospital is divided into internal and external networks due to network security concerns. The two networks are physically separated, and the Internet/email uses the external network while the medical software operates with the internal network. The hospital medical software

structure is as follows (Figure 7-1):

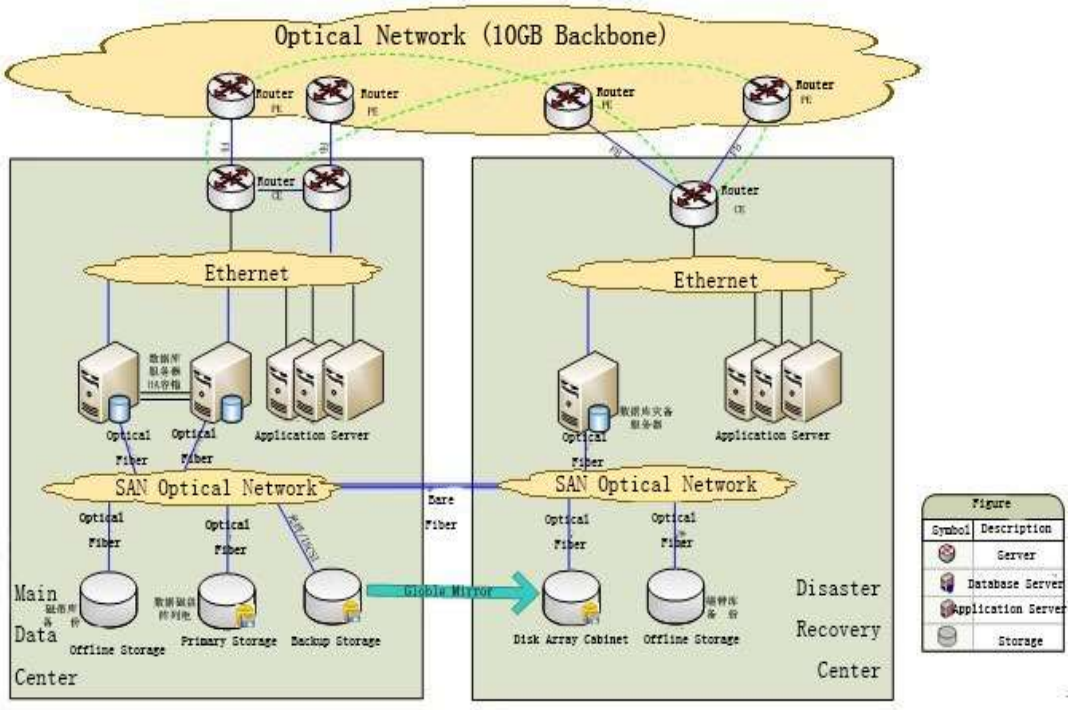
Figure 7-1 Hospital Medical Software Structure



Source: The author

Adopting HL7 international standards, those seven systems transfer data on the data exchange platform developed by Orion New Zealand Limited. As there is no direct communication among the systems, their interdependence will be reduced to the lowest level. If one system doesn't function well, the others will not be affected. The hospital needs only to follow the HL7 interface standard when replacing the malfunctioning system and it is the same when some small functional software is connected to the medical software system. The hospital has two main computer rooms: the Main Data Center on the fourth floor of the Science and Education Administration Building, and the Disaster Recovery Center on the third floor of the Outpatient Medical Technology Building (Figure 7-2).

Figure 7-2 Allocation of Computer Rooms in the Hospital



Source: The author

Currently the hospital has 30 PC servers, 20 of which have been equipped with the VMWARE virtualization software to provide the virtual environment for software operation. Systems such as LIS, PACS, CSS and HRP are installed in PC servers. There are also two IBM minicomputers and two supporting storages, in which HIS and CIS are installed. Besides, the hospital has two blade servers and two supporting storages. Equipped with CTRIX virtualization software, they can provide the installation environment for programs purchased from small companies, including the reproductive system, dental system, central lab system, tumor center system, maternity and child care system, birth certificate management system, knowledge management system, infant anti-theft system and examination management and training system. The blade servers also provide the software testing environment for the hospital.

Additionally, due to the considerable image data, a 300T storage is attached to the PACS system. Each day the hospital produces data of 35G, and it is estimated that the number will reach 80G per day after the hospital is fully opened.

The University of Hong Kong-Shenzhen Hospital has almost completely achieved electronic operation. As the whole treatment process is recorded by electronic medical records, and there are electronic results of various examinations such as biochemical test, imaging examination and pathological examination. Doctors can check the results on computers, and paper records will be abandoned. The hospital is also testing the CA system, an electronic authentication system. According to the plan, the CA system will first of all be applied to PACS and LIS. After it is stabilized, it will be applied to all software systems in the hospital. At that time, the hospital will truly realize electronization while paper-based medical records will be abandoned completely. The CA system has national legal force. It consists of two parts: personal identification and real time data. The system can show clearly who conducts what operation at what time, since all traces of modifications are recorded.

All those measures will significantly enhance the standardized management in the hospital and enable the medical staff to examine various materials in accordance with rules and regulations. It will also promote the development of medical research through data mining.

The information technology based subsystems are listed below:

(1) HIS, including the medical card management system, outpatient and emergent treatment registration and billing system, triage queuing system, transfusion room management system, inpatient ADT system, inpatient billing system, medical advice pricing system, pharmacy stock system, outpatient pharmacy management system, inpatient pharmacy management system, appointment center management system, patient self-service system, library management system, researching and teaching management system, physical examination management system, patient relations management system, medical record management system, hospital infection-control management system.

For instance, in the Outpatient Pharmacy there are two ROWA auto-dispensing machines which can dispense 30,000 pieces of drugs per day. The machines are connected to HIS, which means that they will automatically select drugs and assign

service windows for patients in 10 seconds. The efficiency is increased as the time spent in pharmacy is shortened to 15 seconds. They can also improve medical safety since the risk of choosing wrong kinds or wrong dosage of drugs, which exists in manual operations, can be avoided to some extent.

However, just like Hong Kong doctors, doctors in the University of Hong Kong-Shenzhen Hospital give prescriptions which include several pills or even half a pill. Such prescriptions, which account for almost half of the total number, could only rely on manpower since auto-dispensing machines cannot tackle prescriptions in which the number of pills is specified. Consequently outpatients still have to wait for quite a long time in the Outpatient Pharmacy. If the hospital stipulates that doctors could only prescribe certain amounts of drugs, then the Outpatient Pharmacy can prepare several combinations of drugs in the same way of preparing changes. As a result the efficiency will be improved in spite of the involvement of manpower.

The Inpatient Pharmacy uses the Japanese Sanyo automatic medicine packaging machines, which can automatically package drugs according to prescriptions no matter how many kinds of drugs are prescribed. They can also print information such as a patient's name, inpatient area, hospital bed number, the names and doses of drugs and the time to take them on packaging bags. This process is safe and quick and the error rate is low.

(2) CIS, including inpatient doctor workstations, outpatient doctor workstations, medical record writing management, medical record quality control management, medical record research and analysis management, the nursing management system, mobile nurse workstations, clinical knowledge base and the nursing department management system.

(3) HRP, including the comprehensive operation management information system platform, the financial accounting system, the cost accounting system, the budget management system, the fixed assets management system, the logistics management system, the performance appraisal system and the human resources management system.

(4) PACS, including irradiation PACS diagnosis workstations, the

ultrasound/endoscopic image and text report management system, the pathological system, the PACS/RIS video server management system, the clinical WEB server management system, clinical WEB browsing terminal, the radiotherapy management system and the radiotherapy planning system.

The hospital is equipped with advanced imaging equipment such as Siemens X-ray apparatuses, Siemens CT apparatuses and Siemens NMR machines, which are directly connected to PACS. Results of examinations will be sent to and stored in computer rooms, while pictures and examination reports can be retrieved through computers in clinical doctor stations.

(5) LIS, including nurse stations and bar code system, basic testing system, the microbiological examination system, image and text report module, HIS-LIS data interface design, equipment communication interface design, testing of automatic pipeline interfaces, data maintaining and setting, the self-service reporting system, information communication platform, post-processing of specimens, digital signature on examination reports, the laboratory quality management system, the standardized auxiliary system of clinic laboratory, the blood bank management system, reagent management and the medical information interaction platform. The biochemical testing equipment utilized by LIS are automatic biochemical analyzers produced by Beckman Coulter, an American company. Such equipment can send several examination results of one patient to the management system of the Lab, so that clinicians can access the information immediately through computers in doctor stations. This quick and convenient process helps the hospital provide efficient and timely treatments.

