CHAPTER 2

Literature Review

2.1 Introduction

Information system is an enabler for operation process in an organization. It plays a major role for interactive process service in the organization system by updating, saving, deleting, retrieving, storing, and sharing data. In addition an operating and robust information system provides the right information to the right person at the right time with the lowest cost (Mehdi et al., 2004).

Therefore, in the business world today, most organizations would prefer to use information system to manage their database, which include among others, the name of business employee and work schedule. As data and information are increasing and becoming more complex with time, computerize data are unavoidable not only to improve the performance of practical works but also safeguard the database from bad intentions such as hacking and doodling.

Information system uses a client-server environment to provide flexibility for interactive adding, deleting, updating, etc of data among the clients. In addition to managing data, it also distributes data based on client-server environment, thus increasing its efficiency (Mehdi et al., 2004).

The challenge here is how an information system manages the health care database to save time and reduce cost and improve the quality of services. A health care system generates a large amount of patient data, archived and can be manipulated by a computer based information system. For instance, a computer-based medical record improves the accessibility of patient information and provides useful data for several studies in patient health information.
This chapter highlights earlier researches on health care management system, which contains several aspects of managing the health care and the health care information systems. The chapter starts with the introduction on information system and how it supports patient’s health care. Then, it highlights the health care management model and managing the appointments in the health care information system, touching on previous studies on managing the appointment system in the health care center. Finally, the advantages and disadvantages of the current system used in health care center are discussed.

2.2 Health Care Information system

Using information system for managing patient information such as electronic patient record, patient appointment system, and patients scheduling appointment system not only saves time but also reduces cost. It is a means to support and improve patient information availability to be more accessible and flexible (modifying, saving, deleting, updating, etc) for users (health care center staff); and to store patient data efficiency. Moreover it improves the quality of data control (Liu and Zhu, 2007).

On the other hand, information system works as guidelines, using system prototype, patient monitoring and documentation tools to integrate the health care information database, financial system, scheduling and the entire user requirements - patient, nurse, doctor, etc. Therefore to get better performance and implementation, the system developers should interact with several medical health care staff physicians, nurses, medical device users, finance personnel and the administrators, to have an in-depth knowledge of how the health care center works (Song et al., 2007).

Furthermore, any process or sub-process in the health care system of an existing information system provides a service to the patient. This service is produced within a particular process according to defined requirements, rules, and constraints.
Consequently, a health care system needs to manage patient services, while it is working with users to improve the system performance and the quality of health care (Snyder et al., 2005).

Nevertheless, a health care information system is still not utilized in many health care centers because of the lack of economic incentive and cost-benefit justification, let alone developing the ability to share information with different systems and the ability to change from the traditional environment based paper documentation to the new digital environment (Liu and Zhu, 2007).

2.3 Definitions of information system and health care information system

An information system is an arrangement of information technologies used for capturing, storing, and distributing data to meet an organization needs. These include computer hardware, operating system and application software as well as telecommunication and networking technologies. Profit making business enterprises, non-profit making charity bodies, social organizations and government agencies all rely on information systems to be effective (Wikipedia.org, 2008).

Hence, health care information system is a computer application for patient health center to represent patient information in a user friendly interface to allow users to review and interact (adding, saving, modifying, deleting, etc) with patient health information, such as diagnosis, medicine orders and other services. Moreover, application health information system works as data repository for patient health information such as patient registration, systems administrator and financial management (Giffin et al., 2006).

In addition, a health care information system has a set of important patient information stored in electronic format that provides health staff, the flexibility and accessibility to patient's information, stored in the system server.
On the other hand, an Electronic Patient Record (EPR) is defined as the process to convert the traditional documentation medical paper based records into electronic computer based information system medical records. These include all patient medical records such as written text, codes, images, audios, and video notes and any other information related to the patient (Liu and Zhu, 2007).

In the same manner Laserfiche (2007) developed application software to improve the health care services in the health care called EMR/HER. Initially EMR/HER are working to reduce using paper inside the health care through generating an electronic health record or electronic medical record for each patient and improving the electronic document management (EDM). Moreover, this system can work as two categories.

1- Stand alone: typically focus for developing comprehensive functions that can be used in a side-by-side manner or integrated with other applications. This category helpful for health care that required a document management and caring about the digital record.

2- Add-on modules to primary applications: Realizing the need and importance functions, that makes it easily to linking to a specific record which help the health care that care about integrating a module with the primary application.

The advantages of this application are the ability to be integrated with other application based on the user requirements such as the following:-

i. **Side-by-side:** Most people are familiar to working with multiple applications like Outlook, word and excel. Electronic document management system provides very easy way to switch to for retrieval the electronic records.

ii. **Data Look-Up:** EDM provides solution to populate template automatically, and the source of the populated data for instance a data stored in another application such as a practice management or an EMR system.
iii. **Data Push to Other Applications:** which mean the data that is manually or automatically captured in template fields can be exported to other applications.

iv. **Image-Enablement:** The most common integration of stand-alone EDM with third-party applications involves searching the document repository from within the other application by activating an option in EMD to activate the function.

### 2.4 Health Care Management system

It is very important to keep extensive information of patients, but it is not easy to retrieve them from traditional patient records (papers) because the amount of available data about patients is huge. So, initially the importance of information system in health care has originated from this issue, which means systematically replacing the papers documentation in health care to electronic media record (Zeng and Cimino, 2000).

