Dentist Web Based Patient Information System and Services in Cloud

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ABSTRACT

Context:

Cloud Computing is the new field that was invented and developed during period not so long ago. It has a lot of benefit like decreasing the cost that the user need, process the operation faster, and memory and storage requirements are satisfied. The security of cloud is the most important issue for several sensitive occupation, for Dentist using this kind of computing does not need more than computer and good internet to use application which is developed by cloud computing.

Objective:

The goal this thesis is finding the benefit of using cloud computing for software application as Dentist development environment for dentist patient system and save their information on one database which is available in cloud. Then expect the future of Cloud Computing.

Methods:

The environment that we use is EC2 on AWS (Amazon Web Services) as host for dentist web application which has several services to allow each dentist, and patient used the application separately and securely. SQL server is used for creating the database. This database is saved on server that is generated by a database management system on EC2.

Results:

Preparing web site for dentist allow each dentist to keep his patients’ information in database on cloud computing.

Conclusion:

Drought knowledge about cloud computing, precarious cost, and finding trust host are the Challenges that facing cloud computing now but I believe these problems will be solved in the near future.

Keywords: Cloud computing, dentist application, Amazon Web Service(AWS),e-Heath.

ÖZ

Kaynak :

Bulut Bilgi İşlem , bilgisayar kullanımında yeni bir kavram ve çalışma sahası olup, gerçekleştirilecek yeni buluşlar ve gerçekleştirilecek yeni yazılımlarla her geçen gün zenginleşmektedir. Bu ortamda geliştirilen yazılımlar kullanıcılara bir çok avantajlar sağlamaktadır. Bu ortamlarda daha az maaliyetli bilgisayar olanaklarından yararlanılarak, işlemler daha hızlı yapılmakta, güvenilir ortamlarda işlenmekte ve daha büyük bellekler kullanılarak saklanabilmektedir. Bütün bu özellikleri kullanarak sağlık sektöründe yazılımlar geliştirilebilmektedir.

Amaç : Dis hekimi Hasta takip sisitemi de Bulut Bilgi İşlem ortamı kullanılarak Web üzerinde bir sunucu üzerinde oluşturulan veri tabanında kayıtlı olan hastalara ait bilgilerin diş doktoru denetimindeki kullanımını hedef alıp geliştirilmiştir. Gerçekleştirilen sistemde ayrıca hastaların aynı veri tabanına ulaşarak randevu talepleri de karşılınabilmektedir. Bulut Bilgi İşlem olanakları olarak Amazon Web Servisi hizmetinden yararlanılmıştır. Hazırlanan sistemde bir çok metod tanımlanarak hastalara ilişkin her türlü veritabanı işlemleri ilgili diş hekimi tarafından güvenli olarak yapılabilmektedir.

Sonuç: Bulut Bilgi İşlem günümüzde oldukça yaygın kullanım olanağı bulabileck bir servis, bir yazılım ortamı olup,diş hekimi hasta takip sisitemi de bu olanaklar kullanılarak gerçekleştirilmiş bir sistemdir ve diş hekimlerinin kullanımına sunulabilir özelliklere sahiptir. Ayrıca üzerinde yapılabilecek olan yeni değişikliklerle mobil uygulamaları ile bütünleştirilebilir alt yapına da sahiptir.

Anahtar Kelimeler: Bulut Bilgi işlem, Diş hekimi hasta Kayıt sistemi, Amazon Web Sevisi, e-Saglik.

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INTRODUCTION

1.1 Background:

Cloud computing is one of the biggest dream for computing in IT industry. By this kind of computing the applications software become as a web services based on demand. These services process the operation faster, secure, and high performance, therefore the large companies can obtain the result of their processes quickly as their program can extend [1].

By universal use of cloud computing all of desktops become clean from data and applications, users do not need to update or configure their applications; also installation for any program that related with application is not required. With using cloud computing user can access to any of hardware, software, and data resource [2].

National Institute of Standards and Technology's (NIST) definition of cloud computing describes three services models and four deployment models. Services types are: Infrastructure as a service (IaaS), Platform as a service (PaaS), and Software as a service (SaaS).

Infrastructure as a service (IaaS): With this kind of services the provider supplies all requirements, network and so on; this thesis shows IaaS by using Amazon Web service.

Platform as a service (PaaS): Which refers to the second type of services; it supply platform only and other requirements, will be build by user.

Software as a service (SaaS): On this type of services the provider gives the software applications as services to the user [3].

Private model, public model, community model, and hybrid model are cloud computing models. All of services are available for public users by infrastructure when the model of cloud is public; unlike private which its infrastructures customize for particular user (organization) and services are controlled by cloud owner then the user can access to these services locally. On the other hand infrastructures on community are not monopolized for one organization; hence services can manage from one of these organizations. Finally hybrid cloud refers to combine two kind of cloud together [3].

1.2 Cloud Computing in E-health:

When cloud computing are using for e-health then there is opportunity to access for patient data quickly or find some information about patent like history medical, allergy medicine, and diseases to allow doctor treat patient quickly. On the other hand patients need privacy for their medical information which is available on cloud computing.

1.3 Related Work:

Using cloud for compute the operation is innovated not so long ago, hence there is some research related with cloud especially for health information. The paper [4] pointed out some problems for stander e-health and found solution by using cloud. Improving hospital management system based on cloud is developed by the paper [5]; the author in this paper found that by cloud the efficiency of medical records increase, for instance easy access to different medical department.

1.4 Aim and Objective:

The aim of this thesis is using visual studio to build a cloud data service which takes data from instance in EC2 on Amazon Web Services (AWS), then let AWS host data services from the cloud. Implemented web based project will be used by many dentists for their patients' information system. The dentists or their patients can access to that application by server.

1.5 Thesis Structure:

The content of each chapter will be described as below:

Chapter 1: Contains the introduction of thesis, which includes cloud computing background, benefit of using cloud in e-health, some works which are related with our work and then aim of this thesis.

Chapter 2: Contains theoretical information about cloud computing and Amazon Web Services (AWS).

Chapter 3: Contains literature review of cloud computing and some explanation of these works.

Chapter 4: Contains analysis detail of application such as Entity-Relationship-Diagrams (ERD), interfaces and etc.

Chapter 5: Contains the design and implementations for dentist, patient information system.

Chapter 6: Conclusion of our work and describe future work.

Chapter 2

CLOUD COMPUTING THEORETICAL BACKGROUND

In this chapter some theoretical information about cloud computing will be described; definition of cloud computing, essential characteristics, advantages of cloud computing, concerned, model services, etc.

2.1 What is Cloud Computing?

Cloud computing refers to any application, data, and etc. which is hosted by internet. The name of cloud is coming from symbol that is used for internet in graph. The cloud can be public or private, users can have any services if the cloud is public otherwise service allow limiting of users to access on that service when it is private.

2.2 Why do We Prefer Cloud Computing?

When the cloud computing used, carrying out any files, data, software application from one place to another become unnecessary, because they are available on cloud, hence when the user transfer from one location to another s/he can use any of his/her application easily, also with cloud computing work group can connect to one application even if they are in different location by using security group of IPs address.

2.3 The Reason of Using Cloud Computing:

The reason of using cloud in computing is related with both developer and user. For developer using cloud offer high performance, wide storage and share the application for groups in different location.

For user the benefits above are available and also there are some other benefits such as accessing to his application via internet and get rid of desktop computer, so the user does not lose any data when his/her computer crash or s/he moved from one location to another.

2.4 Cloud Computing Overview Model:

Essential characteristics, service models, deployment models for cloud computing according to NIST (National Institute of Standards and Technology's) shown in figure1 as below. These models will be explained in this section.

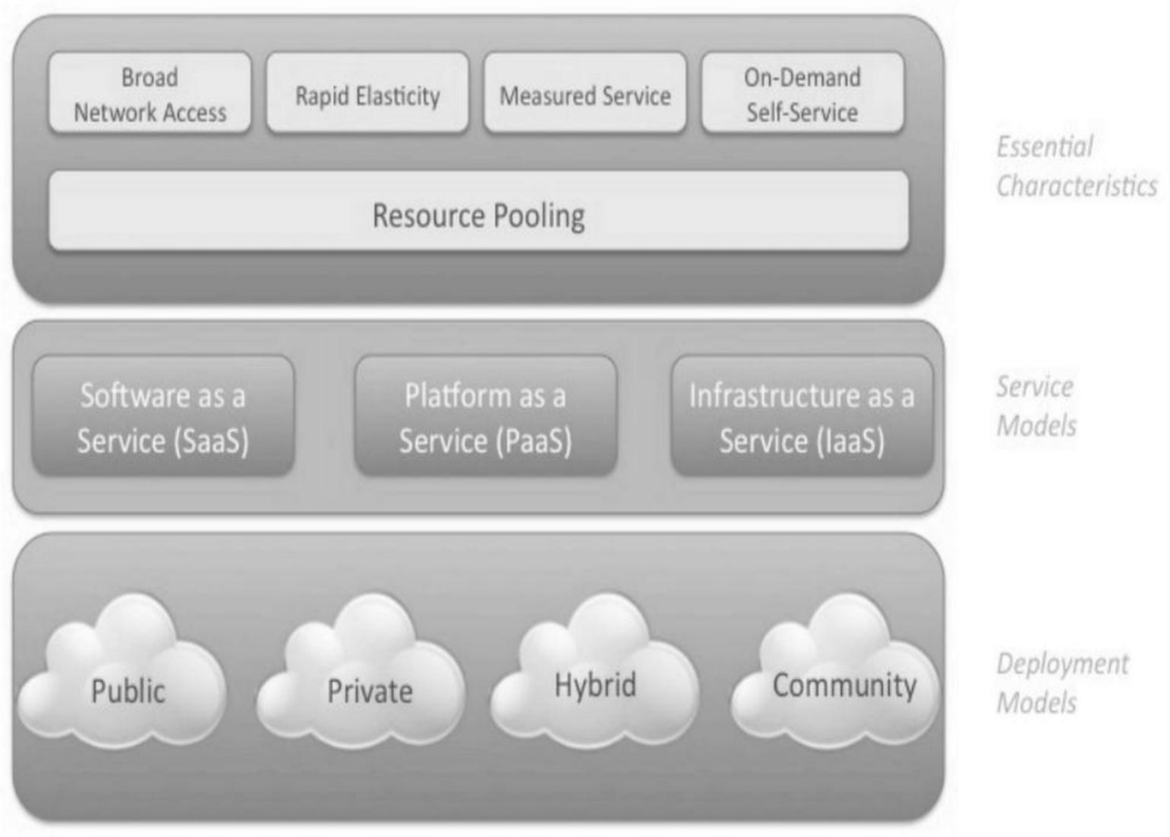


Figure 1. Cloud Computing Overview Model [6].

2.4.1 Essential Characteristics:

Cloud computing has five essential characteristics as follow:

On-demand self-service: User can insert any resource require (network, storage, server, etc.) as soon as s/he wants automatically without needed for human effort.

Broad network access: Here the resources are saved on server which the customer can use them by heterogeneous (laptop, mobile phone, etc.).

Resource pooling: The resources are gathering together then serve several customers. These customers don't know about the saving location for the resource on cloud. The benefits for using this characteristic are "economies of scale and specialization" [7].

Rapid elasticity: Computing resource price is flexible; that means customers can raise or lower the price immediately, for instance increase the price for web site when it has more load otherwise decrease it.

Measured service: In spite of the recourses are pooling together to serve several customer, it can measure usage resources separately for each customer.

2.4.2 Service Models:

There are several models for represent cloud computing. These models are:

Software as a Service (SaaS): Refer to software associate with data that is hosted in a cloud. Users can use these applications by thin layer interface like web browser which is connected with cloud. Google Mail, SalesForce.com are some examples about SaaS [7].

Platform as a Service (PaaS): The provider kept application and all of its tools, configuration management on server. Hence cloud infrastructure completely manage automatically.

Infrastructure as a Service (IaaS): In here IT infrastructure will be used by customer directly. On the other word the provider will supply the servers, equipments, storage, and backup[3]. In IaaS the user can rent resources that s/he needs from provider doe to distributed the resources as a services. Amazon's EC2 is one example of IaaS. The user can use this type of cloud with flexible because it provides highest amount of customization and flexibility to the users [8].