(6) CSS, including the intensive care clinical information system, the anesthesia clinical information system, the nutrition and diet management system, the rational drug use system, the ECG management system, and the information center for mental health.

(7) DSS, including the decision support platform, operation monitoring management, index management, multidimensional analysis, statement analysis,

financial management, statistical management and the Balanced Score Card (BSC).

Though there are already 1991 desktop computers and 715 printers, the numbers keep growing so as to meet the demands brought about by the establishment of new departments and expansion of old ones. The software management system covers the whole hospital. Work is assigned through the EMAIL system, which is the major tool of communication between managers and departments and among departments. All the steps aim at paper-free operations and sharing of data among hospitals (after getting permission from patients for the use of their data). This will help to compare and check examination results, save medical costs and improve the effectiveness and effects of treatment.

The hospital's long-term plan of informationization centers on patients. A complete Clinical Data Repository (CDR) will be built. With a unified standard for data exchange, date in all information systems is concentrated and stored in one place. Searching the unique ID of a patient, this person's information can be presented quickly and comprehensively. Adopting principles of statistics, the data can also be used to predict progression of disease and breakout of epidemics in scientific research.

The University of Hong Kong-Shenzhen Hospital also has management information systems such as IVF, Lab, the intravenous drug dispensing management system, the hemodialysis system, the disinfection supply room system, the unique patient ID system and hospital appointment system. It also joins in information systems set by various administrative departments of Shenzhen Municipal Government. For instance, it is a part of the Shenzhen Maternity and Child Care Management Information System, the Shenzhen Blood Bank Management Information System, the Guangdong Medical Record Management System and the Birth Certificate Management System of Shenzhen Municipal Public Security Bureau. The number of systems is still increasing due to the development of the hospital and its building of clinical departments.

7.2 Goals of the Building of the Hospital Outpatient Services Information System

1. To reduce ineffective procedures so as to improve efficiency. Through the combination of registration with triage, and that of prescribing with billing, medical procedures will be streamlined. As a result, patients will no longer have to queue repeatedly and their time will be saved. Meanwhile, the all-in-one card mechanism enables hospital staff to get the basic information and medical status of patients in procedures such as billing, examination and drug dispensing through swiping the patients' all-in-one cards. This measure saves the hospital from entering the basic information repeatedly, thus increasing the efficiency of medical treatment.

2. To promote sharing of medical information and improve working efficiency. This means that HIS, LIS and PACS are automatically and seamlessly unified into one procedure. After payment, prescriptions are sent directly from workstations to the Pharmacy, and staff there immediately starts to dispense medicines so as to cut the waiting time of patients. Besides, examination results are directly sent to doctor workstations through PACS and LIS, and therefore can be checked on the network. As a result, patients can spend less time in the hospital while doctors can give timely diagnosis and treatment.

3. To record the conditions of patients when necessary: HIS stores examination, treatment and imaging data of each patient in various periods. As all the medical records are electronic, historical data of patients can be retrieved quickly from HIS with all-in-one cards, thus enabling doctors to make medical decisions quickly.

4. To protect and strengthen the patients' right to be informed by improving consulting services with streaming media technology. Information that scrolls down electronic displays helps patients know their positions in the waiting line clearly, estimate the waiting time and then plan their time more reasonably.

5. To develop intelligent doctor workstations and a brand new electronic medical record system by developing the outpatient prescription set, medical advice set, examination set or treatment set in the doctor workstation system. Doctors can click

on buttons in the menu bar to achieve shortcut operations. For instance, electronic prescriptions can be sent to relative systems, and examination reports can be sent directly from the laboratory to doctor workstations; all historical diagnostic data of patients can be retrieved when their names or all-in-one card numbers are typed in; the system can give prompts of drug allergy tests, indications, drug shortage, drugs covered in the medical insurance and overdoses. With the help of those devices, doctors can type more quickly and accurately, thus saving people from travelling back and forth.

6. To establish an effective control system of medical resources and control the operating costs. With fully informationized outpatient procedures, dynamic performance indicators and tables for data analysis, the hospital can conduct dynamic monitoring on the cost-benefit, standardize medical procedures, and reduce or even avoid mistakes in payments. The electronic prescription system will help to control excessive prescriptions. When the cost reaches a certain limit, or when drugs of the same kind or with the same effect are prescribed, the system will automatically remind doctors, so as to cut the medical cost for patients effectively.

7.3 Demand Analysis of the Outpatient Information System

7.3.1 Functional Demands

The outpatient information system of a hospital should encompass the following six subsystems, namely, appointment registration subsystem, outpatient payment subsystem, outpatient dispensary management subsystem, outpatient doctor workstation, queuing and number-calling subsystem and systematic management subsystem. The functional organization and flow chart of these subsystems will be discussed in the following part.

(1) Appointment Registration Subsystem

The main purpose of appointment registration is to enable the hospital to know the dynamic information of registration beforehand so that it can make full use of its various resources to allocate medical resources in a rational manner. The functions in

detail are as follows:

a. Access to basic information of patients: information includes patient name, gender, age and phone number. For those patients who have applied for medical cards in hospitals, their information can be retrieved directly from the HIS system. Their medical record number can be used as the main index for search and can be connected with the account name of all-in-one card, name of patients and ID number. For those patients who have applied for medical cards in banks, their information can be retrieved directly from the banking system. Connected with other subsystems, this system can provide hospitals with basic information of patients.

b. Application of all-in-one card business mode: individual account numbers of patients are connected with information system of the hospital, leading to a change in the current medical payment approach and effectively enhancing efficiency of medical staff.

c. On-the-spot registration and triage: Patients who register on the spot can first go to triage stations of different departments to register and make an appointment under the assistance of nurses. Their registration will be identified based on the current appointment registration situation of the hospital. Then patients will be charged with registration fee and receipts will be printed. At that time, the system will generate an outpatient serial number, indicating that the patient has entered the queuing and number-calling system.

d. Appointment registration: internet, phone calls and text messages are used to make an appointment for registration. The procedures are similar to those used in on-the-spot registration. Once an appointment registration is successful, the quota for corresponding departments in corresponding period of time will be reduced. All the appointment registration data are managed by registration database.

e. Registration withdrawal: the medical service of patients may be aborted due to, for example, registration of wrong departments and mistakes in operations of registration staff. Both situations need registration withdrawal. The withdrawn registrations should be marked and the serial numbers of them should be counted.

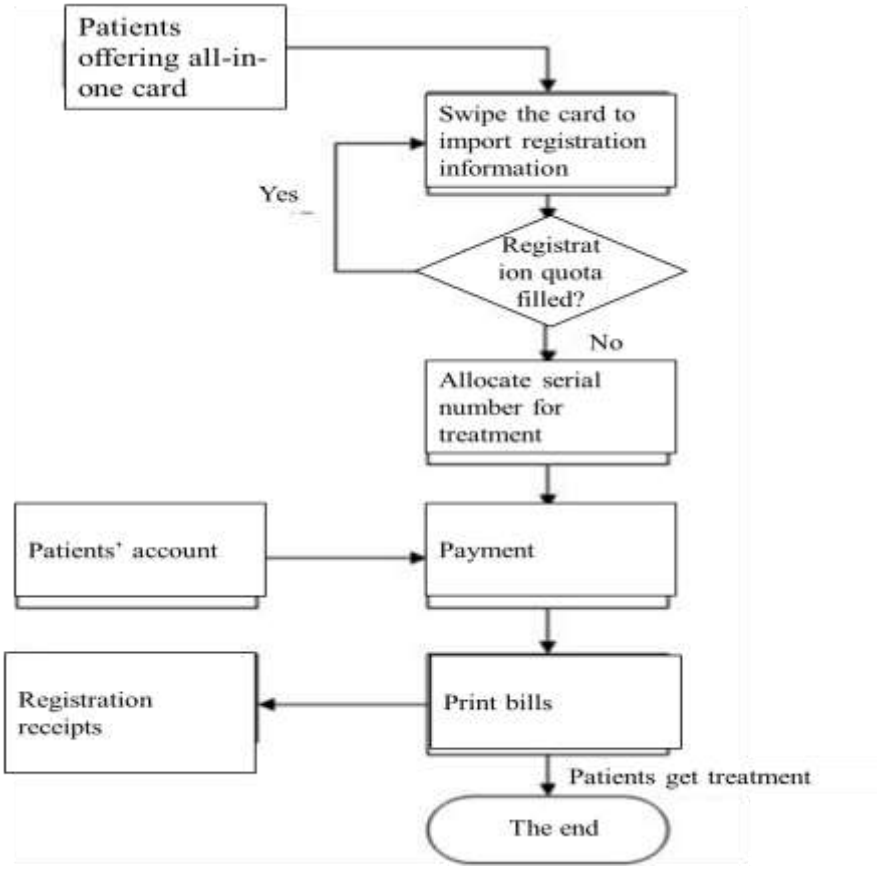
f. Registration change: if patients need to change the category of registration, the original registration form will be invalid, but the serial number remains the same. The invalid registration form will not be counted into the outpatient volume.

g. Emergency registration: its function is similar to that of general registration.

h. Inquiry and statistics: its main functions include inquiry of patients' basic information, statistics and analysis, inquiry of patients' registration and inquiry of work shift schedule of medical staff. Statistics and analysis of registration can also be done based on categories of medical departments and patients.