Moreover, a health care information system protects patient health information history and provides the flexibility and accessibility of the information to be more reachable by authorized personnel (Rogers et al., 2006).

Therefore, paper documentation is not practical as it has limited aptitude (saving patient information, retrieving patient information, etc) to support patient health care and cannot be accessed remotely. Health care information system addresses these limitations by providing the flexibility (saving, updating, modifying, deleting, etc) to patient information. In addition, it supports remote access to patient health information (Wilcox et al., 2005).

According to Brown et al. (2008) the benefit for using the health care information system is to provide a complete patient health records to make proper diagnoses and prescribe proper treatments and provides track crucial medical information, insurance data, consultation history, medications, and special conditions.
In addition, using the information system to improve the quality of health care to improve the health care performance in several ways such as allowing the physician to diagnose diseases faster and more safely since historical information will be collected from numerous sources to present an obvious picture of a patient’s health at the point of care.

According to Ibrahim (2002) using the Health Management Information System (HMIS) it is an effective way for planning, developing, co-ordination and evaluation the work in the health care because it is linked the Health Information system to the management, which provides the necessary information for future planning. Moreover, the health care integrated system it’s not only for managing patient information but it also is used for managing the entire health care information, which is the best way to observe and control the huge information of health care (diseases, finance, medication, treatment, out patients, etc).

According to Stolyar et al. (2006) the health information system supports patient health care and gives patients the opportunity to access their own medical health information. Patients can access health information, modify and control information in their records. In addition, the system also allows patients to keep their medical health record even if they change the doctor.

Ciminoa et al. (2000) developed a health care information system with a common gateway interface that presents a set of applications to patients, organized into:

i. Data Entry which contains entering information into the patient record.

ii. Data Review which contains reading and retrieving information stored system database.

iii. Education which contains information resources on various topics.

iv. Advice which contains application of patient data to be online guidelines.
The system developed by Ciminoa et al. (2000) gives patients the opportunity to access their own medical records and to observe the results for a patient view (Figure 2.1). In addition, the health care data are presented in the same manner that is used to present to the health care staff.

Chua (2005) developed a Tele Primary Care implemented as distributed application has a repository of medical records for patients. The health care maintains the patient’s Electronic Medical Record (EMR), which are local to each clinic in the health care and contains patient’s medical history, surgeries, immunizations, risk factors, and health and activity status, providing a historical database. In addition, this system maintains the central repository by having the member clinics update the repository. Other advantages for this system in the following:

i. Capability to capture online EMR for all patients at primary care area.

ii. Consolidated reports for all patient records, and historical data.
iii. Ease of patient registration.

iv. Provide an easy way for making appointments.


vi. Increased network reliability.

vii. Ensured scalability for expansion to 2,000 clinics.

Mazzi et al. (2006) refer to result of study about current system use in the healthcare, which reveal most healthcare technology is dedicated to the resolution of a patient’s complaint of the healthcare and there is a lack of software that fulfils the patient’s need for medical information and the doctor’s desire to monitor patients. Furthermore the study also reveals that current software applications are dedicated to only one activity of the healthcare and that this functionality is not integrated with other systems.

Based on that study Mazzi et al. (2006), a health care information system called agent software was developed. This system illustrated the relationship between doctor and patient during a treatment process, using a prototype agent system, which consist of three stages:

i. An initial Personal Meeting stage.

ii. An Examination stage.

iii. Integration through Dialogue stage.

The most important is the third stage, which involves the integration of medical information into the continuing dialogue between doctor and patient. In addition, this system able to provide the following services to the patients.

- The patient-doctor relationship is extended
- Proactive healthcare with emphasis on prevention
- Patients have access to high quality medical information
- Patients are monitored at home or on the road.
Patients often do not know if their symptoms are serious enough to see a doctor. Agents can help to identify those patients who really need medical attention from those that only need information.

Better treatment completion

Wald et al. (2004) developed a web page Patient Gateway portal called Longitudinal Medical Record (LMR). This system is an electronic medical record system used by physicians and other clinical staff in the outpatient setting to automating the documentation of medical care, including patient problems, procedures, medications, allergies, health maintenance topics, and encounter notes. In addition LMR is used to write prescriptions and to communicate with other providers.

The main concept for LMR system (see Figure 2.2) is web-based health care management system portal to provide very secure communication between patients and physicians, in addition incorporates services such as prescription renewal and appointment.

![Figure 2.2 Integrated Web Page Patient Gateway Portal (adapted from Wald et al. 2004).]
Lindemann-v et al. (2002) developed a TBase2 health care system. This system is designed to store relevant data for each patient and allow access to that data by all persons who are authorized to do so in the health care. In addition, there exists an intranet within the health care that allows connecting almost every computer to the health care system (TBase2) (Figure 2.3). TBase2 is designed to comprise the whole medical information about a patient, e.g. medical free-text, numerical data, standard definitions and medical images. Moreover, it is presented at web-based electronic patient record of transplantation patients running in the daily routine of large health care distributed over a wide area.