2.4.3 Deployment Models:

Private cloud: Each organization has special cloud that it can control it. Using private cloud has many benefits. Firstly, increased utilization of resources which are existing in organization, secondly, more security for private data, thirdly, the amount of money which one should spend to transfer data from infrastructure in local to public cloud will be saved, finally, create private cloud for specific utility like education [7].

Public cloud: Public cloud is available for all the kind of consumers. The provider has whole of proprietorship of public cloud. Example of this cloud is Amazon EC2, Amazon S3, Google App Engine, and Force.com [7].

Community cloud: Pool several organizations and share with one infrastructure cloud. Hence the control of this cloud will be with another party for instance seller or with one of these organizations [7].

Hybrid cloud: The cloud is integration for two clouds or more, hence their entities become unique. This kind of cloud is used when some organizations want to combine their business functions together for improving [7].

Virtual Private Cloud (VPC): This kind is special kind which is innovated by Amazon Web Service [7]. Its blend between private and public cloud because it use resources for Amazon for all of consumers and on the other hand the connection between application and cloud is secure.

2.5 Advantages of Cloud Computing:

Cloud computing has many advantages at the technical level, user level, company level, and environment level. On this part these advantages will be explained.

Technical Advantages: cloud computing has many advantages on technical side. These advantages are Power Management, Scalability, Data Storage, Efficiency and reliability.

- Power management*:* The advantage of using virtual server is easy management compare with normal physical server [8].

- Scalability: Cloud computing is processing all of operation easily and rapidly during traffic times without extra infrastructure. This action happens without disturb the user work [8].

- Data storage: Cloud computing allows organizations to choose their datacenter easy and use unlimited of data storage on it.

- Efficiency and reliability: Cloud computing has security enough to save all of important data for organization such as financial data which it saved on an external [8].

User advantages: There are some advantages for user as follow [9]**.** The most important advantage is no need special infrastructure for using cloud, therefore any device can access to internet can use for cloud application, hence save capacities on user’s computer. Other advantage is, the user doesn’t worry about updating his/her program or worry about capacity for data because all of these action will be done by cloud provider.

Companies advantages: Cloud computing is useful for small and medium organizations to improve them by spend not much more money for resources [9]. When the company transfers to the cloud, the cost needed for serve its data will be decreased [8].

Environment advantages: cloud computing is used to share data for several center which it good for save electric power for run each server separated or maintain datacenter [8].

2.6 Examples of Cloud Computing:

Some cloud applications are used already for a long time such as web based email (Gmail, Hotmail), some websites for sharing pictures, files, or web based applications (Google, apple MobileMe).

2.7 Challenges of Using Cloud Computing:

When the organizations move to cloud computing they face many challenges. These challenges are [10]:

- **Security:** In cloud computing either provider will be responsible for control the resources or there is no control at all. Hence the security will be less.

- **Lock-In:** The data, procedures, tools are not surely to be portable, so it's difficult for user to move from one provider to another.

- **Isolation failures:** Resources on cloud computing are shared with multi costumers, thus it's hard to separate them.

- **Data protection:** The customer has problem for checking if the data is process or not on cloud and if it is processed in legal way. This kind of problem is faced when the data transfer several times.

- **Insecure or incomplete data deletion:** There is no guarantee when request for delete is given, the data is deleted correctly due to one of two reasons; first several copy from same data are stored but not enable, second this data are used by another user.

- **Malicious insider:** This is the most dangerous risk for cloud computing which is damaged by malicious insider.

2.8 Service Providers:

- Amazon (aws.amazon.com)
- Rack space (rackspacecloud.com)
- Sales force (salesforce.com)
- Google (Google App Engine)
- Microsoft (Windows Azure)
- Joint (joyent.com)
- Gorged (gogrid.com)
- Terre mark (terremark.com)
- Savvis (savvis.com)
- Verizon(verizonbusiness.com)

Nevertheless all of those providers are useful and they have same usage, Windows Azure, Google App Engine, and AWS are become more famous which will be explain them in below:

Microsoft (Windows Azure):

Windows Azure is one of the providers for cloud computing which is built by Microsoft. It is designed for easy use web applications via internet. Cloud services model for Windows Azure is either PaaS or Iaas. Windows Azure is type of both public cloud and private cloud. SQL Azure is one of the services which are available in Windows Azure. This service has Azure database, SQL Azure data Sync, SQL Azure reporting, and Appliance [3].

Microsoft data centers maintain the web application on cloud. Windows Azure can sport Microsoft program languages and even not Microsoft program languages, and also sport XML (Extensible Markup Language), SOAP (Simple Object Access Protocol), and REST (representational state transfer) protocols [3].

Google (Google App Engine):

GAE is platform as a Service (PaaS) which hosts web based application, on Google managed data center. In GAE the application is processed by several servers in different locations which make the architecture of it very complicate [11]. GAE had been generated since 2008, it refer to public cloud. The services which available on this provider are: Memcache, URL Fetch, Mail, XMPP, Images, Google Accounts, Task Queues, and Blobstore.

Some products were created by GAE, such as Gmail, Google Docs, Google Calendar, YouTube, and Google Videos [3].

Amazon Web Service (AWS):

AWS is one kind of provider which is used in this thesis. It refer to Infrastructure as a Service (IaaS) that use elastic for computing the services. By this provider the user can use any kind of operation system like Windows, Linux also any kind of software, hence it is very flexible to use.

AWS contains a group of services; those services allow database, network and etc. to store and use on it.

There are several services are available on AWS such as:

- **Virtual Private Cloud(VPC):**

VPC is service which allows the user to create virtual network that include all AWS services for private using. By this service user can define a range of IP address, create sub network, and all other things that it's been on normal network [12].

- **S3:**

S3 is database storage on internet that allow user to retrieve or access to the database easily [13].

- **DynmoDB:**

DynmoDB is one of database service available on AWS. It is NoSQL database which manage huge of data with high performance by distribute the data into more other servers during the traffic [14].

- **Amazon Relational Database (RDS):**

RDS is relation database which allow user to store his/her database and manage it as same as other database environments like Mysql or Oracle. Hence the user doesn't need to change the application to be compatible with RDS. RDS keep back up for database automatically and make it available in any time that the user needs it [15].

- **Identity and Access Management (IAM):**

IAM is one service which controls accessing on AWS; by using it the users can access to their service securely [16].

- **EC2:**

Ec2 is a central part of Amazon.com's cloud computing platform, Amazon web services (AWS). Ec2 allows users to rent virtual computers on which to run their own computer applications. Ec2 allow scalable deployment of applications by providing a web service through which a user can boot on Amazon machine image to create a virtual machine, which Amazon calls as "instance" containing any software designed. A user can create, launch, and terminate server instances as needed, paying by the hour for active servers, hence the term "elastic". Ec2 provides users which control over the geographical location of instances that allows for latency optimization and high level of redundancy.

This service is used in our thesis refers to Infrastructure as a Service (Iaas). By EC2 users can create virtual machine and choose any specifications for that machine such as memory, hard size, processor, and so on… [17]. There are multiple benefits for EC2 Infrastructure will be configured by a user; thus user can use any program language or tools. EC2 supply huge capacity for user; on the other word the user can store until terabyte from data.

Create various machines on EC2 and use them on-demand, will not charge more than what you use [17]. From multiple places the expense of cases are arranged by user. List of IP addresses can either set up user’s instances or change the users instance when it has error. Manage the resources during traffic by distribute them on several instances.

2.9 EC2 Features:

There are several features in using EC2; in below there is explanation of those:

Elastic: The capacity for EC2 if flexible, this means it can be increase or decrease as soon as it need.

Completely controlled: Instances on EC2 are managed completely by users who can stop, reboot, or start their instances due to using web service APIs.

Flexible: any kind of operating system, memory, or processor can be chosen by users. For instance choosing operating system as Microsoft windows server, as it will be described later in this thesis.

Reliable: EC2 instance is reliable due to quickness for serve the tasks, and expected commissioned.

Secure: the reasons for security of EC2 are; confined accessing to the instance for specific group by firewall, using VPC to control the instance manually by users.

2.10 EC2 Services

There are several services available in EC2; in below there is explanation some of services:

Amazon Elastic Block Store: EBS is persistent storage using with EC2 as same as hard disk on computer. It can store huge amount of data, hence it is suitable for applications which have a lot of data, files.

Elastic IP Addresses: Elastic IP Address is static IP Address related with cloud computing account not with specific instance, therefore it can associate with one instance then realize from it. There is no need waiting for DNS to broadcast the name of server for all of customers by using Elastic IP Addresses.

Amazon CloudWatch: Amazon CloudWatch supply monitoring for resources, applications on cloud, it allow users to visible its application metric data.

Auto Scaling: with Auto Scaling the size of instance can be decrease or increase automatically on demand, hence decrease the commotion for using it. Auto Scaling is suitable for applications which work hourly, daily, or weekly.

High Performance Computing (HPC) Clusters: EC2 is designed to compute the customers during traffic with high performance due to using clusters which create automatically on the load situation. Then it is suitable for any kind of applications such as tightly coupled parallel processes.

2.11 Instance Types:

There are several instances types available in EC2. These types depend on the memory size, number of EC2 used, Performance I/O and etc. below the tables are described each type separate.

- **Small instance:**

Table 1. Small Instance's Features

Memory	1.7 GB
Number of EC2 can Used	1
Instance Storage	160 GB
I/O Performance	Moderate
EBS-Optimized Available	No
API name	m1.small

- **Medium Instance:**

Table 2. Medium Instance's Features

Memory	3.75 GB
Number of EC2 can Used	2
Instance Storage	410 GB
I/O Performance	Moderate
EBS-Optimized Available	No
API name	m1.medium

- **Large Instance:**

Table 3. Large Instance's Features

Memory	7.5 GB
Number of EC2 can Used	4
Instance Storage	850 GB
I/O Performance	High
EBS-Optimized Available	500 Mbps
API name	m1.large

- **Extra Large Instance:**

Table 4. Extra Large Instance's Features

Memory	15 GB
Number of EC2 can Used	8
Instance Storage	1690 GB
I/O Performance	High
EBS-Optimized Available	1000 Mbps
API name	m1.xlarge

2.12 Amazon EC2 Versus Google App Engine and Windows Azure:

These differences depend on service model, applications that are available on each one, program languages that each provider support, capacity storage, and the way for control each of them. Table 6 and 7 will be illustrated the compression between those providers.

Table 5. Compression Between Amazon EC2 and GAE [11]

	EC2	**GAE**
Service Model	IaaS	PaaS
Applications	Any kind of applications	Web based applications
Program language	Any language can be used	Java, Python
Data	NoSQL, SQL.	NoSQL
Storage	Form 1GB to 1TB	Not more than 10 MB
Controlled	Controlled by user	Completely automatic

Table 6. Compression Between Windows Azure and Amazon EC2 [3]

	Windows Azure	**Amazon EC2**
Server	Virtual server which can manage and access via web browser	Rent virtual computer to run the application on it
Application Support	Sport only windows environment and windows server 2008.	Sport any kind of environment (windows, Linux)
Scalability	Easy to scale up	It need some logic and manage from company to scale up
Pricing	Pay for capacity used	Pay for resource used

Chapter 3

LITERATURE REVIEW

3.1 Cloud Computing in E-Health:

There are some opportunities of using cloud computing in e-health such as rapidly retrieve the data for patient, or find some information about patients like history medical, allergy medicine, and diseases to allow doctor treat patient quickly. On the other hand patients need privacy for their medical information which is available on Cloud Computing [8].

Cloud computing in e-health has many issues like security of data, SLA, privacy patient's data, and knowledge from the person who work on cloud [8], [4].

For finding best deployment of using cloud computing in e-health, some scenarios are done.

First scenario is sharing the data for patient on the cloud, the benefit of this scenario is availability of patient's data in any location for emergency time.