When a patient successfully makes a registration, the quota of registration volume in corresponding departments will reduce by one. On this occasion, the patient is in the state of "to be treated". If the doctor has already treated the patient, the patient will be in the state of "treated". The procedures of registration and triage are shown in Figure 7-3.

Figure 7-3 On-the-spot Registration and Triage Flow Chart



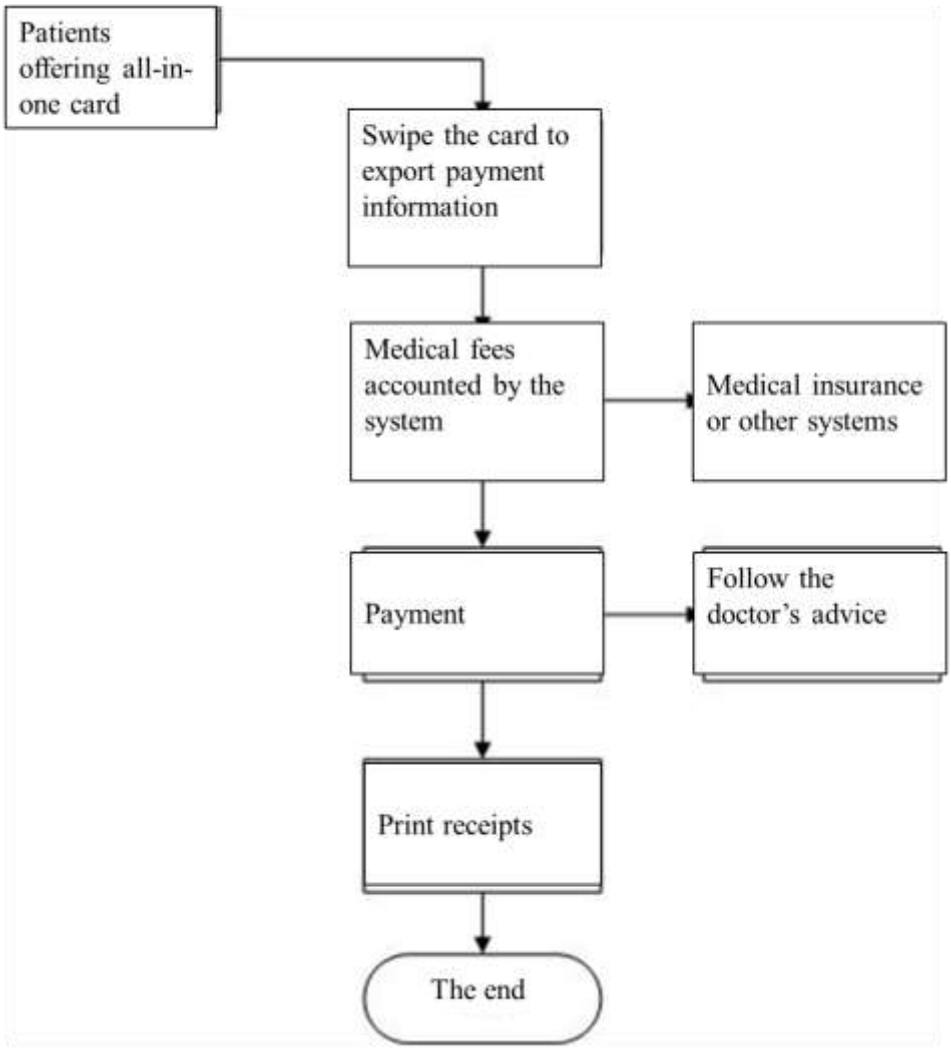
Source: The author

(2) Outpatient Payment Subsystem

The main targets of outpatient payment subsystem are as follows: first, use system to identify the price and collect payment automatically so as to reduce workload of medical staff; second, avoid arrearage or omission in collecting fees by using system science to manage settlement of patients' medical fees; third, simplify the payment procedures of patients, designate the rights to collect different types of medical fees to different departments and shorten the waiting time of patients; fourth, allocate various medical resources in a rational way, enhance efficiency of medical staff and reduce operational cost of the hospital; fifth, manage and control the settlement management of fee collectors; sixth, inquire and control different types of medical fees in a convenient and rapid manner and carry out relevant statistics and analysis. The detailed functions are as follows:

a. Price identification and payment: in order to effectively manage the flow direction of fees, different types of medical fees are designated to be collected by different departments. All windows or departments involving medical fees are under control so as to integrate the price identification and payment function. After integration, the triage station will collect registration fees, the doctors' workstation will collect drug fees, examination or laboratory department will collect examination or lab test fees and treatment departments will collect treatment fees. At the same time, in order to ensure a smooth operation in printing invoices, refund and paying fees through medical insurance as well as to avoid paralysis of payment after the fee collection system is dysfunctional, the hospital can set up several additional cashiers to finish the job. All fees are paid through cards. Those under medical insurance can pay by their medical insurance cards. Invoices, if needed, can be printed at the cashier when patients leave the hospital. The procedures of payment are shown in Figure 7-4.

Figure 7-4 Outpatient Price Identification and Payment Flow Chart



Source: The author

b. Refund: patients who need refund on the same day can confirm their refund applications at different departments with their all-in-one cards. For those whose invoices have already been printed, they need to go to the cashier to get refund in cash; for those whose invoices have not been printed, they can get refund directly at different fee collection sites, and the money will be returned directly to their accounts. Patients who need refund the next day should carry their all-in-one cards and department certificates to the cashier. The money will be returned in cash and new receipts can be printed once the original ones are returned.

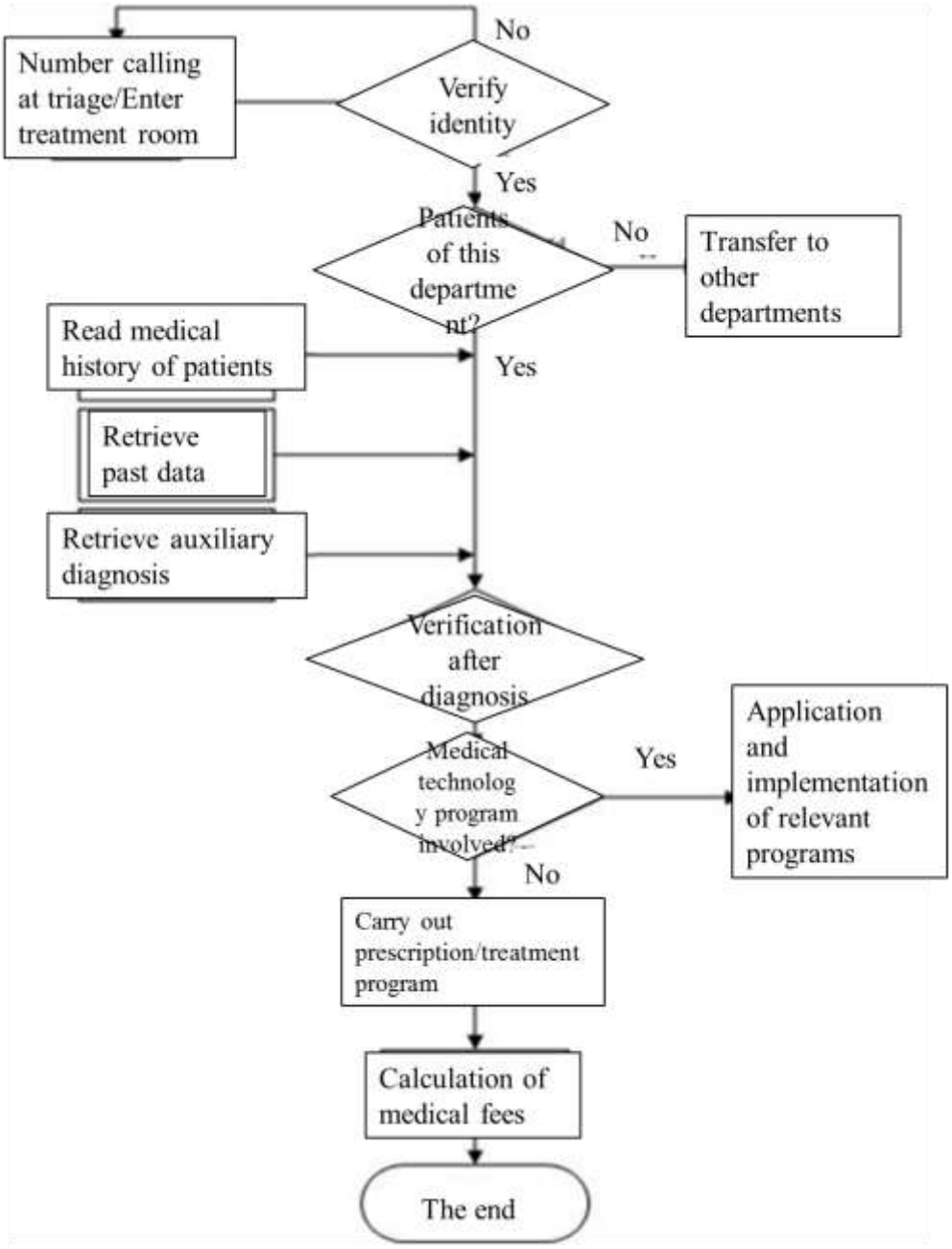
c. Inquiry and statistics: first, inquiry of outpatient and emergency revenue: all