![Figure 2.3 The Integrated Tbase system](adapted from Lindemann-v et al., 2002)

Lim et al. (2006) developed a portal web-based healthcare system that integrates components such as patient management, patient accounting, appointment, house call and communications into one complete package solution. These components are developed using portal technology. A healthcare web portal serves as the integrated getaway in a healthcare centre website and provides to the users a single point of access (Figure 2.4) for the healthcare services delivery. This portal technology supports single point of access and also different accessing levels to prevent patients’ records being accessed by un-authorized personnel while maintaining one simple gateway for all levels users.
A health care information system has an interface that facilitates the user to interact with the system. So, once the patients arrive at the clinic, they must register their personal information and health history in the health care center. The system automatically updates the patient information. Then, the patient will be under queue to make an appointment for medical check-up by a physician. Next, the physician will specify whether the patient case is an emergency case or not. If it is an emergency case, the physician will retrieve the relevant patient information from the system database. Nevertheless, in general, the system can also request the examination queue for the patient. Finally, after the patient has completed the medical check, the system will place the medicine order to the pharmacy unit and update the information of the patient record (Tang et al., 2001).

2.5 Patient Appointment system

A patient appointment system or appointment schedule for health care center started long time ago. Management of patient appointments has earlier works and has developed simplified queuing models and fairly static scheduling conditions. Another attempt was made to calculate the waiting time between patient and doctor using the mathematical queuing models to minimize waiting time (Harper and Gamlin, 2003).
However; traditionally the appointment system has considered that the doctor time is more important than patient time. So an appointment system was designed to minimize the doctor idle time but current designing of an appointment system is based on decisive factors with respect to both the patient and doctor (Wijewickrama and Takakuwa, 2005).

The patient appointment system has complex structures because it represents the patient appointment time in the healthcare center and controls the patient waiting time based on the type and the period of patient appointment (Harper and Gamlin, 2003). Moreover, a patient appointment system is meant for:

i) Managing doctor time.

ii) Reducing patient waiting time

iii) Reducing doctor idle time.

iv) Reducing nurse idle time.

v) Improving the quality of service in the health care.

2.6 Managing Patient Appointment system

According to Dexter (1999), managing patient appointment system is a computer application used to manage and reduce the patient waiting time in the health care center. Some health care centers do not use any appointment system. So it has a longer average patient waiting time than the health care center that adopts the patient appointment system.

While patients can wait for more than one hour to be attended to by a physician in a health care center, they also can feel that they are being disregarded and treated unfairly. So when patients are given the time of appointment in a health care centre, they can evaluate the quality of service in the centre (Dexter, 1999).
Hence, developing a patient appointment process for health care center necessitates the use of a sophisticated queuing model that captures much of the real system’s features (saving time, reducing idle time, etc). Therefore the appointment schedule represents the real situation in the health care center faced by patient appointment schedulers. On the other hand, the standard practice for scheduling and processing patient appointments are based on the nature of treatments of the patients and that better approaches more sensitive to patient needs are desirable (Rohleder and Klassen, 2002).

According to Hall (2006) the success of a patient appointment system depends on how the patient appointment can be managed. Therefore there are several approaches to improve the management of patient appointment. They are:

a) Enforcing the continuity of patient care.

b) Increasing the effectiveness of each appointment.

c) Reducing the demand for face-to-face patient physician interaction.

The continuity of a patient health care can be improved by reducing the unnecessary appointments, once the patient is attended by a physician, who did not treat patient in the previous visits. The probability for extra appointment is increased. In addition, once the patient requests an appointment, the schedule is checked for any appointments and/or some predictable appointments in the future. Thus, a single appointment can be used to attend to multiple patient needs. An effective manner for an appointment request is through phone call and/or email. Through this means, the patient need not worry about getting an appointment and need not go to the health centre personally to make an appointment, thus saving precious time. Moreover, using the email or phone for direct interaction between the health care centre and the patient enables also checking test results, appointment reminders and other services (Hall, 2006).
In the same manner, in some appointment systems, the patient appointment is scheduled directly by the primary care provider in the health care centre at the beginning of each month. All appointments of new patients are also scheduled in the health care centre. The patient could mail a letter containing explanation of the purpose of the appointment to a health care center and requests for information on the procedures of health care, primary care providers and the attendance time. Generally the schedule is set between two or four weeks. After the patient has visited the health care center and is already charged a fee for treatment, patient can then make another appointment. In addition, approximately 10 patients are scheduled for each clinical session. The patient registration is done by the nurse, who has to give information to the patient about procedures in the health care center and collects patient information, which are then entered into the patient’s medical record (Jain and Chou, 2000).

One application developed to manage patient appointment scheduling has used exponential enter arrival times. This model assumes that the exponential enter arrival times could not be directly validated by date, and it is limited due to the nature of the appointment scheduling. Since appointments are scheduled in the future, the exact model of call arrivals will only have limited impact on measures related to the time between the call and the appointment time. For this reason, the challenge for making appointment system is designing a suitable system based on the health care procedure environment. Hence, the appointment provider in the health care center can schedule a patient into an appropriate time slot on a given day (Rohleder and Klassen, 2002).

Klassen and Rohleder (2004) have developed another method for managing patient appointment using multiple schedule appointment in multiple period environments. Patients can call for any appointment time but if the period time is full, they should replace the appointment to another time.
Moreover, various combinations for multi appointment and double booking are measured and recommended for different operational use depending on the health care environment, because the varying appointment request has little effect on appointment system performance especially maintaining acceptable performance, except when the system has the overloaded option.