Second scenario for e-health is data storage which means that patient can store his/her data with authentication on cloud then any of doctors can access to it easily even the fitness daily data as it show in figure below [8]:

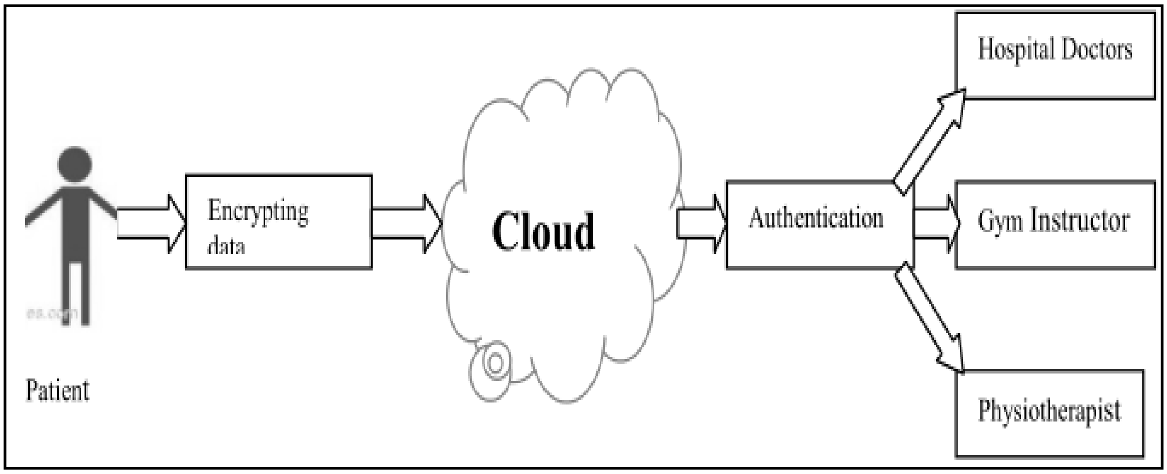


Figure 2. E-Health Data Flow in Cloud [8]

As for the third scenario is multi cloud which means store the data in more than one cloud, hence if one cloud is crash then the data will not be lost because it save in another cloud [8].

The best deployment model used for e-health purpose is depending on the number of users who use the system and the sensitivity of data for them. For instance public model is suitable when the number of users is high and the data is not very sensitivity. On the other hand when the data is important and it needs more security, the private model is good choice. The chart below (figure 3) shows statistical result of the suitable cloud model in e-health questioners [8].

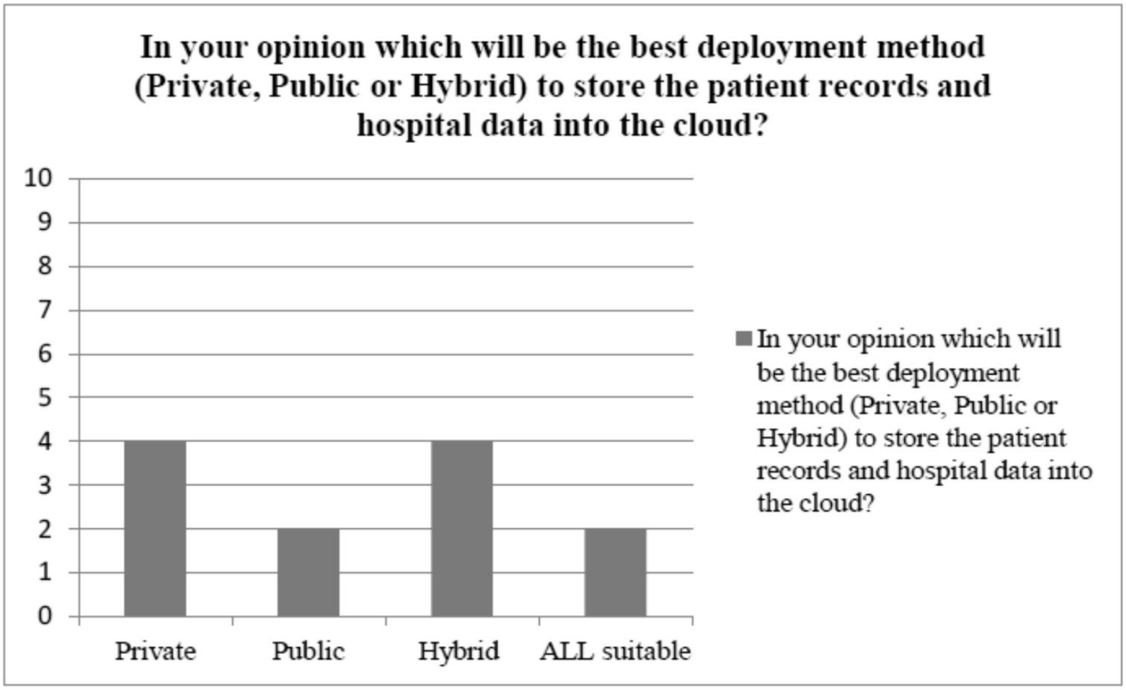


Figure 3. Statistical of the Best Model in E-Health [8]

3.2 Future of Cloud in E-health:

In the future, cloud providers must have some techniques to provide security for patient's data and be as trust as possible. With experimental platform to show the benefit of using cloud computing in health care, it could make adoption for cloud computing [8].

However e-health cares about security of data "cloud computing may grow rapidly in e-health" That was some people opinion; while the other people said that the cloud computing will not be grown in future. Those opinions collected and the result was drawn as below [8].

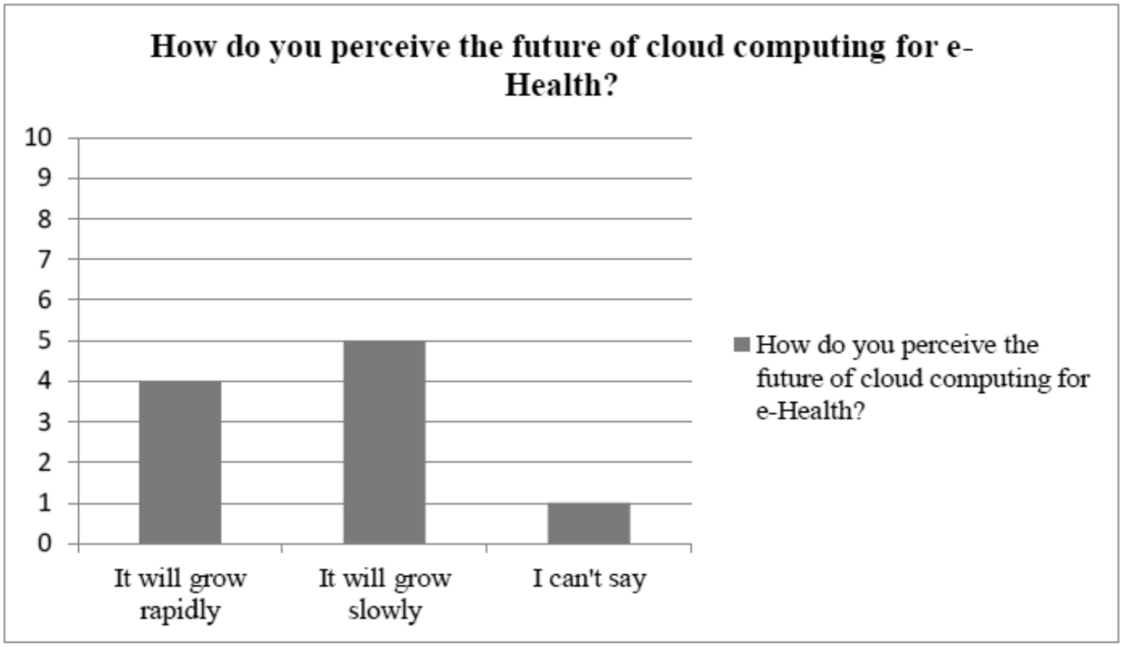


Figure 4. Future of Cloud Computing in E-Health [8]

3.3 Performance of Using AWS for Applications:

EC2 supply high security, less hardware, pays on-demand for applications that are used. Hence performance is approximately stable within time on service oriented applications [18].

Performance stability based on CPU workload and database I/O workload. CPU workload require process client request, retrieve html page; hence the average is 4 requests per second which is require between 2 and 7 ms response time. Also for database I/O that is saved in two separate instances with size 6.5 GB; the performance for small instance almost stable, it arranged between 1.6% and 8% from the mean value [18].

3.4 Cloud Services for Applications:

There are a lot of applications which migrated to cloud services. One of these applications is library system. Example of transfer library application into cloud is Electronic Journal Subscription Management Systems. Library can be as PaaS which supply platform for application; despite of that organization can serve the application but cannot control the server; or can be IaaS which the server can be controlled by organization [19].

Library has been done as SaaS since 2000. However immigrate software applications such as library into IaaS is offered by Amazon Web Services. Those services allow organization to specify each of server size, operating system (Linux or windows), and save limitless data by using S3. As result by using Infrastructure as a service the library application can be brought without any extra service to sport this version, on the other hand insert new application become easy with IaaS; so for pricing of EC2 is comparable with hardware; that it need for five years, but with more benefit of EC2 [19].

The approximate price of using small instance of EC2 is 100$. Some challenges were faced such as training for staff and pay attention for security. AWS is the best providers on the market because of speed for mount and configure the server and easily for bring it online [19].

In paper [20] the steps of transfer any application into cloud was shown. These steps are: learning about cloud, find out organization need, choose prototype of cloud that is suitable with needed, cloud assessment, initialize the strategy of cloud, and finally continue improvement step [20].

3.5 Cloud Computing in Telecommunication:

Example of migrate telecom system into cloud is ECE (Ericsson Composition Engine) which was case study of reference . Cloud computing in IT world is widely vise versa of cloud in telecom system which is limited. Because the cloud computing has virtualization for memory, storage, and etc. then reduce the cost needed; it can be very good opportunity for telecom system to migrate to cloud [21].

The most important issue for telecom system is security of data, thereby using private cloud computing is solution of them. There are some example of telecom system that they are using cloud on their system such as France Telecom, Shanghai Telecom, and SK Telecom [21].

Cloud services are supplied into IT and Communications Technology by Huawei, Cisco system and Google. Huawei created software, integration practices, some applications (SMS, MMS) to migrate telecom system into cloud. Companies of telecom system have some concerns for using cloud computing; for instance: application security, latency, and trust the vendor [21].

Chapter 4

PROJECT ANALYSIS

4.1 Project Scope:

The scope of this thesis is using cloud computing services to host one application and take advantages of these services. The application which built is dentist, patient information system. On this implementation the dentist can easily do all the necessary database operations such as insert, delete, update, retrieve his/her patient information without any need of infrastructure.

4.2 Input and Output of System:

Input: Patient table is one of the most important input issues in the application. The dentists can insert their patients and all of other information belongs to those patients like privacy information, operation information, and even payment information. Hence the Input tables are patients, diseases, payment, treatment, appointment.

Output: implemented system is used by dentist to save all of information whether privacy information, or health information belong to patients. Then dentist can point out these information whenever s/he want then those information are marked as output for application. For instance the dentist want to know his/her time table for one week, then by this system can print out all of his/her appointment during the time that is specified.

On the other hand knowing history health for patient is very important thing for dentist to quick treats his/her patient.

4.3 Software Functions:

There are two sides of the system. One side is entering by dentist who should login by system account; the other side of system is patient who can login by his/her account which is specified when the patient registers.

There are several functions that are available in the system, these function will describe below.

4.3.1 Functions on Dentist Side:

- Login:

The first step of using the system is logging into it. When the dentist want to login to system s/he should know username and password for the system. For this purpose dentist will enter those username, and password which are case sensitive. Then those username, and password will be processed by system and comparing them with username and password belong to the system. If the username, and password which are entered correct, dentist can login to the system otherwise dentist cannot login.

- Select dentist:

After the dentist have been logged in to the system, s/he should choose which dentist s/he is (choose dentist name). Then the system asks to enter password which is specify by dentist when s/he register. Thereafter the dentist is allowed to enter to the system and choose the operation that s/he likes to do.

- Create dentist:

When the dentist entered to the system and s/he cannot find his name in dentist list, then creating new account should be done by dentist. The input requirements to create new dentist are insert name, last name address, telephone number, field, email address. Thereafter this information will be saved in dentist table on database by system, and the output is main menu for system.

After the dentist login with system account, s/he can register to keep his/her patients' information away from other dentist.

- Patient information:

The dentist who is created by function above can insert, update, and delete his/her patients by this function. For creating new patient there are some fields should be filled; these fields related with patient such as name, last name, address, telephone number, mobile number, birthday date, birth place, marital status, sex, username and password. Posteriorly username will be checked by system whether there is somebody use same user name or not. The username should be unique in system, since if the username is used before, the system will ask the user to change it. While all of information that dentist insert it is correct, the system will save it into patient table and allow that patient to login to the system with his/her username, and password. On the other hand the name of that patient will be shown in list box depend on alphabetical order. When dentist choose one of his/her patient who is shown in list box, all of his/her information will be seen on the screen, at that time the dentist can update or delete this information, also can add operation for him/her.