fee collectors can inquire the business revenue in real time, including cash revenue, card revenue and refund. Medical staff can inquire the hospital revenue within a certain period of time, including medicine revenue, medical insurance revenue and examination and lab test fees at any time based on the extent of their rights; second, outpatient and emergency receipts inquiry: details of receipts can be searched in real time through parameters such as receipt number, receipt status, date and fee collector; third, statistics of fees collected by fee collectors every day: based on the daily fee collection data, all the collected fees are calculated, added up and checked; fourth, data check: the system can carry out data statistics, check and rule out abnormalities according to requirements of the China Construction Bank and medical insurance system; fifth, control the settlement management of fee collectors; sixth, inquire and control different types of medical fees in a convenient and rapid manner.

(3) Outpatient Doctors' Workstation

Outpatient doctors' workstation is the core of outpatient information system. Its main function is to serve outpatient doctors in their treatment. For example, first, standardize outpatient medical prescription, simplify doctors' paperwork and enhance efficiency of treatment; second, facilitate doctors to get access to the past medical history of patients and to make quick decisions; third, doctors' advice is stored automatically by a database, which can enhance their efficiency and reduce errors; fourth, the system will automatically issue warnings to control medical fees of excessive prescriptions; fifth, ICT is applied in the outpatient medical records by connecting medical records with other outpatient systems so as to regulate the outpatient business. The outpatient doctors' business procedures are shown in Figure 7-5.

Figure 7-5 Doctors' Workstation Flow Chart



Source: The author

After appointment, patients will enter the queuing and number calling system, waiting to be called by the system. At the same time, doctors can identify the identities of patients through their all-in-one cards, finding out whether the patient goes to the right department. If the appointment is not correct, patients will be suggested to first go to the general doctors for a comprehensive diagnosis before

seeking help in other departments. In this case, diagnosis can be tentatively made based on the medical history of patients or medical information such as auxiliary diagnosis. If there is still not a definite diagnosis, further examination will be needed in the laboratory test department, whose results will help doctors make prescriptions or work out a concrete treatment program. For the prescription part, fees can be paid at the doctors' workstation, and for the corresponding treatment programs, fees can be paid at the treatment departments. If further consultation is needed, patients can make an appointment registration on the spot. If the doctor requires hospitalization, s/he can suggest the patient to get hospitalized.

The doctors' workstation should include the following functions:

a. Medical record writing and searching: doctors at the workstation should create outpatient and emergency electronic medical records for every patient during treatment. According to patients' description and doctors' inquiry, the doctors can resort to auxiliary diagnosis and relevant templates to retrieve outpatient and emergency medical records, prescriptions and application forms of lab test. Templates in the system are all preset. Doctors can retrieve needed templates according to the name of patients' disease so that doctors can be objective in using the templates. Certainly, the doctors can also set proper templates on their own so as to suit their own occupational habits. For patients bearing all-in-one cards, doctors can know their medical history, outpatient record and prescription information by swiping their cards, facilitating doctors to make more accurate judgments and serving as a reference for them to provide treatment.

b. Setting of regular items used in departments: according to years of experience working in the hospital, generally the number of regular drugs used by doctors is less than twenty. In addition, based on their own medical experience, doctors have all formed their own experience in using medicine. In order to raise doctors' type-in rate and to suit their habit of prescribing medicine, it is advisable to maintain the regular medical items of doctors. As a result, when offering advice, doctors can base on their own habit and experience to search for information, which can narrow the scope of

their search. For example, the regular medical items can be set as diagnosis, medicine, test, surgery, treatment, medical materials, nursing and nutrition.

c. Maintenance of preset information blocks: while offering medical advice, doctors can use this function, which means the basic information of patients, diagnosis and medical advice are classified and medicine and examination programs that are often jointly used are put together. As a result, doctors can offer advice more rapidly and accurately as they can have access to relevant data in the information blocks.

d. Type-in of prescriptions and auxiliary functions: doctors can retrieve the basic information of patients during treatment, and when giving prescription, they can directly resort to data of regular items of preset information blocks. On this basis, if doctors still need to add new medicines, they can use the first letters of pinyin of the medicine name and modify the instruction, dosage and days of the medicine to finish a prescription. In addition, the system should also provide an auxiliary prompt function, which can remind doctors of the basic information of a drug such as its dosage, taboo, price, stock and supply and incompatibility of drugs in a prescription. Based on these prompts, doctors will seek opinions from the patients. The communication between doctors and patients are two-way, since doctors can modify the prescription immediately if their advice is not accepted by patients. This can help to further communication between doctors and patients, to conciliate contradictions between them as early as possible and to promote a healthy development of doctor-patient relationship.

e. Control of excessive prescription: when the amount of money listed in the prescription has surpassed the maximum or when medicine of the same category appears on one prescription, the system will automatically start the prompt function. If patients do need the prescription or the medicine, they should be informed beforehand by doctors before signing their names in the prescription. Relevant departments in hospitals will regularly check prescriptions with excessive amount of fees or drugs, hoping to effectively reduce medical costs and fees through source control.

f. Application for examination and test: doctors can use pinyin code, wubi code

or program serial number to type in names of medical service programs and issue application forms of examination and test. Doctors can also use the regular items of departments and preset information blocks to type in. Once created, the application form will be passed to corresponding medical technology departments through network and system interface. When patients finish examination and test, the report results can be directly viewed in the doctors' workstation, considerably enhancing the efficiency.