Many studies about patient appointment have found that there are rules or policies for scheduling appointment system such as no scheduling for more than 20 or 30 clients and the best schedule is to place two patients in the first appointment and spread the rest consistently over a period based on average service times. On the other hand, a patient can call for an appointment without knowledge of the type of appointment and appointment queue number and patient is not aware whether the appointment is variable or not. Sometimes the exact duration for each patient can be known but at other times this is unknown (Klassen and Rohleder, 2004).

Giachetti et al. (2005) have observed the process for patient flow, from the time they arrive at the health care center until they are discharged and designed a patient appointment flowchart as shown in (Figure 2.5), giving more explanations about the patient appointment process.

a. Patients are checked in the scheduled appointment by a Patient Care Assistant (PCA). Patients, who arrive after 15:30 are not allowed to check-in. They have to leave the clinic without being treated.

b. After the patients have checked in, they are given identification numbers.

c. Then they have to wait in the waiting area. Meanwhile, the PCA prepares the charts for the checked-in and places them on a table.
d. A nurse retrieves the charts to call in the patient for preliminary assessment. If a patient is a follow-up (not first visit) then patient does not require a preliminary assessment.

e. Once the preliminary assessment is performed, the patient returns to the waiting area, and the nurse places the charts on the disposition table for the doctors.

f. After the doctor has treated the patient, patient gives the (patient’s chart) to the PCA.

g. The PCA enters the patient information into the computer and gives the patient the next appointment date as needed.
Through observation of this process, the patient’s appointment is not a strictly first-in first-out (FIFO) process. Once the patient is checked in, the appointment process is done upon ordering of the patient charts. If the charts get shuffled out of order then the FIFO processing is upset. Moreover, a physician will skip over a patient if the patient is a follow-up of another physician. This is done for clinical reasons called continuity of care (Giachetti et al., 2005).
Another system developed by Mustafa, (2004) allows a registered patient, having user name and password, to access and explore the list of physicians alphabetically and select a physician, whose email contact and profile are also provided. A patient can also view the physician working calendar to find out his/her working and non working day to make an appointment. When the patient selects ‘View Calendar (Figure 2.6), the patient can then choose any valid day in any month to make an appointment (Figure 2.7). After that, the patient will receive an e-mail from the system to confirm the appointment time or to inform the patient that the selected time is already taken by another patient or blocked by the physician.

Figure 2.6 Information about physicians
(adapted from Mustafa, 2004)

Figure 2.7 Appointment time table
(adapted from Mustafa, 2004)
In general, the patient appointment system provides all the choices and the capabilities to the patients, such as selecting a physician, selecting the time of appointment, and allows them to access the health care system day or night and schedule their own appointments using the Internet without spending time holding for a nurse or having lengthy phone calls (Mustafa, 2004).

A study by Wijewickrama and Takakuwa, (2005), mention that the health care operating time (due time) is from 8:30 am to 5:30 pm during the week days. Throughout this period, four types of patients arrive to have a consultation appointment in the health care center-appointed patients, same day appointment patients (walk-ins), patients who come for a medical test and new patients.

Therefore, for the patient flow in the appointment system as depicted in (Figure 2.8), new patients will have to go to the reception for registration (filling-out the application) and other patients may have to go to the reception to check whether they have to submit some requirements such as insurance care. Patients, who have appointments are given priority over those who walk-in for consultation. Consequently, these latter patients have to wait a long time in the waiting room to meet a doctor even if the consultation time only last few minutes (Wijewickrama and Takakuwa, 2005).
Harper and Gamlin, (2003) studied the methods of managing patient appointments in health care centers to reduce outpatient waiting times by improving the appointment schedule. They made several schedules to do this process. The aim of the initial step was to find out the balanced number of patients arriving every 5 minutes, for instance, between 14:00 and 15:40 and all the extra patients would be scheduled between 15:45 and 16:00. The patients are arranged in booking blocks, which have different sizes according to the type of patients as follows:

a. Follow-up – 3 every 20 minutes.

b. Extra – 2 every 30 minutes.
c. New – 1 every 15 minutes.

d. Urgent – 2 every 30 minutes.

e. Ward discharge – 1 every 30 minutes.

This block appointment contains also buffer periods (15 minutes) for patients without booking. Hence, for the system flexibility, the appointment time between 15:35 and 15:45 is kept free. This process of managing patient appointment is based on an algorithm, which spreads among the appointments based on clinical sessions, for instance, using the time between 14:00 and 16:55 for patients, who are in the schedule but not in the block appointment. The algorithm below has considered this process (Harper and Gamlin, 2003):

a. Choose the patient type, except diary patients, with the largest average consultation time.

b. From the patient type, schedule individual patients in every available appointment slot, determined by total number of patients divided by the total number of appointment slots, in the clinic sessions.

c. If no patient type remains to be allocated, go to step (vii).

d. Else, if there exists patient types not previously located, choose (i).

e. For the clinic under consideration, calculate the total number of patients booked for each time duration and identify the largest consecutive cluster of time duration, that contains the minimum total number of patients booked.

f. Scheduling a patient in the middle of the group. If the group contains a numbers of times, scheduled the patient in the earlier of two middle.

g. If there are still patients of this type, which need to be allocated then, go to step (iv), Otherwise go to step (iii).

h. Stop.
Porta-Sales et al. (2005) have developed another system. The main concept of the system is contacting, screening and scheduling appointment with the health care center initially by an expert nurse and the patient initiating contacting with the health care center using the telephone. Moreover, the health care center can be accessible from different places. So there should be PC resources and PC consultations to be accessed from different sources, from other hospitals, from general practitioners, or even from the patients themselves (see Figure 2.9).