- Patient’s operations:

Patient’s operations can be done by dentist when he chooses that patient. There are tree operations available in this system.

First operation is **diseases** which are allow dentist to check whether that patient has some specific diseases and save this information in database to use them for treatment

Second operation is patient’s **treatment;** by treatment dentist will save all of information about patient’s treatment like operation name, tooth number, date of treatment, diagnosis, and even medicine name that the dentist give it for his/her patient.

Finally the third operation that is available by system is payment which it allow dentist to save the amount of payment from specific patient and the date of this payment.

- Approve patient:

When the patients register by themselves then their dentist should approve these registrations, otherwise the patient can’t login to the system. The list of patients who are registered is shown, and then the dentist should choose one of these patients and check it as active patient. Hence the patient can enter to the system by his/her account after approve it.

- Appointment:

The dentist can reserve appointment for one patient by this operation. Dentist should choose the patient who wants to have appointment, and specify date, start time, end time for that appointment and create the event.

- Operation:

Each dentist has special operation that s/he can do it, and also these operations have different prices from one dentist to another. Hence the operations are saved separately. The input of operation is operation name, price, image for each operation, and tooth number. Each tooth may have zero or many operations, each of these operations has different picture. When the dentist inserts this information, the system will process them and save them in database. On the other hand the dentist can do necessary modification for his/her operations like update on operation, or delete it.

4.3.2 Functions on Patient Side:

- Patient registration:

By this function the patient can make account for him/her self. First step for registration, the patient should choose dentist to be under his/her serve. Once the patient has done that, s/he can insert his/her information and has username and password then s/he can use that username for Login. Patient should fill all of fields for his/her information which are described previously, then the system will saved this information in database after check it as illustrated before. Subsequently one note will be shown to tell the patient that s/he registers successfully and s/he have to wait until the dentist will approve this account then s/he can enter to the system.

- Appointment:

After the patient creates account, s/he can login by this account and can have appointment with his/her dentist. As previously explained patient have to specify each of date, start time, and end time then create new appointment with those parameters.

4.4 Project Requirements:

There are several requirements to implement the project. These requirements divided into financial requirements, and hardware requirements which will be illustrated in below:

4.4.1 Financial Requirement:

For host the application in EC2, some amount of money is required. This amount is calculated depend on the number of hours that the application runs on EC2. That amount equals $0.115 per hour for small instance.

Despite of Amazon possibilities for research's students, 100$ is given for my account to use their services during two years.

4.4.2 Hardware Requirements:

Some hardware is required to efficient processing the application; these requirements are divided into two sides:

- Server side requirements: On cloud computing the server is virtual server which is created as instance on EC2. The image of this instance is Microsoft Windows Server 2008 R2 with SQL Server Express and IIS, and the type of instance that is used in this thesis is small instance which it has specifications as described before on chapter 2.

- Client side requirements: The only one thing that requires running the system on client computer is internet, due to using the server on cloud. Hence there are no specification requirements for client which it make it available and easy to use.

4.5 Structure of the Conventional System and the Proposed System:

Previous web application worked as follow: When the client connect to the server by browser, s/he send request to the server, then the server will process the request and send the result as it shows in below:

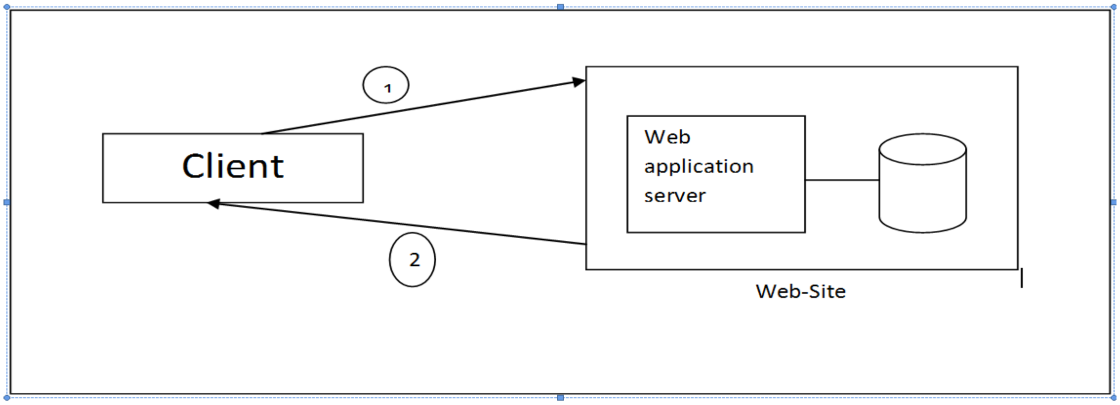


Figure 5. Process with Conventional Server

Therefore while the operation is complex then it needs connection into more than one website, for instance when the dentist wants to have specific operation for his/her patient s/he should connect with other website to collect the data like teeth image for that operation then it could be very complex with using conventional way. On the other hand with using cloud computing all of information will be saved on cloud which it doesn't need complicated way as figure 6 in below shown:

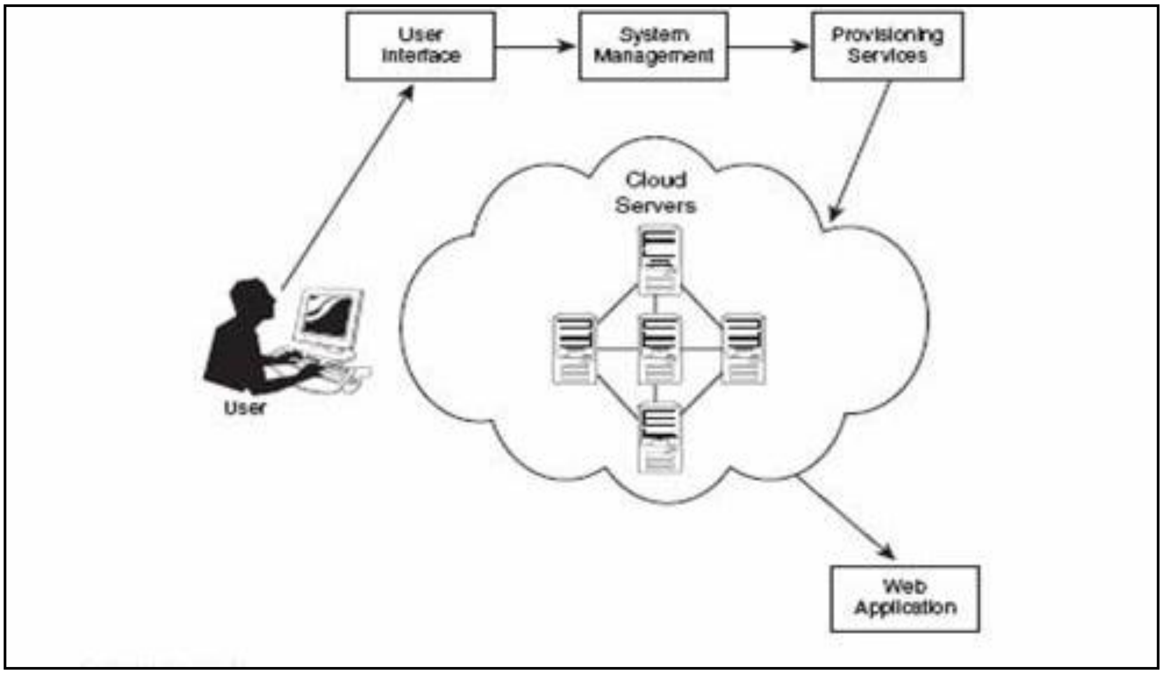


Figure 6. Process with Cloud Computing Server [22]

4.6 Data Analysis:

In this step the data is analyzed, and point out essential entities, attributes, and relationships between those entities. Thereafter normalized the database, finally create entity relation diagram for this data. All of these steps are explain as following:

4.6.1 Conceptual Design of the System (Entity Relation Diagram):

Entities that are elucidated for this system are patient, dentist, operation, appointment, and diseases. Each of these entities has several properties which are called attributes to save some information related with each entity. As for relationships between those entities, refer to the action that can be done between these entities. In this section the entities of the system with their attributes, and their relationships will be illustrated by detail.

4.6.1.1 Diagrams for ERD:

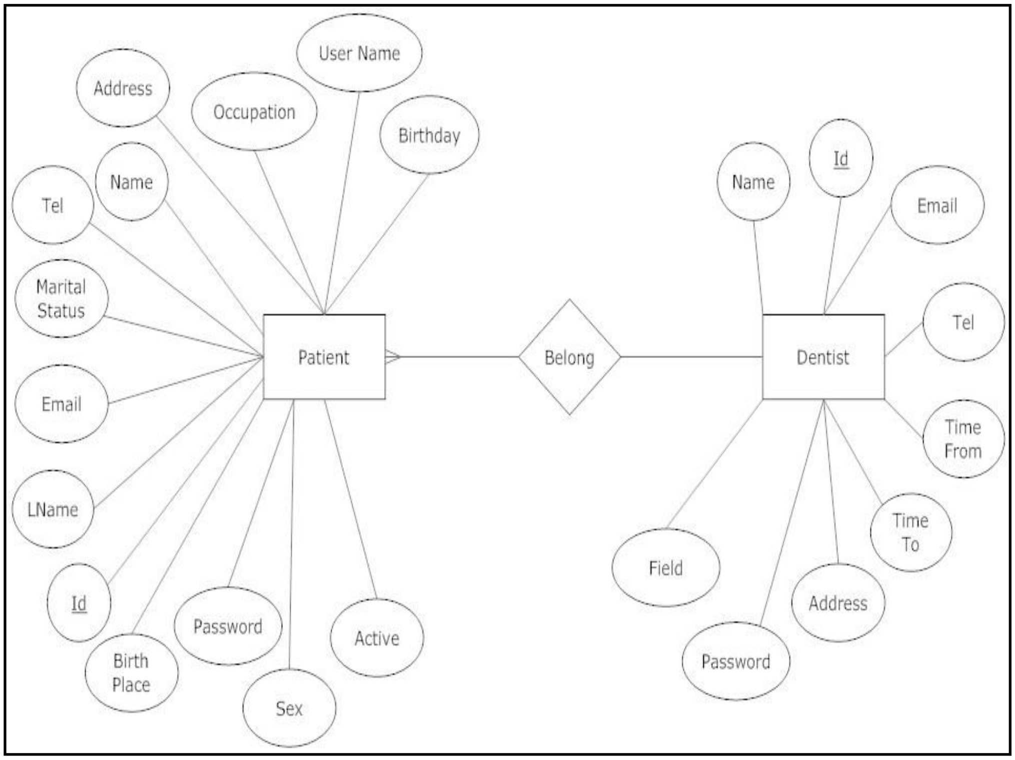


Figure 7. Relationship between Patient Entity and Dentist Entity

As it can be seen in figure 7, the patient belong to only one dentist then the relation between patient and dentist is one to many relationship.

As for relation between patient and operation, it is many to many relationship, the patient can have more than one operation for more than one teeth. On the other hand one operation can be done for more than one patient. The diagram below in figure 8 shows that relation.