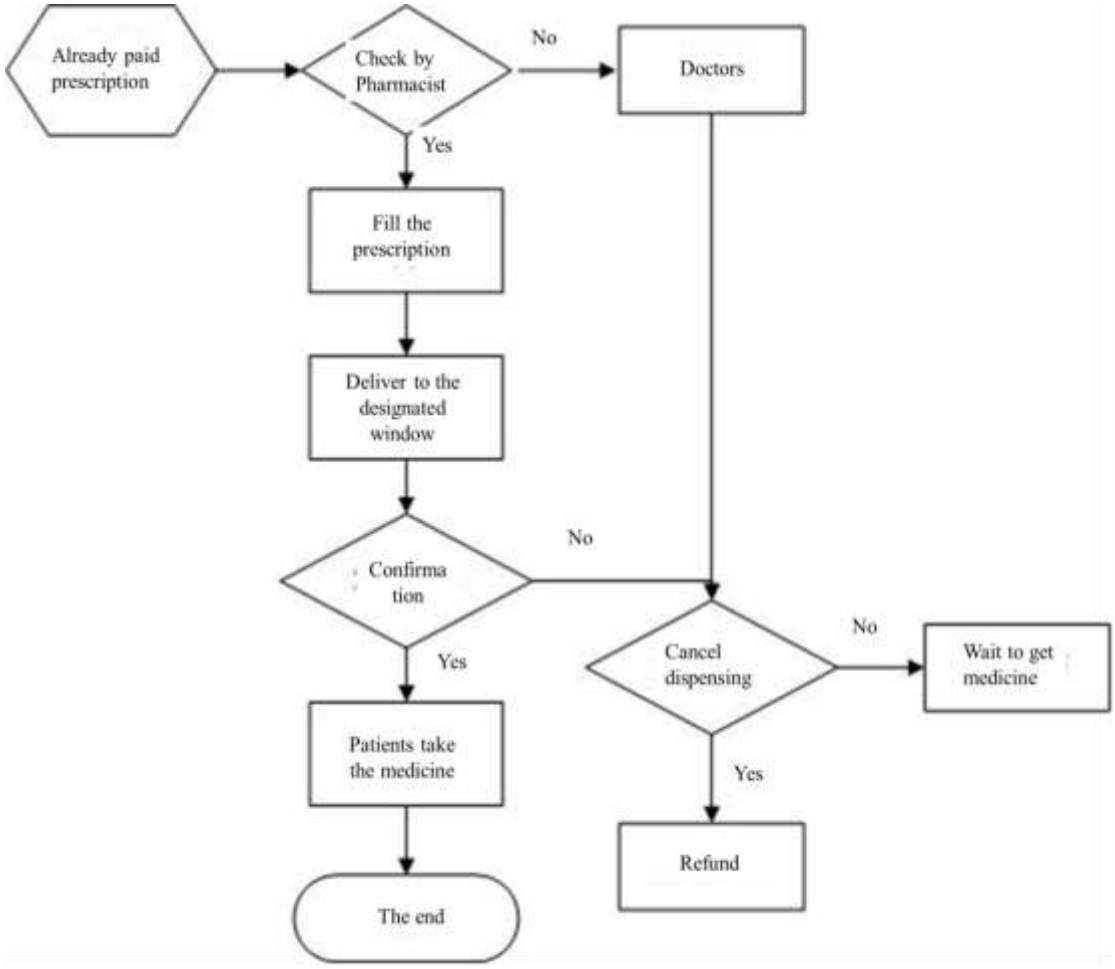
g. Inquiry and statistics: doctors' advice that has already been given within a certain period of time can be inquired. Compliance with doctors' advice can be inquired according to the classification of system configuration. Doctors' advice that patients fail to comply with during a certain period of time can also be inquired.

(4) Outpatient Dispensary Management Subsystem

The objectives of outpatient dispensary management subsystem are as follows: first, standardize the process of outpatient dispensary and establish an orderly environment for getting medicine; second, systemic transmission and background dispensing enables the dispensary to prepare medicine in advance for patients so as to reduce their waiting time; third, strengthen internal coordination and trans-department cooperation and enhance efficiency of medical staff; fourth, achieve dynamic management of dispensary stock; fifth, realize inquiry and statistics of outpatient prescription and manage medicine stock in advance.

After patients get treatment and pay fees in the doctors' workstation, the medicine that patients need will start to be prepared in the dispensary automatically due to a seamless integration of the doctors' workstation system and the outpatient dispensary system. Staff at the dispensary will fill the prescription according to the form generated automatically by the system and deliver the medicine to designated windows. Patients can get the medicine through a number calling system. When patients successfully get the medicine from the dispensary, the medical staff will confirm this in the system. The procedures of getting medicine from the dispensary are shown in Figure 7-6.

Figure 7-6 Flow Chart of Getting Medicine from Dispensary



Source: The author

The detailed functions of outpatient dispensary management subsystem are as follows:

a. Receive and display already paid prescription: this subsystem, which is linked with the doctors' workstation subsystem, can automatically receive paid prescriptions and display them on the system interface. Staff at the dispensary can directly inquire the stock shelf of medicine in the system and can get medicine rapidly and accurately.

b. Optimization of dispensary windows: according to the specific situation of the hospital, every dispensary window can receive several teams of prescription-filling staff. After patients finish paying fees, this subsystem can automatically calculate the average number of patients waiting in front of every window and adjust the number of them. As a result, the hospital can optimize the operation of dispensary windows and

reduce the waiting time of patients to the minimum.

c. Drug shortage prompt: when the amount of a certain kind of medicine at the dispensary is lower than the minimum stock, the system will give prompts and issue warnings, reminding the dispensary staff of replenishing the medicine stock. When the medicine warehouse is out of stock, the inventory system will automatically mark the medicine that is to be depleted so as to remind doctors of controlling the current use of medicine. Once the medicine warehouse is replenished, the mark of medicine shortage will be cancelled automatically.

d. Medicine suspension and maintenance: if there is abnormal situation detected in a type of medicine, then the system will prevent it from being sold in the hospital, no matter whether there is stock or not. At the same time, the system will mark this medicine so as to remind doctors of stopping using it. Even if patients come to get the medicine at the dispensary with paid prescription, they will be rejected.

e. Medicine return: if permitted by doctors, patients who want to return medicine can file an application to medical staff at dispensary. After confirmation with department doctors, the dispensary staff will put the medicine back to shelf, and the system will record the returned prescription to make it convenient for future statistics. Patients can get refund at medical departments or the cashier.

f. Inquiry and statistics: first, medicine shortage/suspension inquiry: log in the system to inquire and calculate data of medicine shortage or suspension at different pharmacies according to medicine types and date; second, medicine return inquiry: inquire the medicine return data according to parameters such as patients, date, return department and return pharmacy; third, details of prescription-filling inquiry: inquire the details of how a patient’s prescription is filled based on parameters such as patients, medicine type, pharmacy and date; fourth, medicine dispensing inquiry: according to features of medicine, inquire data such as the amount, price of medicine dispensed within a certain period of time and patients who have received medicine; fifth, real-time medicine inquiry, medical staff that fill prescriptions can inquire the input, output and stock of all types of medicine in real time; also they can track the

real-time status of medicine, such as whether the prescription has been filled, whether the medicine has been dispensed or whether the prescription has been filled but the medicine has not been dispensed.

(5) Queuing and Number Calling Subsystem

The objectives of the queuing and number calling subsystem are: first, arrange patients to get medical service in a preset order so as to create an equal, rational and fair medical service environment. With patients as the center, the system enables patients to do other things while waiting; second, reduce human errors and enhance work quality and efficiency; third, provide dynamic information of medical service and patients' waiting in real time; fourth, carry out a quantitative assessment of the medical staff based on all kinds of statistical forms generated automatically by the system so as to identify weakness of the service.

The detailed functions of this subsystem are as follows:

a. The system can be automatically integrated with the HIS, LIS and PACS subsystem of the hospital. It can obtain or type in information of patients and display them through voice prompts or big screen;

b. Department or patient category can be used as a parameter for screening to achieve automatic management of patients;

c. The LED display at the triage station can show the service information of doctors such as the number of patients who have already registered, the number of remaining quota for registration and the current waiting information including treatment rooms, patients and waiting patients so as to inform patients of the updated treatment information; the LED display at the dispensary will show guide for patients to get medicine and the price of all kinds of medicine; the LED display at the laboratory department can show information of patients to receive examination, room number, reports that have been obtained and the list of lab test fees.

d. Voice broadcast: apart from information shown on the LED display, there is also voice prompt so that patients will not miss any treatment while they can also be spared from focusing on the screen.