![Figure 2.9 Patient Flow diagram](adapted from Porta-Sales et al., 2005)
Porta-Sales et al. (2005) studied 534 patients for a period exceeding one year. After the first visit, 195 patients did not return for the second scheduled appointment and 203 patients had progressed on to the third scheduled visit. The main reason given for the scheduled visits was admission into the health care; the median time-lapse between the first and second visit was 21 days, between the second and third was 27.5 days and between the first and third was 48 days. Comparing patients, who did not attend the three consecutive visits with those who did, indicated that the former had (at the first visit) a lower performance status.

According to Guo et al. (2004), the patient appointment is a process performed by customer service representatives in call centers and the schedules are assigned to incoming requests for appointments but the main problem in determining the appointment is the randomness of patient demand. For outpatient scheduling appointment system, there are four components detailed below:

a) **External request for appointments**

Once a patient calls to request an appointment, the request is taken by the system appointment model. Patient calls are organized into types of appointments (Table 2.1). Calls are usually different day to day, and the requests for appointments sometime are for specific time periods (e.g. weeks or months) in the future. In addition, the type of an appointment depends on the patient request, whether if it is a specific type or not.

<table>
<thead>
<tr>
<th>DL</th>
<th>Dilated “regular” appointment</th>
</tr>
</thead>
<tbody>
<tr>
<td>FU</td>
<td>Non-dilated follow-up appointment</td>
</tr>
<tr>
<td>DM</td>
<td>Dilated regular appointment (Medicated/self-pay)</td>
</tr>
<tr>
<td>RM</td>
<td>Non-dilated follow-up appointment (Medical/self-pay)</td>
</tr>
<tr>
<td>ER</td>
<td>Emergency patient appointment</td>
</tr>
<tr>
<td>PO</td>
<td>Pre-post-surgery checkup appointment</td>
</tr>
<tr>
<td>AN</td>
<td>Adult patient dilated appointment</td>
</tr>
<tr>
<td>AF</td>
<td>Adult patient non-dilated appointment</td>
</tr>
<tr>
<td>RO</td>
<td>Specialty appointment for ROP patients</td>
</tr>
</tbody>
</table>

Table 2.1 Appointment Type
(adapted from Guo et al., 2004)
b) Patient Flow Logic

Patient Flow Logic is a sequence of appointments (Table 2.2). The historical data is used to determine the appointment. Often the patients prefer to see the same doctor for each visit to the clinic and new patients would like to get early appointment times. Follow-up appointments are sometimes scheduled well in advance of the actual date.

Table 2.2 Basic Patient Flow Logic
(adapted from Guo et al., 2004)

<table>
<thead>
<tr>
<th>1. Arrival of new patient call</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Patient characteristics are drawn from distributions (appointment type, insurance.)</td>
</tr>
<tr>
<td>3. Appointment is scheduled</td>
</tr>
<tr>
<td>4. Delay until appointment day</td>
</tr>
<tr>
<td>5. Does patient show up for appointment? If not, go to 6, otherwise go to 7</td>
</tr>
<tr>
<td>7. Does patient need a follow-up appointment in the same appointment category? If so, then go to 8, if not then go to 9.</td>
</tr>
<tr>
<td>8. Delay until patient calls for follow-up appointment, then go to 3.</td>
</tr>
<tr>
<td>9. Does patient need a &quot;regular&quot; follow-up appointment? If not then exit system.</td>
</tr>
<tr>
<td>10. Delay until patient calls for follow-up appointment, and then go to 3.</td>
</tr>
</tbody>
</table>

c) Supply

In practice, schedules providers are determined by templates, which are essentially daily specifications of the number of appointments for different types of appointments. This accommodates different productivities of the providers as well as different specializations, which will result in different proportions of appointment types attributed to various scheduling requirements, such as vacation time, research time, and other commitments.
d) Scheduling Rules

Computerizing the schedule moves the scheduling operation to the call center, through a specific model, assigned to a patient appointment request. The main principle, currently used by the schedulers, is the level of urgency of the appointment. It determines the scheduling flexibility whether or not an appointment may be over reserved and whether the appointment is specific to a particular provider, any available doctor should provide the necessary care.

Su and Shih, (2003) have studied in a private hospital, which has several clinics. For each clinic, the average patient load is 20 per consultation section (morning or afternoon) and the health care system adopts both a patient appointment model and patient registration model. The system allows patients to have self-selected specific physicians for consultation and registration.