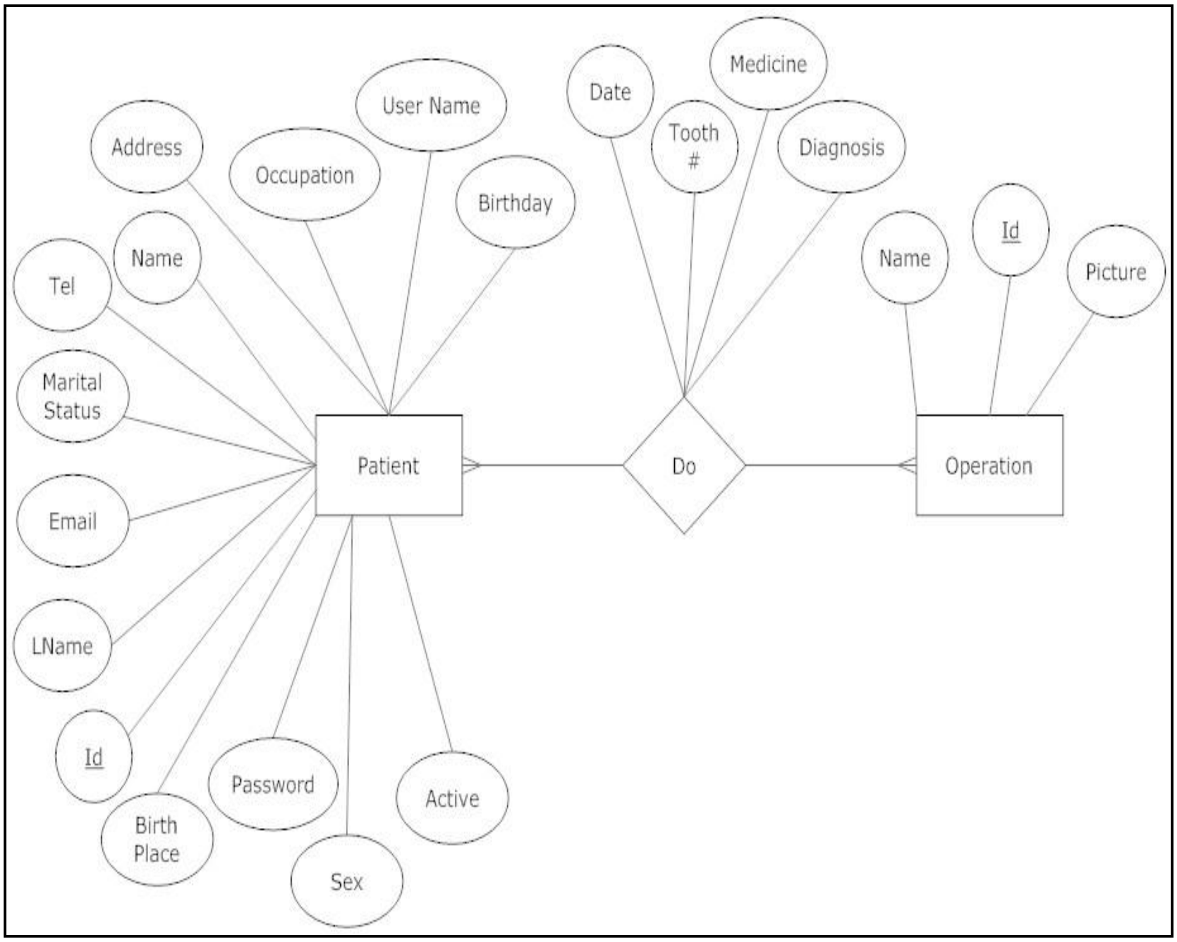


Figure 8. Relationship between Patient Entity and Operation Entity

On the other hand there is a relation between dentist and operation; the dentist who make the operation for his/her patients. The dentist can do more than one operation then this relation is one to many relationship as in figure 9 shown:

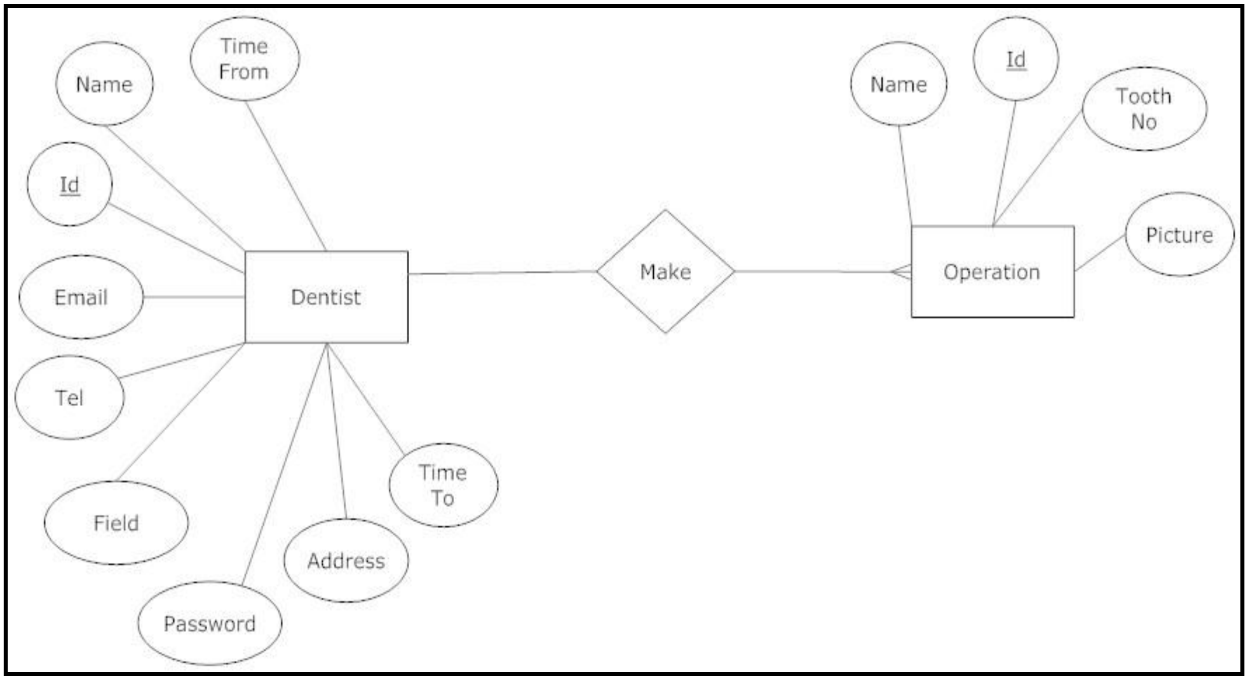


Figure 9. Relationship between Dentist Entity and Operation Entity

The important part for this system is getting appointment for patient with particular date and time, therefore patient can have many appointments with several dates and times then the relationship is one to many between patient and appointment as figure 10 shown:

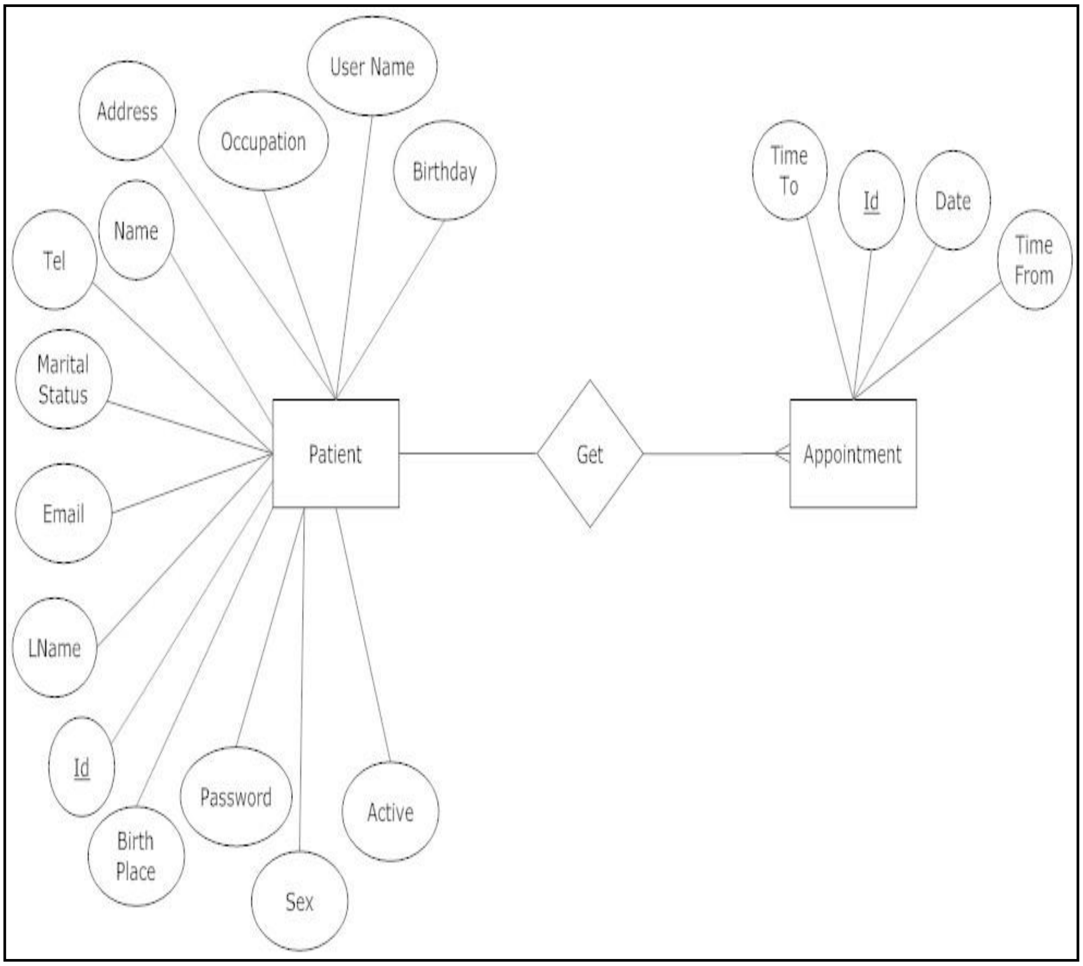


Figure 10. Relationship between Patient Entity and Appointment Entity

For more information related with patient, chronic diseases should be saved in database for each patient then each patient will click on any disease that s/he has to save them in database as detail information for patient, so the relation between patient and diseases is one to one relationship as figure below shows:

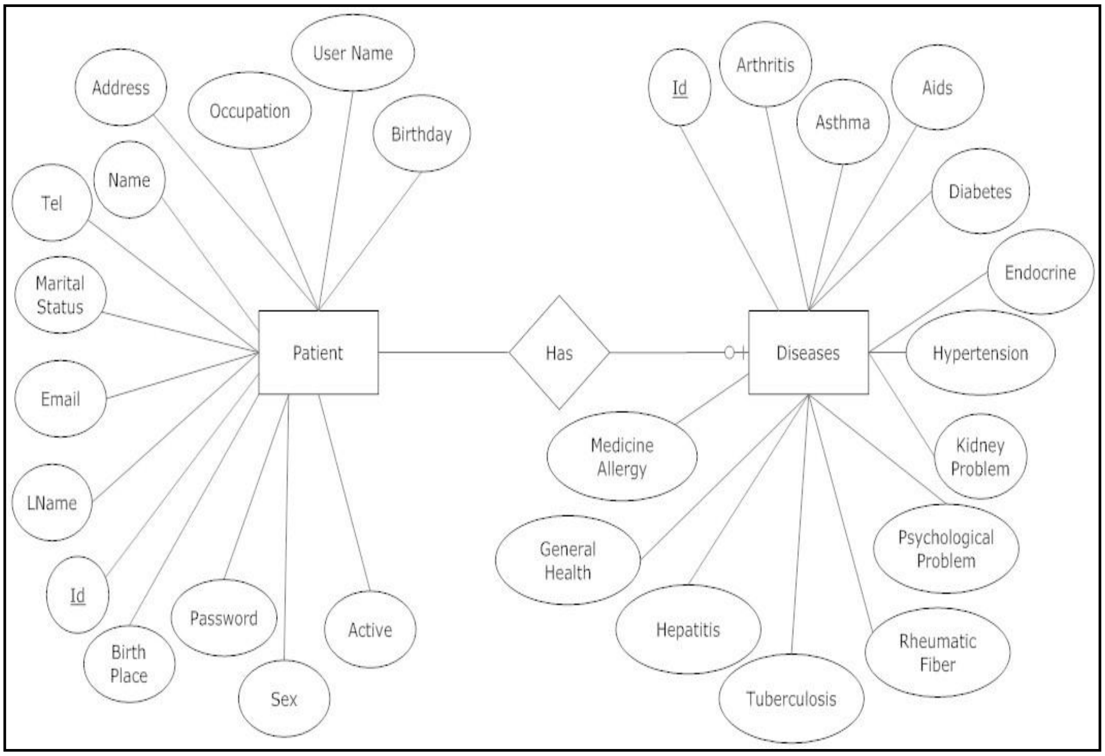


Figure 11. Relationship between Patient Entity and Diseases Entity

Finally the whole diagram for entity relationship will be shown as below:

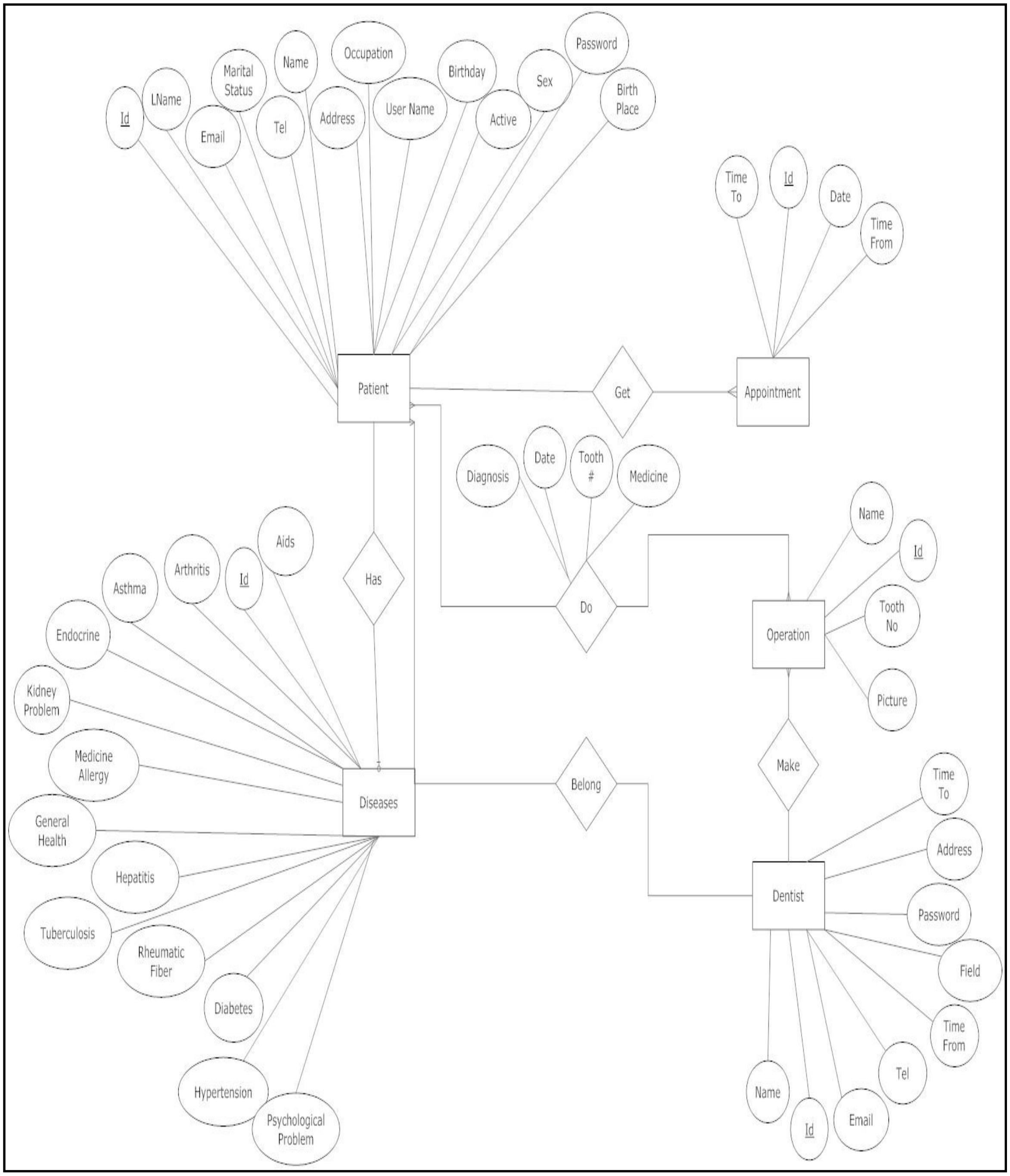


Figure 12. Complete ER Diagram

4.6.1.2 Entities of The System:

Table 7. **PATIENT** Entity with its Attributes

Attribute Name	**Description**
Id	Defined the identity for each patient
Name	Defined the name for each patient
Last Name	Which save the Last name for each patient
Birthday	The date of birth for the patient
Birth Place	The place that the patient was born
Address	The address of patient
Home Tel	Telephone number for patient
Job Tel	Job telephone number for patient
Mobile	The number of mobile phone for a patient
Occupation	The job occupation for patient
Marital Status	Is he patient married or single
Sex	Is the patient male or female
Email	Email address for a patient
Username	The name that the patient can use it to login to the system
Password	Password used for login by a patient
Active	When patient register by him/her self then active is false until it approved by dentist

Table 8. **DENTIST** Entity with its Attributes

Attribute Name	**Description**
Id	Identity for each dentist
Name	The name of dentist
Telephone	Telephone number for dentist clinic
Email	The email address for dentist
Time From	The time that the dentist start to work
Time To	The time the dentist finish the job
Password	Password used for login to the system by dentist
Address	The address of dentist clinic
Field	Specialization for each dentist

Table 9. **OPERATION** Entity with its Attributes

Attribute Name	**Description**
Id	Identity for each operation
Name	The operation name
Picture	Which save image for each operation
Material	The material used for each operation
Price	The price of each operation by each dentist

Table 10. **DISEASES** Entity with its Attributes

Attribute Name	**Description**
Id	Identify for disease
Arthritis	The value is True if the patient has this disease otherwise the value is false
Asthma	The value is True if the patient has this disease otherwise the value is false
Aids	The value is True if the patient has this disease otherwise the value is false
Diabetes	The value is True if the patient has this disease otherwise the value is false
Endocrine	The value is True if the patient has this disease otherwise the value is false
Hypertension	The value is True if the patient has this disease otherwise the value is false
Kidney Problem	The value is True if the patient has this disease otherwise the value is false
Psychological Problem	The value is True if the patient has this disease otherwise the value is false
Respiratory	The value is True if the patient has this disease otherwise the value is false
Rheumatic Fiber	The value is True if the patient has this disease otherwise the value is false

Tuberculosis	The value is True if the patient has this disease otherwise the value is false
Hepatitis	The value is True if the patient has this disease otherwise the value is false
General Health	Save some health information for a patient
Medicine Allergy	Save the medicines names that the patient has allergy from them.

Table 11. **APPOINTMENT** Entity with its Attributes

Attribute Name	**Description**
Patient_Id	Identity The patient who want to have appointment.
App_Date	The date of appointment
App_TimeFrom	Start time for creating appointment
Appo_TimeTo	End time for creating appointment

4.6.1.3 Relationship of the E-R Diagram:

Table 12. Relationship between Patient and Dentist

Relationship Name	**Belong**	
	From Entity	**To entity**
	Patient	Dentist
Cardinality	1:1	1:N

Table 13. Payment Relationship between Patient and Dentist

Relationship Name	**Pay**	
	From Entity	**To entity**
	Patient	Dentist
Cardinality	1:N	1:N

Table 14. Appointment Relationship between Patient and Appointment

Relationship Name	**Make Appointment**	
	From Entity	**To entity**
	Patient	Appointment
Cardinality	1:1	1:N

Table 15. Relationship between Patient and Operation

Relationship Name	**Do**	
	From Entity	**To entity**
	Patient	operation
Cardinality	1:N	1:N

Table 16. Relationship between Dentist and Operation

Relationship Name	**Can make**	
	From Entity	**To entity**
	Dentist	Operation
Cardinality	1:N	1:1

Table 17. Relationship between Patient and Diseases

Relationship Name	**Has**	
	From Entity	**To entity**
	Patient	Disease
Cardinality	1:1	1:1

4.6.2 Normalization:

Normalization is the step in database design which refers to eliminate the problems for design with re-organization the database structure. Normalization is used to avoid redundancy and anomalies in database, after applying normalization steps all the duplicated attributes and relationships will be removed. There are three normal forms;

1NF, 2NF, and 3NF, the database for patient, dentist system in this thesis is achieved all of those three normalization forms as will be illustrated:

First Normal Form (1NF):

If the table does not have multi-value attribute, then it is in the first normal form [23]. By consideration to the database which is used in the system, can be noted that database is in the first normal form duo to there is no multivalve for any attribute in the database.

Second Normal Form (2NF):

The database become in the second normal form if each of non-key attributes is depend on the whole primary key[23]. For more details some explanation will be illustrated as following:

For patient table the primary key is Id, and then each of attribute in this table is depend on that primary key such as name, last name, birthday date, and etc. As well as dentist table which has id mark as primary key and all of other attributes depend on it. As for Treatment table, the primary key of it is date, patient id, tooth number, and operation id, then for other attributes (diagnosis, medicine name) they are dependent on whole primary key, for instance diagnosis is depending on treat in which date, patient, tooth number, operation, hence that table is achieved 2NF.

Third Normal Form (3NF)

The database should not have any transitive relation to be in the 3NF [23]. To carefully looking on the system's database, it can be shown that the tables do not have any transitive relation, each of attribute depend on primary key only. For example treatment which it has such as attributes (date, patient id, tooth number, operation id, diagnosis, and medicine name) there is no relation between non-key attributes (diagnosis, medicine name) each of them related with primary key only.

Chapter 5

DESIGN AND IMPLEMENTATION

5.1 Database Design Issues:

For designing the entities which are illustrated in previous chapter, Smart Draw program is used to build data flow Diagram, and flow chart diagram for each action. Smart draw program is one of the famous program using for draw decomposition work such as ERD,DFD, use case Diagram, and etc.

5.2 System Architecture:

Data Flow Diagram represents the architecture of system; therefore building this diagram gives clear idea about action sequences between server and client. Data flow diagram can divide into two parts; one for patient, another for dentist, so two diagram is created as figure below shown:

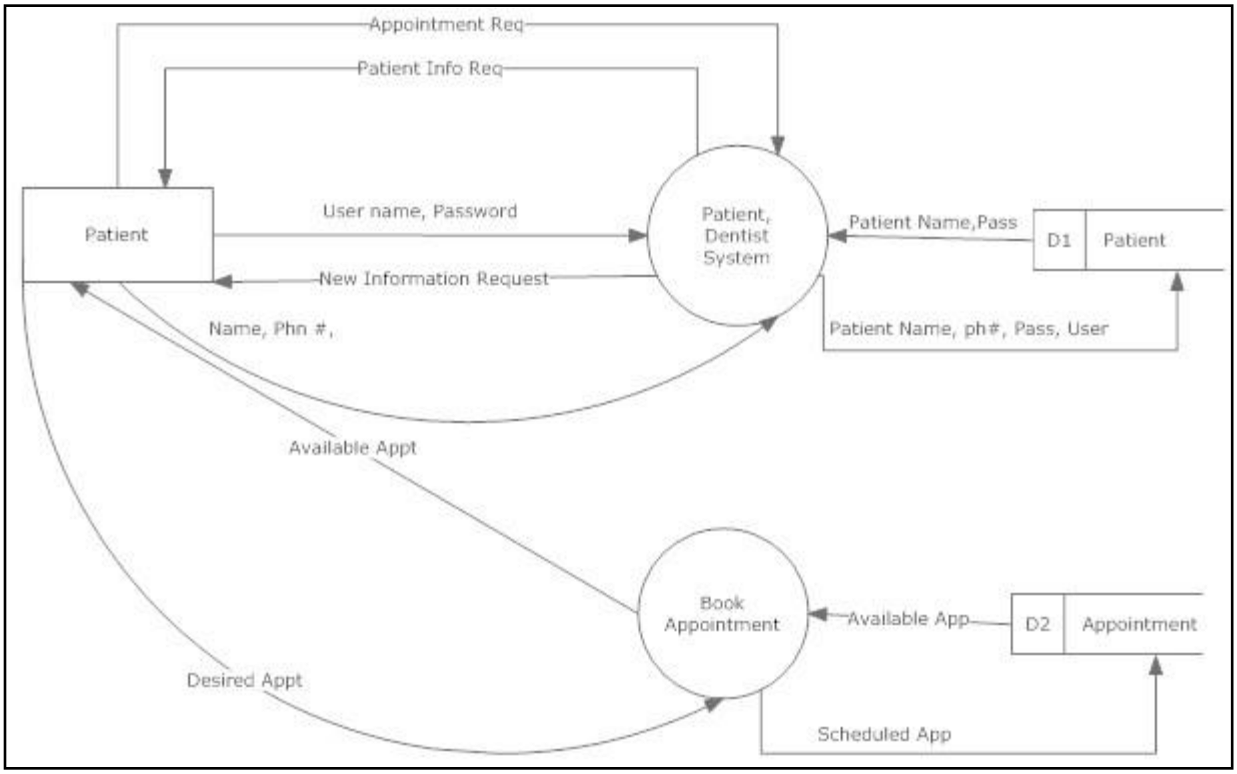


Figure 13. Patient Actions Diagram

In the figure 13 as it shows, the first action is Login to the system via patient, then if the patient has account then directly can find one available appointment and reserve it otherwise s/he should create new account. For creating new account firstly the patient should choose dentist which will be under of his/her services. Once s/he has done that s/he can fill his/her information and create new account. Finally the patient can login to the system and has appointment. On the other hand dentist is another client who can login to system and doing any operation available on it like; create patient, create operation, create appointment, approve patients, and create treatment for his/her patients. Hence sequence action for doing those operations can be seen in data flow diagram bellow:

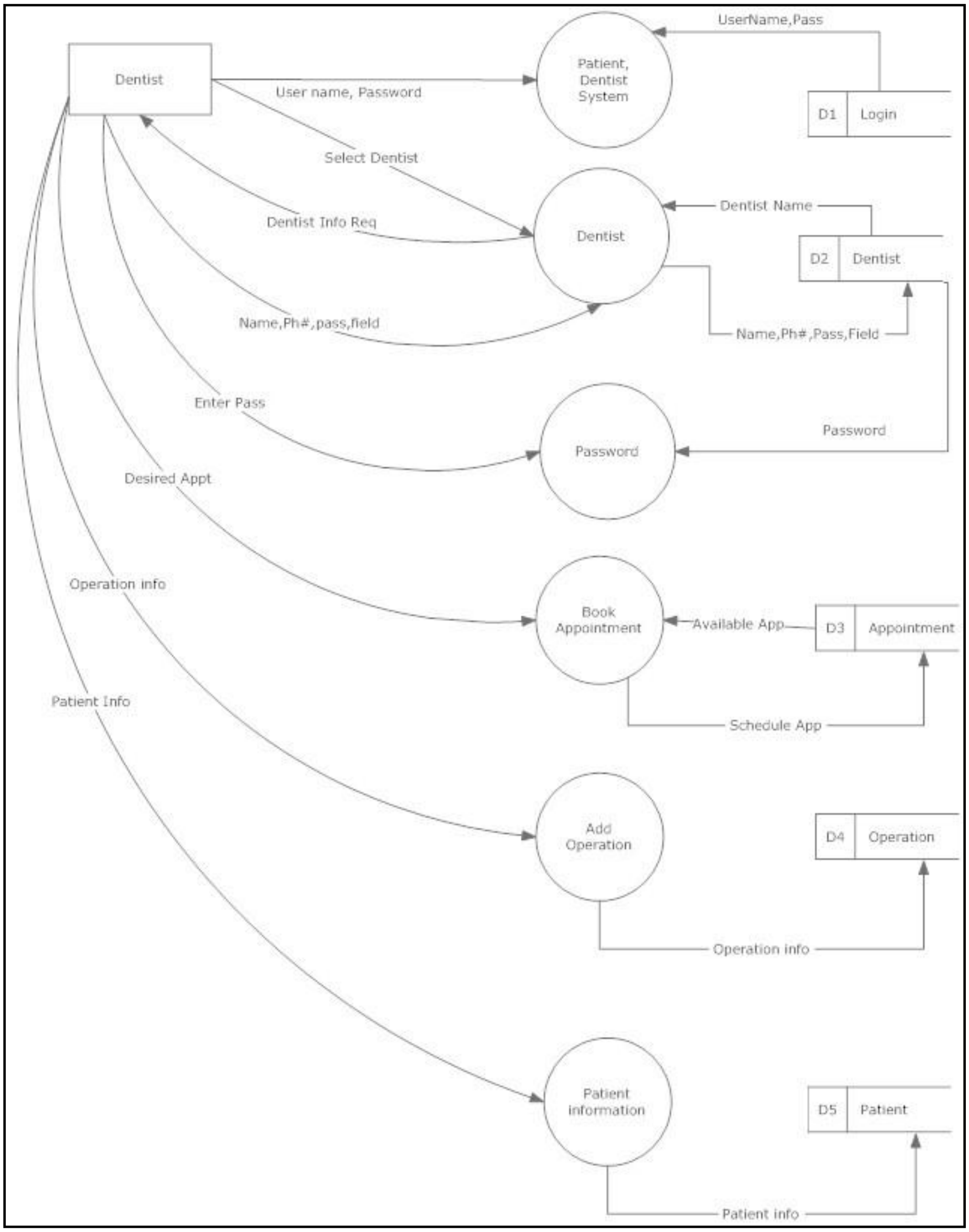


Figure 14. Dentist Actions Diagram

5.3 Flow-Chart Design

There are several actions that can be done in the system wither by dentist or patient. These actions are described before in the previous chapter. In this section the flow chart details of these actions will be limned.

5.3.1 Dentist Login Flow Chart

For keeping the security of the system, it is limited login by system user name and password. When the dentist wants to login to the system s/he should enter user name, and password belong to system. Then the system shows dentists' name list which s/he can choose from it his/her name. Thereafter the system ask dentist to enter his password for allowing him/her to use the whole actions in the system (modify patient information, make appointment, approve patients, and create operation).

The flow chart of this action shows below:

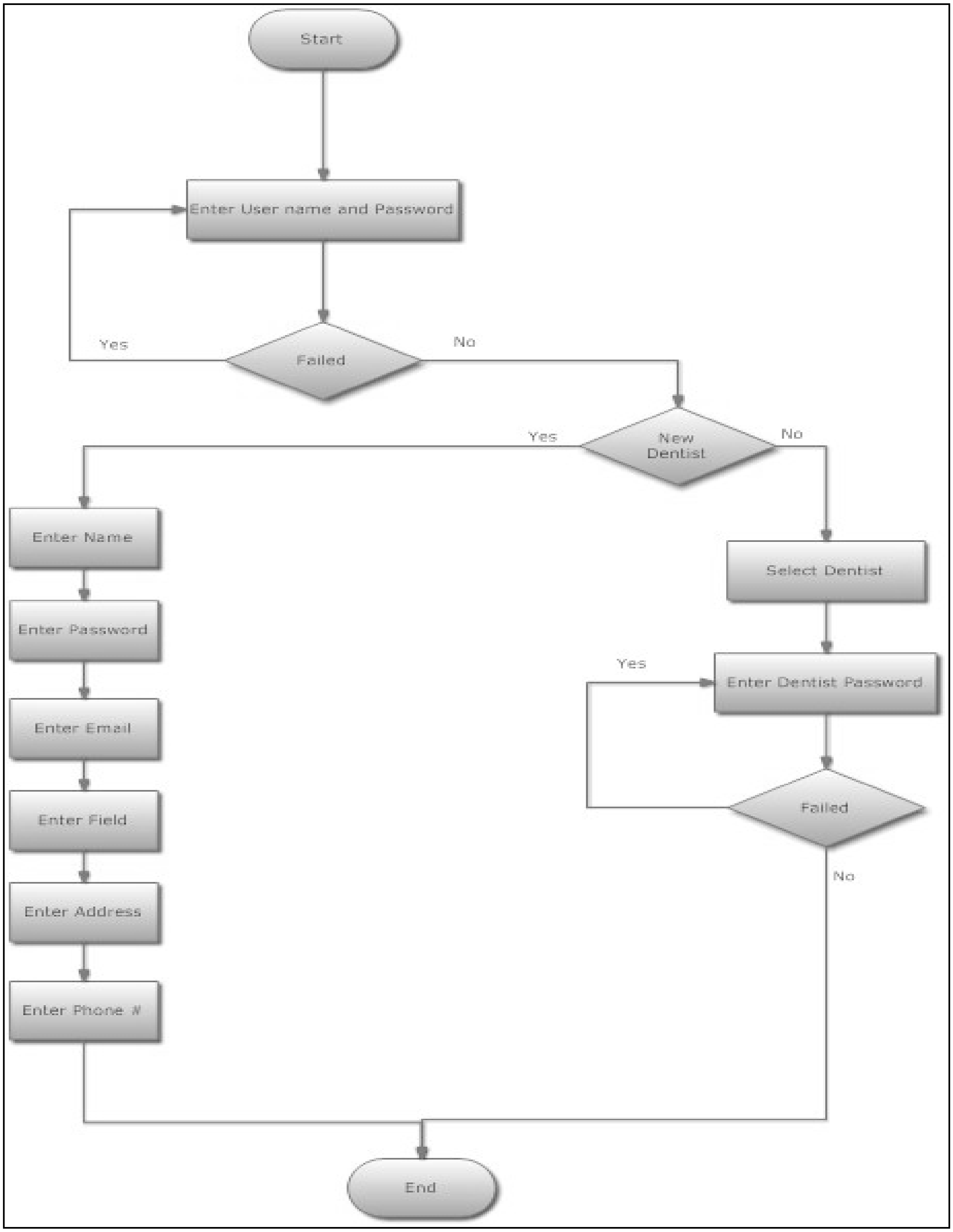


Figure 15. Dentist Login Flow Chart

5.3.2 Create Patient Flow Chart

As explained previously that the dentist can create his patients from the system by entering his/her information such as name, last name, email, user name, password, etc. During this operation the system check wither the user name is exist or not and ask the dentist to add new username if it is existed. Flow chart of this operation as follows:

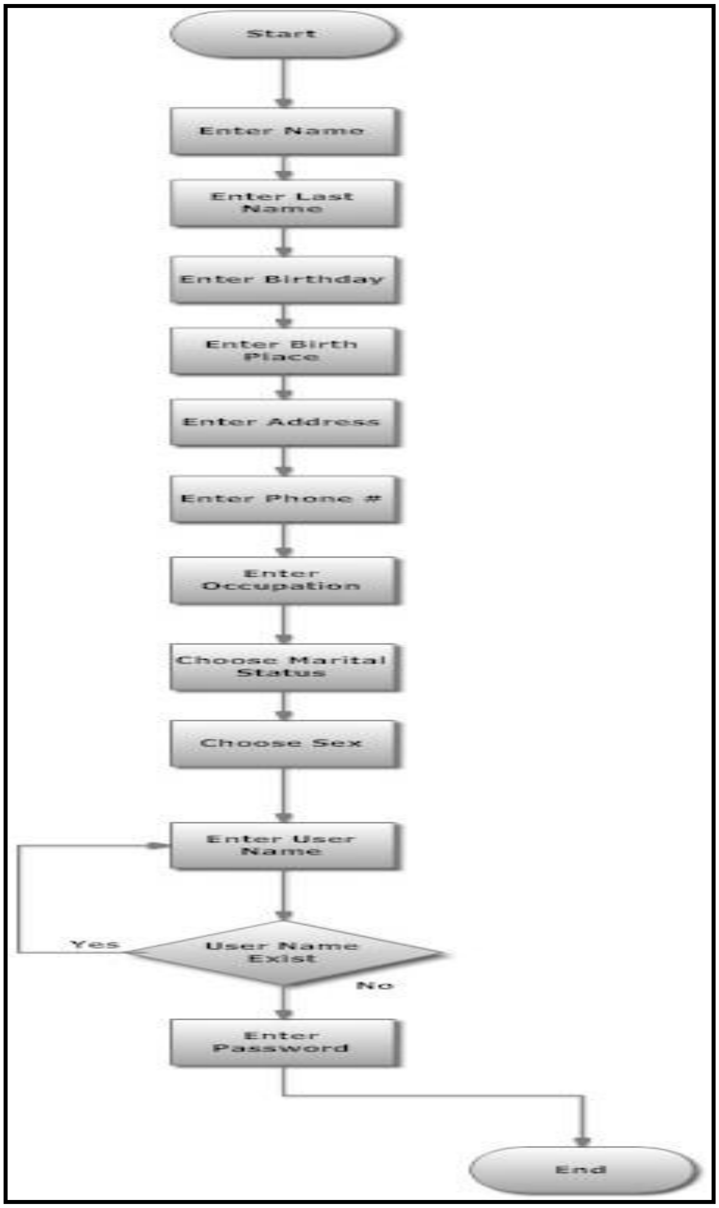


Figure 16. Create Patient by Dentist Flow Chart

5.3.3 Treatment Flow Chart:

Treatment information means any information for patient when s/he visits his/her dentist. This information like date of treat, tooth number treated, operation name for treat, diagnosis, and medicine name. When the dentist treats one patient, all of those treatments information will be saved in database. Hence the flow chart for save this information will be described in following:

Firstly the dentist should choose the patient who is treated. Then choose the treatment from operations that the dentist can do it (dentist can insert three operation related with his/her patient; diseases, treatment, and payment). Thereafter choosing the tooth that is treated and operation name, and then enter; date for the treatment, diagnosis, and medicine name. The diagram below illustrates this action clearly.