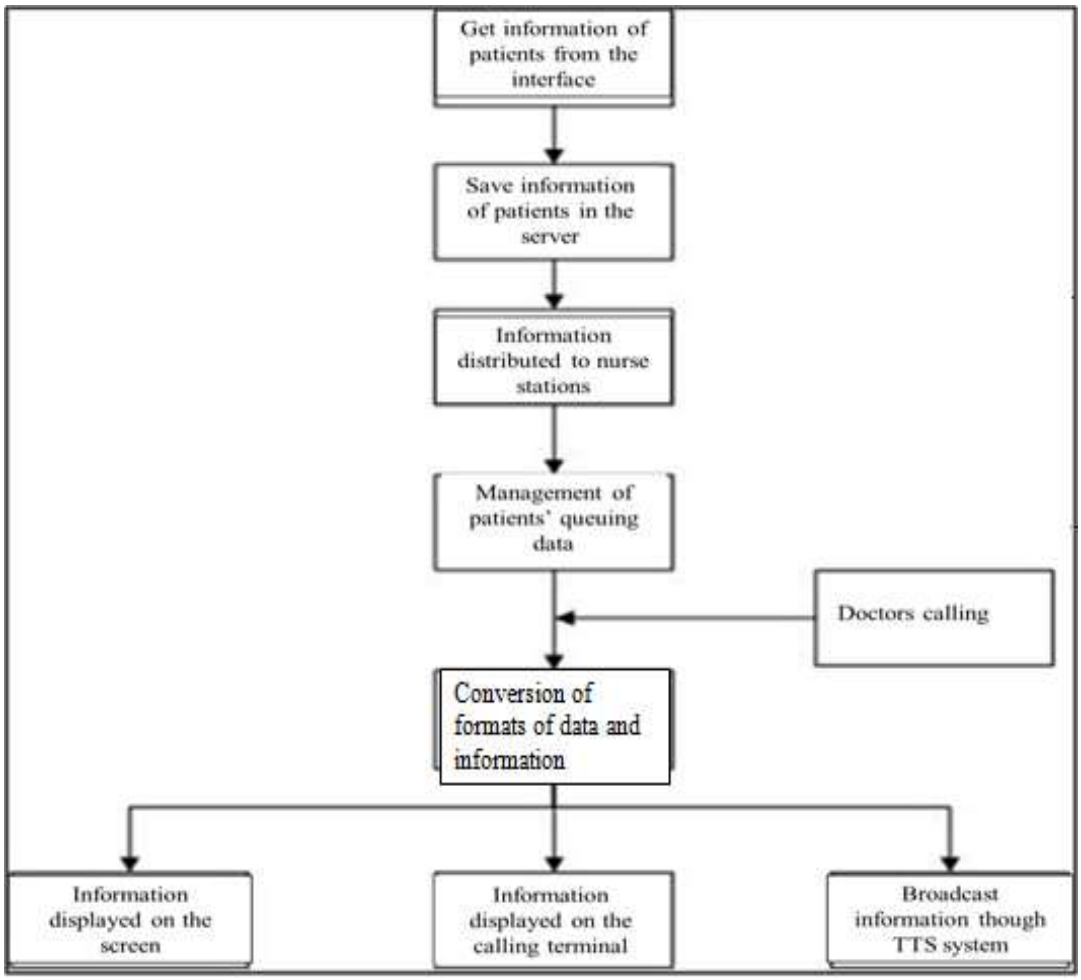
e. Doctors can use smart calling end devices to call patients and use the device to

know in advance the number of patients that day so as to control the treatment schedule on the whole.

f. Statistics and inquiry: this subsystem can be used to inquire the current treatment situation in a real-time manner and calculate data of the workload of departments and doctors within a certain period of time.

This subsystem is composed of smart network calling machine, nurse station management terminal, LED display, voice system, concentrator and servers, mainly applied in triage station, dispensary, and laboratory and test department. Its procedures are shown in Figure 7-7.

Figure 7-7 Flow Chart of Queuing and Number Calling Business

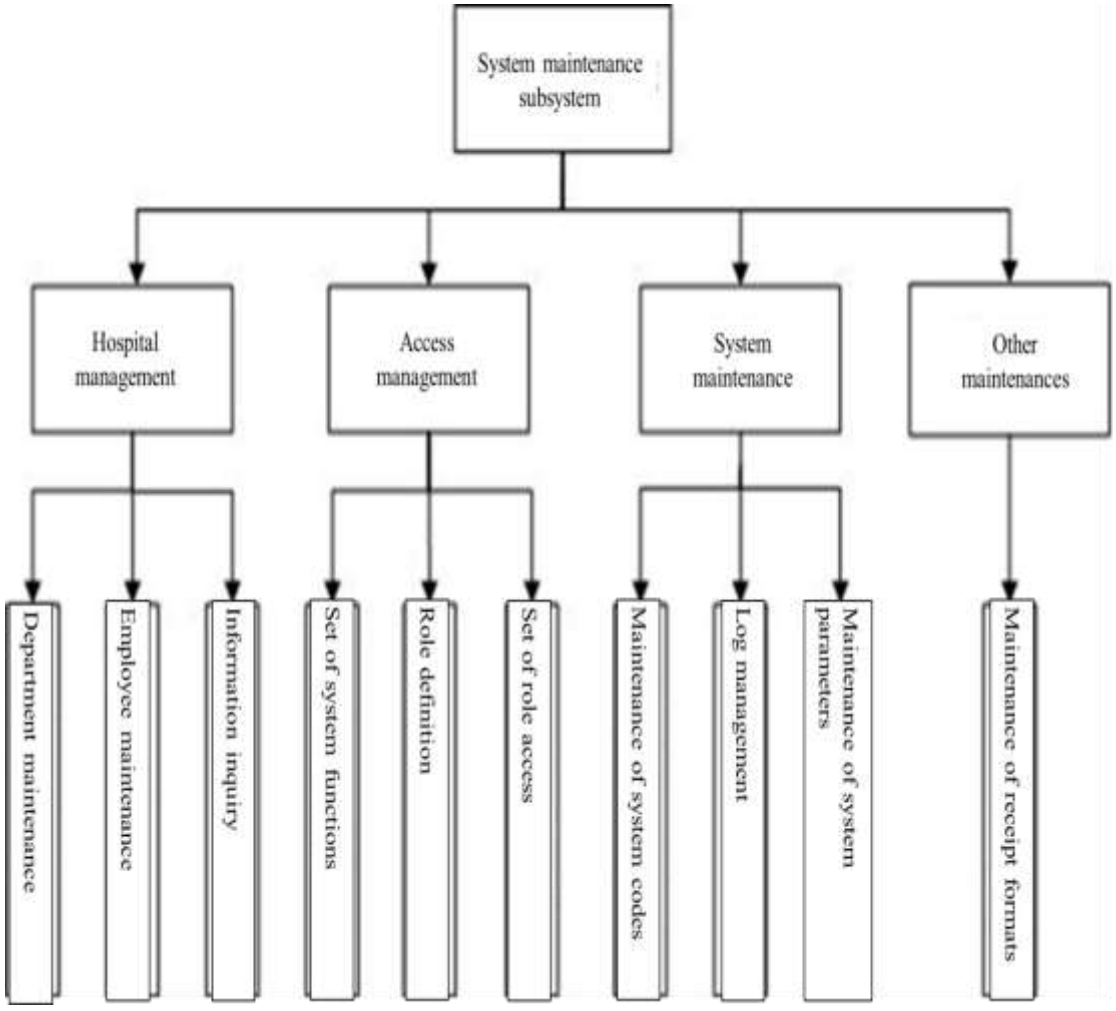


Source: The author

(6) System management subsystem

The objectives of system management subsystem are: first, maintain basic information of all departments and relevant medical staff; second, maintain system codes and system parameters to ensure a smooth operation of business procedures; third, give proper roles and use access to staff in different departments based on actual needs in work; fourth, set different types of printing format to meet the printing need of the system. Its functional organization is shown in Figure 7-8.

Figure 7-8 Functional Organization of System Maintenance Subsystem



Source: The author

The detailed functions of the system maintenance subsystem are as follows:

a. Doctor management: after the system administrator has set information of

doctors, the system will import to the database doctors' individual data, including login name, password, real name and E-mail address. Meanwhile, the system will judge whether the doctor is the system administrator. If yes, the doctor will be able to modify or delete other information in the system. If one who is not an administrator changes his identity to an administrator, he must get authorization from the administrator. Otherwise the system will issue an error prompt.

b. Department management: the hospital will increase or decrease the number of departments according to needs of actual business. Doctors can choose department at the time of registration. Administrators can conduct maintenance and adjustment on doctors' departments and modify, delete or terminate the operation of departments in the system.

c. Information inquiry: doctors can use the inquiry function to find out data such as basic information of patients, treatment situation, medical record information and information of doctors.

d. Role management: administrators can add or delete roles and give them different levels of access to the system.

e. Log management: when doctors log in the system, all of his operation will be recorded in the database and can be displayed in a preset order, such as record of the doctor's addition, deletion, modification and inquiry. The system administrator is able to empty the log.

f. Data backup: data can be backed up in real time based on needs in case of data loss.