The management appointment system studied by Su and Shih, (2003) is based on the first 20 reserved for scheduled patients, after that, only seven are offered for scheduling. Odd numbers after 20 are left for walk-ins. The arrival time of the first patient is assumed to be the same as the clinic starting time. The scheduled patients are assigned based on 3- main intervals and are also informed about their appointed arrival times (see Figure 2.10).
If the scheduled patient does not appear on time, the next available patient receives consultation immediately. The management operating philosophy of services here is based on “first in, first seen” to limit patient waiting time. Therefore, a patient can walk-in to see a physician, when patient shows up at the appointed time (Su and Shih, 2003).
Ellingsen and Obstfelder, (2006) studied on Individual Action Implementing Electronic Booking System. The system refers to the patient's appointment, when patient arrives at the hospital for examination and/or treatment. Traditionally, the patient must have an appointment. Determining the appointment depends on the hospital resources and the patient current condition. When the decision of an appointment time is made, the patient is informed by mail with the hope that it suits the patient. The implementing system here is to solve this problem through establishing a flow of patients through the health care system by giving the opportunity to a patient to choose a suitable date and appointment time for them.

A web-based booking application to help the patients to get an appointment can be developed. Once the nurse decides that the patient needs an appointment, the nurse logs in the web-based booking application using both username and password and then specifies the appointment time. Ellingsen and Obstfelder, (2006) have developed a new concept to facilitate two or more systems in the health care center such as electronic patient record and electronic booking application. They incorporated the electronic patient record and electronic patient record in the same system when a patient needs to enter their particulars, where there is special page for this purpose (see Figure 2.11) and when the patient want an appointment they have to log in the specific page in the appointment process (Figure 2.12).

![Figure 2.11 Patient information for registration](adapted from Ellingsen and Obstfelder, 2006)
Aiello (2005) worked on the patient appointment system in an army primary care clinic. It is an Open Access Appointment System. There are three classes of appointment systems in the army primary care, with each having different types of appointments:

i) The traditional access system: patient has to call the clinic for an appointment and depending on the patient medical need, patient given an appointment type and time.

ii) Predictable request for appointment: Patient, who calls earlier, will benefit from confirmed appointment, whereas the patient, who calls later, will be placed in an unconfirmed future date.

iii) Nontraditional appointment approach: the patient is asked 'Do you want an appointment today? and who is your preferred physician? Then, the patient will define and control the appointment process.

In managing patient appointments in the army primary care, normally, there are nine types of appointments. Once a patient calls for an appointment, patient will be placed into one of the nine appointment types. Many clinics in the army are establishing this service to handle the inability of patients to receive the same day care. The open access method is a solution for patients, who is unable to see the nurse for the second appointment and this reduces the current backlog of clinic appointments until every patient is able to accept the same day appointment.
Kopach et al., (2007) has developed a system, where the appointment can be made many months in advance. Once the patient wants to have an appointment to see the physician, they just have to call the health care informing the preferred date and time. If the appointment slot is available within a day or two of the preferred date, the patient appointment is then scheduled. If not the patient has to call back later; (Figure 2.13) shows this concept, which balances between the request of appointment and the clinic capacity. This has improved patient access to physicians and reduced uncertainty in the health care operations by eliminating no-shows, resulting from long appointment times. In addition, in static appointment, all decisions about appointment times are made prior to the start of a session, but in the dynamic case, the appointment times are adjusted as patients arrive.

![Figure 2.13 Patient appointments process](adapted from Kopach et al., 2007)
There are three parameters in the appointment system - the “block,” which is the number of patients arriving at the beginning of an appointment period; the “initial block,” which is the number of patients arriving for the initial appointment; and the “interval,” which is the length of the appointment (Kopach et al., 2007).

2.7 Critical analysis for previous research

Based on the literature review (see Table 2.3), all the previous studies are targeting to do some or all of the following:

- Improving the quality of health service.
- Managing patient information in the health care.
- Managing the patient appointment.
- Reducing the patient waiting time.
- Providing the easy way for patient health.
- Keep tracking for patient information.

On the other hand, those studies come out with one or both of the following points:

a) Analysis: some of the previous studies were targeted to analysis the current system use in the health and find out the points that can help to improve the performance of health care system and improve the quality of health care. An analyses aim was focusing on the steps of patient treatment and consultation. In addition, managing the patient appointments and focusing on reducing the patient and doctor idle time. Therefore the results of those analyses were Patient treatment and consultation flow chart and Patient appointment flow chart (see Table 2.3).

(Giachetti et al., 2005), (Wijewickrama and Takakuwa, 2005), (Porta-Sales et al., 2005), (Guo et al., 2004), (Su and Shih, 2003) and (Kopach et al., 2007).
b) Developing health care system: some of the studies were targeted to come out with a health care information system, such those systems were developed based on the user requirements and or based on the system needs. The main point here is the health care has much information that needs to be managed such as patient information, medication history, appointment, doctor schedule, health care document and payment and so on. Therefore the researchers followed a different method for developing those systems (see Table 2.3).

i. Application: Computer application developed as a client and server in entrant network. This type of application can manage the health care information and it helps to automate the health care information. Such an application was developed by Laserfiche (2007) and Rohleder and Klassen (2002).

ii. Web-based: It’s a health care website is linked to an interactive database. This system can be accessed as a normal website because it's been developed to be work based on the web browser. Such a Web-based was developed by (Wald et al. (2004), Lindemann-v (2002) and Lim et al. (2006).

iii. Website: It is a health care website and the patient can review and register online through it. Such a Website was developed by Ciminoa et al. (2000).

iv. Email: Used for sending messages from the health care staff to the patient to inform them about new appointments or any announcements and the patient can send to the staff regarding
any inquiries. Such these service used in a system developed by Mustafa (2004).

v. Telephones: The traditional way for connecting between the patient and the health care staff. The patients use it for booking appointments or confirming appointments or any other inquiries. Such this system an integrated with computer application. This system has been developed by Porta-Sales et al. (2005).

vi. Blocks: This means dividing the patients to groups. This way it’s a result for analysis study has been done by Harper and Gamlin (2003).

vii. Multiple methods: Some of the researchers use multiple methods for developing health care system to get the benefit of each method. Such as Application and Web-site by Chua (2005), Mazzi et al. (2006) and Aiello (2005).
Table 2.3 Critical analyses, system features and types for previous studies based on the literature review

<table>
<thead>
<tr>
<th>Features 1</th>
<th>Features 2</th>
<th>Features 3</th>
<th>System Type</th>
<th>Analysis and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laterichhe (2007)</td>
<td>reduce using the paper inside the health care</td>
<td>improving the electronic document management (EDM)</td>
<td>able to be integrated with other applications based on the user requirements</td>
<td>Application Paperless computer applications and flexible enough to add another module based on the user requirement</td>
</tr>
<tr>
<td>Cannava et al. (2000)</td>
<td>Gateway interface that presents a set of applications to patients</td>
<td>give patients the opportunity to access their own medical records</td>
<td></td>
<td>Web-site Health care website only, the patient able to review their records but if not complete</td>
</tr>
<tr>
<td>Class (2005)</td>
<td>Distributed application has a repository of medical records for patients</td>
<td>Able to capture online EMS for all patients at primary care area.</td>
<td>Ease of patient registration and making appointments</td>
<td>Application &amp; Web-site Web-based, patient can register online, and booking appointment; it’s not integrated system</td>
</tr>
<tr>
<td>Sestini et al. (2006)</td>
<td>Illustrated the relationship between doctor and patient during a treatment process, using a prototype agent system</td>
<td>Integrating medical database into the information system between doctors and patients.</td>
<td>Patients have access to high quality medical information</td>
<td>Application &amp; Web-site Patient able to use the system, the architect of this system to allow the doctor to observe the patient health online</td>
</tr>
<tr>
<td>Wald et al. (2004)</td>
<td>Integrated health care system for Personal Health Records</td>
<td>The core of information shared between systems is systematized and patients have the option to update their information without sharing the information if they wish.</td>
<td></td>
<td>Web-based Systems able to interact with the patient information and demonstrating the patient record online and the patient have an account can be updated by them</td>
</tr>
<tr>
<td>Lindemann et al. (2005)</td>
<td>Storing relevant data for each patient and allow access to that data by all persons who are authorized</td>
<td>Connecting inside the health care through the Internet</td>
<td></td>
<td>Web-based Integrated web-based, client and servers but the patient cannot book online</td>
</tr>
<tr>
<td>Lina et al. (2005)</td>
<td>Integrating health care components</td>
<td>Integrated gateway in a healthcare center website</td>
<td>provides to the users a single point of access</td>
<td>Web-based a web-based system to manage the patient information and each user has its privilege level</td>
</tr>
<tr>
<td>Gisberti et al. (2005)</td>
<td>Designing patient flow.</td>
<td>Designing the appointment process flow</td>
<td>Traditional Procedures</td>
<td>Studied the appointment process flow by the traditional way and form on reducing the patient waiting time</td>
</tr>
<tr>
<td>Stibitza (2004)</td>
<td>the patient can view online the physician working schedule</td>
<td>The patient can book the appointment for themselves.</td>
<td>For confirming the appointment system lead to the patient, that the appointment has been confirmed or not</td>
<td>Web-based appointment system, the patient can view the staff schedule online and select the appointment day</td>
</tr>
<tr>
<td>Wijesankala and Thakur (2005)</td>
<td>Improving health care processes.</td>
<td>Studying and developing a model to examine the waiting time for outpatient consultation.</td>
<td>Studying the outpatient flow up in the in the outpatient department of internal medicine</td>
<td>Traditional Procedures Traditional study to reduce the patient waiting time and the managing the patient appointment</td>
</tr>
<tr>
<td>Harper and Goffin (2003)</td>
<td>studying the methods of managing the patient appointments in health care centers to reduce outpatient waiting times</td>
<td>Dividing patients into groups based on an algorithm</td>
<td>blocks &amp; Traditional Procedures Traditional study to reduce the patient waiting time and the managing the patient appointment</td>
<td></td>
</tr>
<tr>
<td>Perga-Silva et al. (2005)</td>
<td>scheduling appointment by an expert nurse and the patient visiting consulting with the health care center using the telephone.</td>
<td>The health care center is accessible from different places.</td>
<td>There should be PC resources and PC consultations to be accessed from different sources, from other hospitals, from general practitioners, or even from the patients themselves.</td>
<td>Web-site &amp; telephone Traditional study to reduce the patient waiting time and the managing the patient appointment</td>
</tr>
<tr>
<td>Gia et al. (2004)</td>
<td>customer service representatives in call centers and the schedulers are assigned to incoming requests for appointments</td>
<td>Dividing the outpatient appointment demand into four components (External request for appointments; Patient Flow Logic, Supply, Scheduling Rules)</td>
<td></td>
<td>Web-site &amp; Traditional Procedures Traditional study to reduce the patient waiting time and the managing the patient appointment</td>
</tr>
<tr>
<td>Su and Shih (2002)</td>
<td>studied in different hospitals the number of patient for each consultation section and developed patient appointment model and patient registration model.</td>
<td>The patient allowed self-select specific physicians for consultation and registration.</td>
<td>Managing the appointment is based on, &quot;first in, first seen,&quot; to limit patient waiting time.</td>
<td>Web-site &amp; Traditional Procedures Traditional study to reduce the patient waiting time and the managing the patient appointment</td>
</tr>
<tr>
<td>Auerle (2009)</td>
<td>Developing an Open Access Appointment System.</td>
<td>Organizing the appointment into three classes (the traditional access system, Predictable request for appointment, Non-traditional appointment approach)</td>
<td>Dividing the appointment into nine types and Once a patient calls for an appointment, he/she will be placed into one of the nine appointment types</td>
<td>Telephone line &amp; Application Multi-system can use computer application and telephone line for booking appointment and managing patient time</td>
</tr>
<tr>
<td>Kopecki et al. (2007)</td>
<td>Organizing the appointment into cliffs</td>
<td>For setting an appointment the patient have to call the health care center and inform the nurse about the preferred date and time.</td>
<td>The patient appointment the patient have to call the health care center and inform the nurse about the preferred date and time</td>
<td>Telephone line &amp; Application traditional way for managing the appointment and confirm the appointment</td>
</tr>
</tbody>
</table>
Based on the previous study, and analysis done in section 2.7 the conceptual framework based on the literature review in an integrated developed system show on (Figure 2.14). In addition the conceptual frame works for the appointment system (see Figure 2.15).