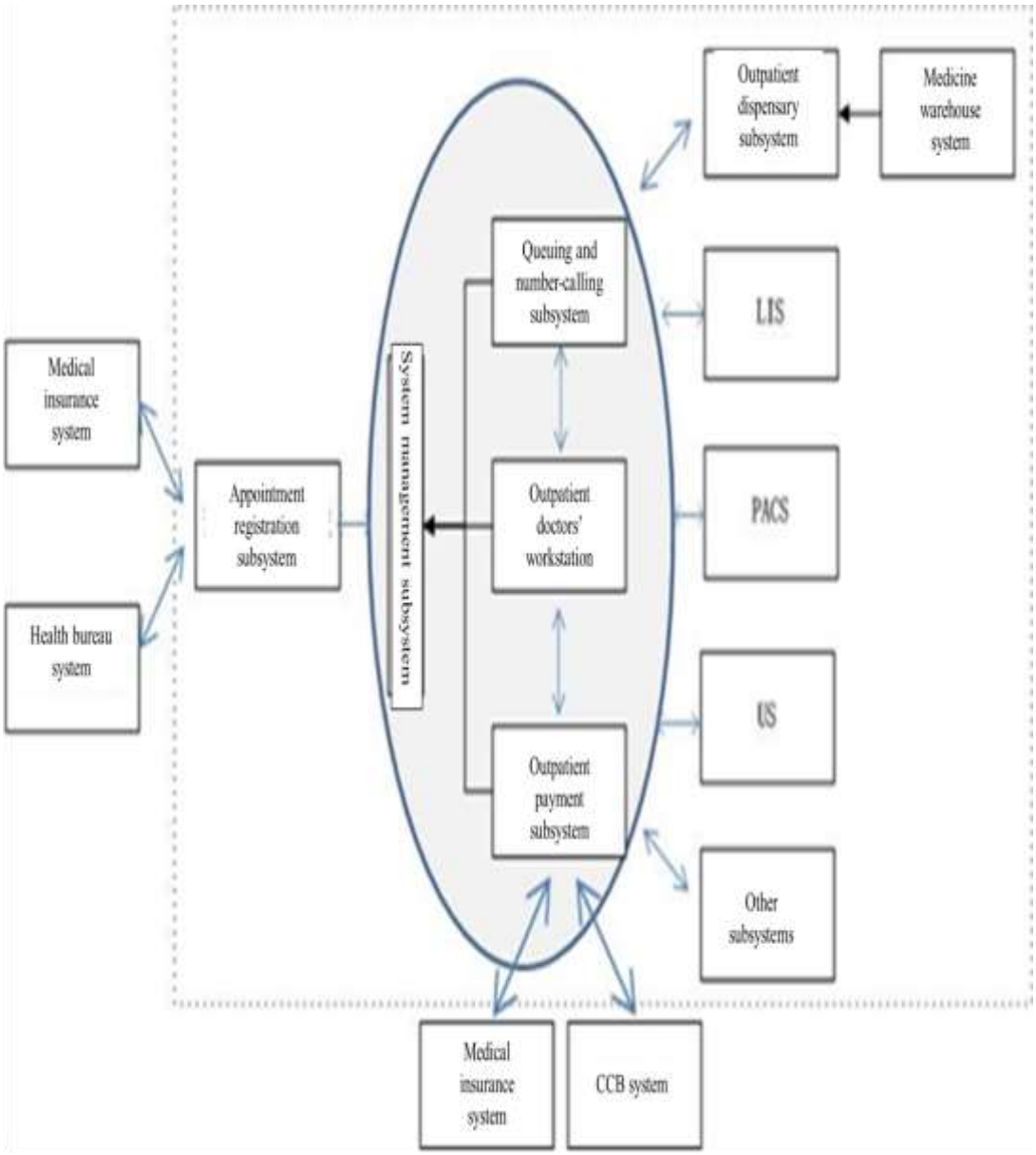
7.3.2 Interface Relationship between Subsystems

After interview and communication with staff of the information system and inquiry of relevant research, it is believed that the outpatient information system is centered on outpatient doctors' workstation, outpatient payment subsystem, queuing and number calling system and system management subsystem. Among these systems, the outpatient doctors' workstation is the core. After patients successfully appoint registration in the system, the registration information will be directly passed on to the

queuing and number calling system in the doctors' workstation and outpatient nurse station. At the same time, the registration fee will be paid through the payment system. According to the actual situation of every patient, doctors will give prescription or treatment forms or lab test forms based on the stock of medicine. As for prescription, the medicine fees can be paid directly and the information can be passed directly to the dispensary where pharmacists fill the prescription in the background. In addition, the dispensary system is directly connected with the medicine warehouse system so that pharmacists can know the stock of medicine in real time. Application forms or treatment forms will be passed directly to LIS, PACS or other subsystems in every medical technology departments. When patients finish tests, treatment and payment, the report will be returned to the doctors' workstation through relevant subsystems so that doctors can look up the reports immediately.

In addition, in the design and planning of outpatient information system, it can be connected with systems of external organizations. For example, the payment subsystem can be connected with China Construction Bank system or medical insurance system. The registration subsystem can be connected with medical insurance system so as to quickly obtain medical insurance information of patients. The interface relationship between subsystems is shown in Figure 7-9.

Figure 7-9 Interface Relationship between Subsystems



Source: The author

(1) The whole HIS system can be installed in the principal computer room of the information center of the University of Hong Kong-Shenzhen Hospital or other designated places in the hospital;

(2) The whole system should support the hardware equipment, network environment and software system of the University of Hong Kong-Shenzhen Hospital and should be compatible with HL7 interface, the internationally standard medical

interface;

(3) HIS system should be able to be connected with new third-party applications of the hospital;

(4) HIS system must have a secure and reliable examination mechanism so as to avoid illegal operations and ensure that all operations are controllable;

(5) Formulate different levels of emergency measures according to the actual situation of the hospital so as to ensure a smooth operation of all businesses of the hospital.

7.4 Database Demands

1. Both the database end and the application end are equipped with complete data backup and restoration functions. The format and duration of backup data can be set by the hospital based on needs. The database end has the function of overall backup, while the application end can flexibly carry out backup and restoration of data within a certain period of time;

2. The data forms and deployment forms in the database can be sorted out regularly in the background;

3. The background database is so powerful that statement formats, data analysis and statistic demands that are applicable to needs from administrative, financial medical affairs and other departments can be formed from the HIS system.;

4. The administrator can use the data collection tool to read various types of data in the database. The formats of documents can be set based on users' needs;

5. Flexible and accurate daily management statements can be exported based on the actual needs of the hospital;

6. The access control for exporting data is established so as to ensure that the data is secure and controllable;

7. The log of all types of application systems should be able to be recorded and inquired completely and conveniently.

7.5 System Performance Demands

1. The business response time of the application system should meet demands for the actual outpatient service. For example, the registration time must ensure registration efficiency per unit time;

2. According to the actual operation demands of the hospital, the system should be able to operate 7*24. Even if the system needs to shut down due to particular situations, the timing should be in midnight when there are few patients;

3. According to the actual operation demands of the hospital, the system can monitor the online internet users through authorization of internet administrators;

4. Statistics reports and suggestions of system performance test should be provided on a regular basis;

5. According to the operation situation of the system at different stages, different kinds of application systems should be optimized based on statistical results;

6. The application system should be able to record all the operation and management logs so that users can categorize errors or prompt information.

7.6 System Stability Demands

When the machines suddenly halt or when it blacks out, all data should be protected intact. At the same time, the emergency system should be able to respond automatically. The HIS system can continue to operate before the mainframe is restored.

When the system breaks down, all the documents to be printed will respond rapidly and get printed again. Staff at all departments can operate on their own and the system can automatically record the reason for and times of printing important documents.

7.7 Data Migration Demands

With the rapid expansion of hospital businesses, considerable data will be

amassed out of various types of hospital information. After the system is upgraded or transformed to a new one, previous data must be migrated to the new system, including:

1. Migration of basic data;
2. Migration of data to be processed.

7.8 Summary

Based on Chapter 6, this chapter further discusses necessary requirements to realize and consolidate the new outpatient process and promotion of bank card technology. Apart from cooperation and coordination with banks and medical insurance systems, ultimately information technology should be relied on. According to the new outpatient business process, different business modules will be connected and rapidly operated, which will facilitate the building of outpatient process system.

At present, the application of ICT in the University of Hong Kong-Shenzhen Hospital, including HIS, CIS, HRP, PACS, LIS, clinical support system and hospital decision support system, has been improving. It is believed that the medical information systems should be improved according to new tasks and new objectives of hospital outpatient information system building so that the newly-developed system functions can meet the needs of business process. Therefore, the focus is on the potential demands of the information system after the outpatient process is optimized. The demands basically cover the following six subsystems, namely, registration subsystem, payment subsystem, dispensary management subsystem, doctors' workstation, queuing and number calling subsystem and system management subsystem. The interface relationship between subsystems is analyzed so as to effectively support the operation of the subsystems.

Finally, it is believed that the establishment and launch of HIS is dependent on the building of database with considerable outpatient information. The environment and technical requirements, including system installation, interface, database operation background, system performance demands, system stability demands and

data migration demands, for the system to operate should be further identified. All these have laid a solid foundation for the successful implementation of the outpatient information system.

Chapter 8 Local Adaptability of the New Outpatient Process

As mentioned in Literature Review, to reengineer the outpatient process, considerations should be given not only to tackle technical problems such as identification of bottleneck problems, methods of managing the process and application of information technologies, but also to integrate specific practices with feasible management strategies. This chapter consists of two parts. Part one mainly explains the major principles of applying the BPR Theory to upgrade and improve the process, including the systematic concept of improving the process, the core idea of managing the process, the main idea of the process and problems needed to be tackled in information technology. Part two lists some noteworthy problems from the perspective of hospitals' organizational structure, IT, allocation of human resources, outpatient culture and optimization of waiting cost so as to give sufficient attention to the problem of local adaptability in the process of optimizing the outpatient process, reducing or avoiding some side effects.

8.1 Principles of Process Optimization and Improvement Based on BPR Theory

1. Transformation of Management Philosophy. In order to introduce and improve new processes, staff of all departments, high-level managers in particular, should first change their old management mode, transforming the single-function management into the management that centers on business processes and taking business process management as the central part of self-management.

2. Shaping of Systematic Concept. Improvement of the current processes should not be limited to optimizing some local processes such as the outpatient appointment process or the queuing process. Instead, priority should be given to the overall value-added services to evaluate BPR and its design from the perspective of business process and formulate the general assessment indicators, taking a holistic approach to ensure the overall optimization.

3. Take Process as the Center. Management process should be regarded as the starting point of the operation of all departments in hospitals. We should set or design appropriate organizational structures in accordance with the actual operation process of the hospital. The Hong Kong University-Shenzhen Hospital cannot indiscriminately imitate the medical model of public hospitals in Hong Kong. Instead, it should set a proper operation model in line with the local business features and patients' customs, fix the number of people employed accordingly and establish job requirements and assessment criteria according to specific responsibilities of different posts.

4. Bring into Full Play Subjective Initiative and Creativity. Based on the principle of "People come first", the hospital should not only build a client-oriented awareness to serving the patients, but also respect the creative fruits of medical staff, giving full play to the unique labor value of each staff. Talents should be allocated properly according to the quality requirements of each post, an equitable and just assessment system and value system should be established and the staff should be motivated to ensure smooth operation of each and every business process.

5. Management and Control on Decentralizing and Centralizing Power. The effective operation of hospital business process depends on information technology. However, application of new technologies will certainly bring about new challenges to the management model. Therefore, hospitals have to reset their business model, including a rational distribution of power. It can be managed in a centralizing or decentralizing way, all depending on the general objective of the hospital. High-level managers do need to give full play to the efficiency advantage of information technology and strike a balance between centralizing and decentralizing of power.

8.2 Local Adaptability of BPR

1. Design of Hospital Organizational Structure

After implementation of a new business process, the management model, which centers on business process rather than functional departments, will no doubt require

more staff. Since the outpatient process is becoming more business-oriented, the number of staff should be small while the management function should be highly effective. In this sense, leadership of managers is of central importance.

After the restructuring of business process, each post becomes more demanding than before. Staff of relevant departments must be familiar with all kinds of testing methods and time, department distribution, report statistics and query. In addition, they must also have good ability of operating, applying and communicating. Driven by a new business process, each staff has to take more responsibilities. Currently, managers face a daunting challenge of how to take a holistic approach to effectively assess the team management and its performance.

2. Problems in the Application of Information Technology

Over the past few years, the rapid development of information technology, especially the network database technology and the IC card technology, has brought about many new management ways and means. With the help of information technology, outpatient process including registration, charging and diagnosis can be distributed to other processes. For example, the outpatient medical workstation enables all business process to center on this workstation and form an interactive process so as to guarantee that every patient can finish their diagnosis process quickly and smoothly. To thoroughly apply the information technology in the outpatient information system, high-level managers should treat information technology system with systematic and forward-looking strategic insights, integrate the information technology with optimization plans for business process and develop corresponding technologies in the light of business requirements. Only in this way can it be more practical and can the huge potential of supporting of information technology be put into full play.

Of course, process restructuring and optimization and the application of information technology usually affect and promote each other. On the one hand, information has generated some new ideas on transforming the process, and this can effectively stimulate the transformation of outpatient business process; on the other

hand, the improvement of business process not only taps the potential of information technology, but also promotes the upgrade and development of information technology. In the business process improvement, information serves as a booster. Without support of information technology, many outpatient business processes could not have been carried out. It is impossible to complete this task by people, even it is completed, it will be rather time-consuming. Information technology has provided effective tools and instruments for improving the outpatient business process. It can always enable the hospital to bring forth fresh ideas, apply the management system and database theory to improve process, break the old tradition and design a new business model and way of working, smoothly advance with the improvement plan. Therefore, information technology plays an indispensable role in the business process improvement. It will change the old business model and bring about a new business model. It is sure to effectively improve the outpatient process.

3. Training Human Resources

In implementing the new business process, many people will be involved. In this period, high-level-managers are crucial to the implementation and influence of the new business process. If they do not support or do not provide sufficient support to the organizing work, then the new business process will not carry out or be hold-up. The more profound the transformation is, the more challenges and influences will be brought about to the management team.

Since new business process will innovate many technologies and change work models, managers need to think over how to establish each post’s assessment criteria and indicators, how to train staff and improve their ability. Only by identifying the quality indicators of each post, can they scientifically and objectively establish rational evaluation indicators and criteria, through which each staff can be evaluated and reach their goals. The hospital can thus cultivate a behavior-evaluation-oriented performance culture.

4. The Shaping of Outpatient Culture

To optimize and improve business process, the traditional mindset must be changed and a concept centers on patients rather than departments should be fostered.

To this end, hospitals need to reshape their outpatient culture. That is, in introducing the new business process, managers should infuse the value of patient-oriented into each part of the new process, reshape the outpatient culture in the specific operation, and make this value an indicator of the assessment. The result of this assessment is directly linked to each staff's performance bonus. All these are to guide and promote the shaping of a new culture. If not taking these measures, the implementation of a new outpatient culture is surely to be impeded, while the old culture still taking the dominant position.

5. Waiting Cost

The fundamental purpose of improving and optimizing the business process is to save the waiting time in each link and create service value for patients as much as possible. All the diagnosis steps, including registration, queuing, diagnosis, laboratory test and drug dispensing, will take a large quantity of time, psychological and strength cost of patients. Therefore, hospitals must reduce the waiting time, but at the same time, they must take into consideration their own medical resources. They should not indefinitely utilize all their resources to meet patients' needs and improve their satisfaction. The right way is that hospitals can take full advantage of their waiting time and properly allocate various medical resources to minimize the total cost of hospitals' operation and service. When patients are waiting for diagnosis, hospitals can utilize their existing resources to the fullest degree. For example, they can invite patients to watch some videos that popularize medical knowledge and read publicity materials about hospitals' culture and health care. On the one hand, this can improve people's knowledge about heath care, on the other hand, hospitals can demonstrate their care on patients, which helps to add to their service value.

Apart from this, hospitals should provide a comfortable diagnosis and hygienic environment to alleviate patients' negative mood and provide customized service to create a positive profile. By reducing patients' average waiting and queuing time, hospitals can also save patients' and their relatives' time. This can indirectly help improve hospitals' reputation and finally improve patients' satisfaction.

8.3 Summary

In this chapter, it is proposed that when hospitals are optimizing and improving their business process, they should not merely utilize the information technology to imitate existing business process and management model. Instead, they should take the practical business features into account. Taking the business demand as a driving force, hospitals should design and develop an information technology system that suits the business function; on the other hand, with all the possible problems that may occur in the process of implementing the new process, such as the organizational structure design, diagnosis culture, human resources and waiting cost, hospitals should make preparations for the local adaptation of new outpatient business process. This will no doubt provide significant guidance and theory to the application of information technology in outpatient process and the improvement of new business process.

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