Figure 2.14 Conceptual framework for health care system based on the literature review

Figure 2.15 Conceptual framework for the appointment system based on the literature review
Table 2.4 Limitation and strength of the health care system based on the previous study in the literature review

<table>
<thead>
<tr>
<th>Strength of health care system</th>
<th>Limitation of health care system</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Improving the quality of service in the health care (Laserfiche, 2007),</td>
<td>- Most of the systems are not integrated system (Mazzi et al., 2006).</td>
</tr>
<tr>
<td>- Using the system online and allowing the patient to view their profile online (Lindemann-v et al., 2002).</td>
<td>- Some of the systems developed to manage part of the health care information (Mazzi et al., 2006).</td>
</tr>
<tr>
<td>- Integrated health care system (Lim et al., 2006).</td>
<td>- All the applications hold around the appointment problems and did not give enough mention about confirming the appointment (Mazzi et al., 2006).</td>
</tr>
<tr>
<td>- Patient can choose the physician and the appointment date online (Mustafa, 2004).</td>
<td>- Confirmation the appointment usually using the call by phone (Porta-Sales et al., 2005).</td>
</tr>
<tr>
<td>- Using the call by phone to interact between the patient and the nurse.</td>
<td>- Using the email for booking and confirming the appointment, which is some time not suitable for some patients (Hall, 2006).</td>
</tr>
<tr>
<td>- Using the online manner to support the health care application.</td>
<td></td>
</tr>
<tr>
<td>- Dividing the problem of managing the appointment into small blocks, which help to find a good solution (Harper and Gamlin, 2003).</td>
<td></td>
</tr>
</tbody>
</table>
2.8 Conclusion

Information system is a technology used to deliver the right information to the right person at the right time in any fields of business. Essentially, the system is an arrangement of information technologies used for capturing, storing, and distributing data to meet an organization's needs. This includes computer hardware, operating system and application software as well as telecommunication and networking technologies.

In the health care information system, the importance of an information system has originated from the need of keeping tracking of patient information efficiently. The Health Care information System is the preservation of individual patient information to represent their health information history and provide the flexibility and accessibility for patient information to be more reachable by authorized personnel. On the other hand, managing patient appointment is a computer application used to manage and reduce the patient’s waiting time in the health care center. This means a patient appointment system uses a sophisticated queuing model, that captures much of the real system’s features.

Traditionally, determination of patient appointment is dependent on the hospital resources and the patient current conditions. So, when the decision of appointment time is made, the patient is informed by mail, phone, or other means with the hope that the appointment time satisfies the patient. Therefore, developing a software or application for solving the health care problems has to consider several aspects of the problems.

Based on the literature review, and the critical analysis done in section 2.6 there are some points of relevance to be considered:

i. The proposed health care information system should cover every single aspect of administrating and managing health care.
ii. In using the information system, for managing the health care information to improve the quality of health service.

iii. In using the information system, the patient is given the opportunity to use the system and access his/her information.

iv. In using the information system, the patient can access the appointment possibilities and chose the suitable time.

2.9 Summary

The literature review dedicated to review what the previous researchers have done to improve the quality of health care. In this research, the objectives focuses into analyzing the previous studies and the current systems use in the health care, then design and develop an integrated health care system for managing the patient information and tracking the patient information history. In addition, provide very secure and sturdy communication between patients and physicians.

Hence, a general information about health care information system has been presented to give briefing about definitions and significant of health care information. Then the next part present the health care management system, patient appointment system, managing patient appointment system, which reviewed the previous studies that explained several methods for managing the health care information and the patient appointments. Finally, it is the critical analysis part for the previous studies, which present the features of each study and the result is conceptual framework and comparison between the limitation and the strength of each study. The next chapter is the research methodology, which describe the method that use to implement this research.