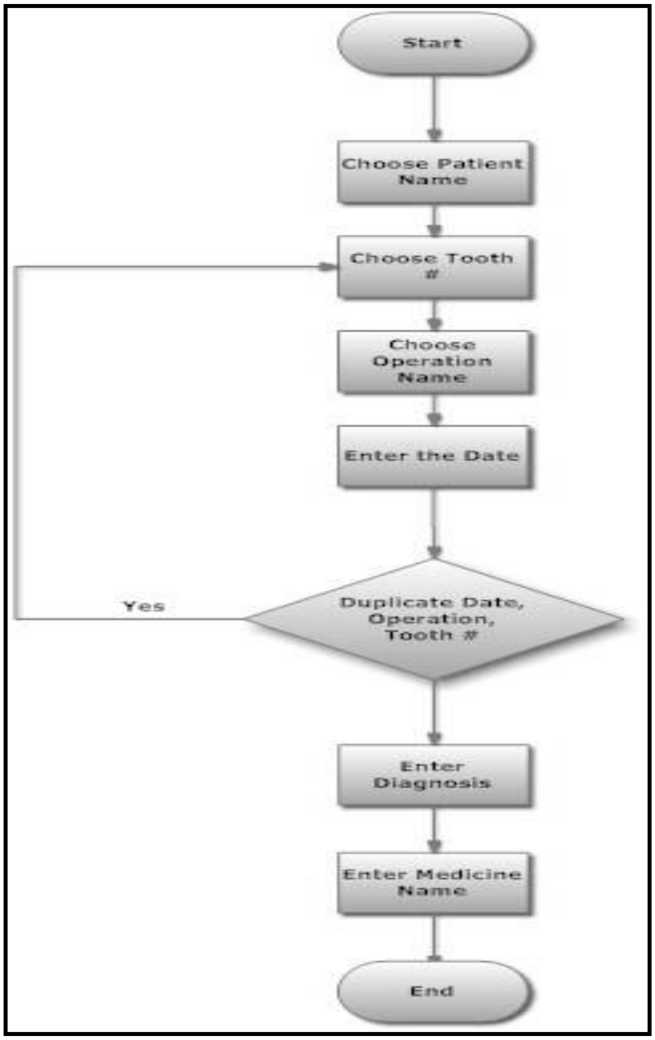


Figure 17. Create Treatment Flow Chart.

5.3.4 Patient Login Flow Chart:

There are two users that can use the system one of them is dentist who can enter to the application by system account as illustrated before, and the other user is patient who can login by his/her account. Hence the strategy of patient login will be described in this part.

Firstly the patient enter his/her user name and password, if this information is true then s/he allowed to enter to the system otherwise it ask his/her to correct this information or register as new patient. The flow chart diagram is:

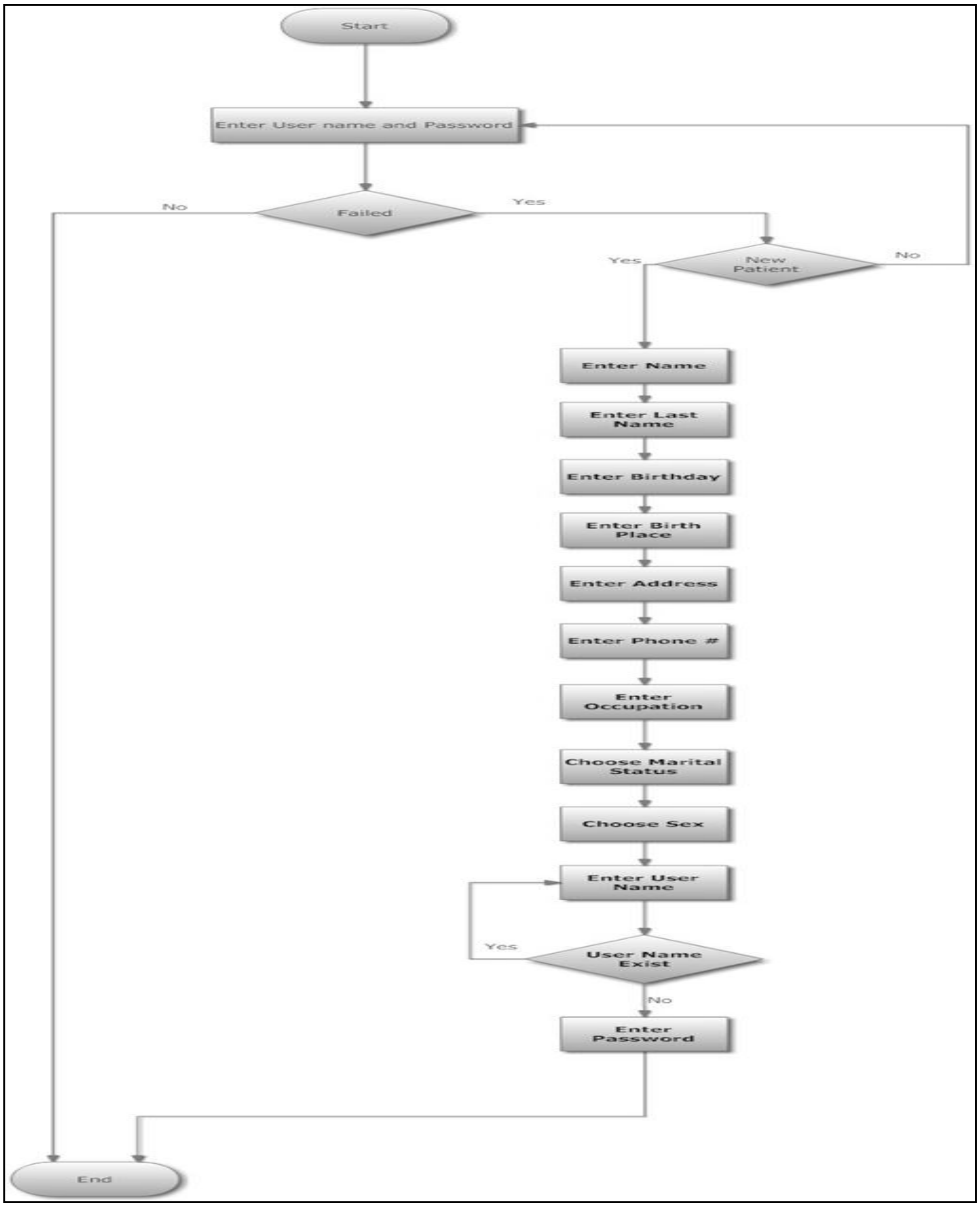


Figure 18. Patient Login Flow Chart

5.3.5 Create Appointment Flow Chart:

The appointment can be done by patient or dentist to his/her patient. For this action choose particular time and date that is available in dentist weekly time table and create appointment on this cell as the flow chart shows:

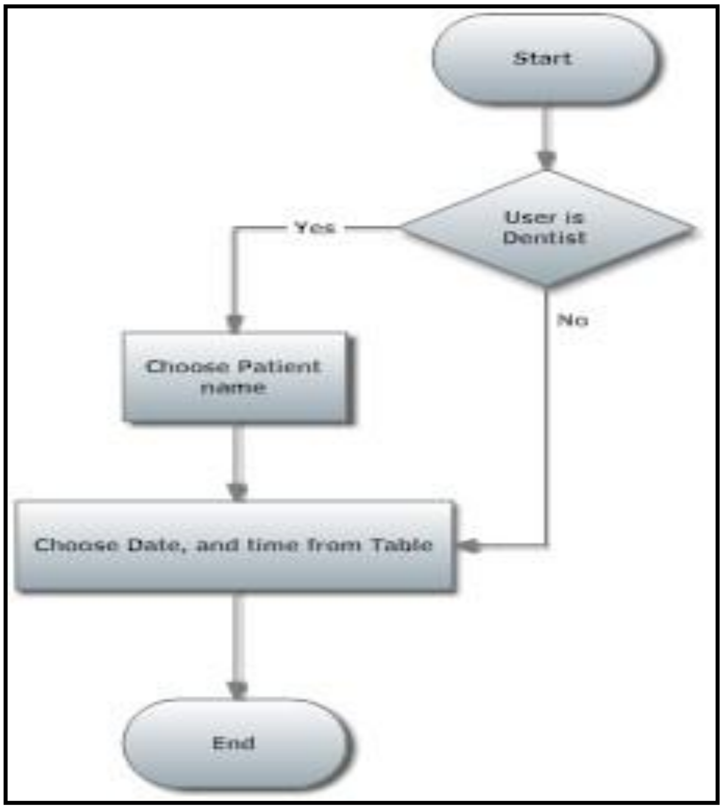


Figure 19. Create Appointment Flow Chart

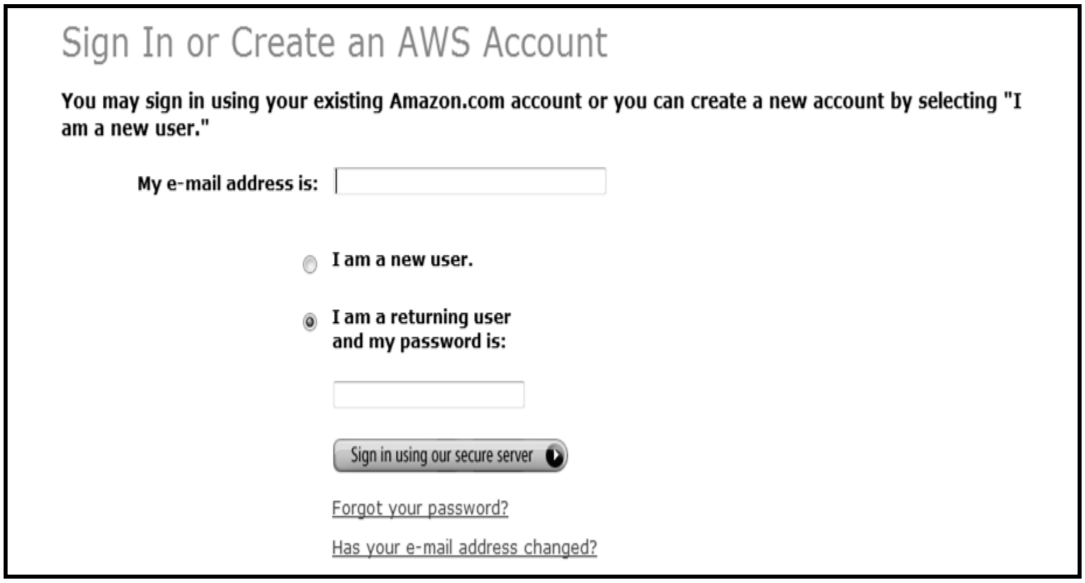
5.4 Implementation:

For implement the system as an application on cloud, ASP.NET is used as programming language, and SQL server to create data base. SQL server is existed on windows server which is created by instance from EC2 as virtual server. Asp.NET can connect with database from remote server via the account that is created on SQL Server. There are two sides for implementing the system; one side for server and another for client. In this section these two side will be described, and then populate the database simulator program is prepared and used.

5.4.1 Server Implementation

As explained before the aim of this thesis is using cloud computing services to supply the application, and using Amazon web services as cloud provider(aws), hence there are several steps for using AWS as provider, these steps are:

- **Create AWS Account**: for creating account in AWS firstly open its website (www.aws.amazon.com), after that click on Sign Up the figure below it will be shown:



Sign In or Create an AWS Account

You may sign in using your existing Amazon.com account or you can create a new account by selecting "I am a new user."

My e-mail address is:

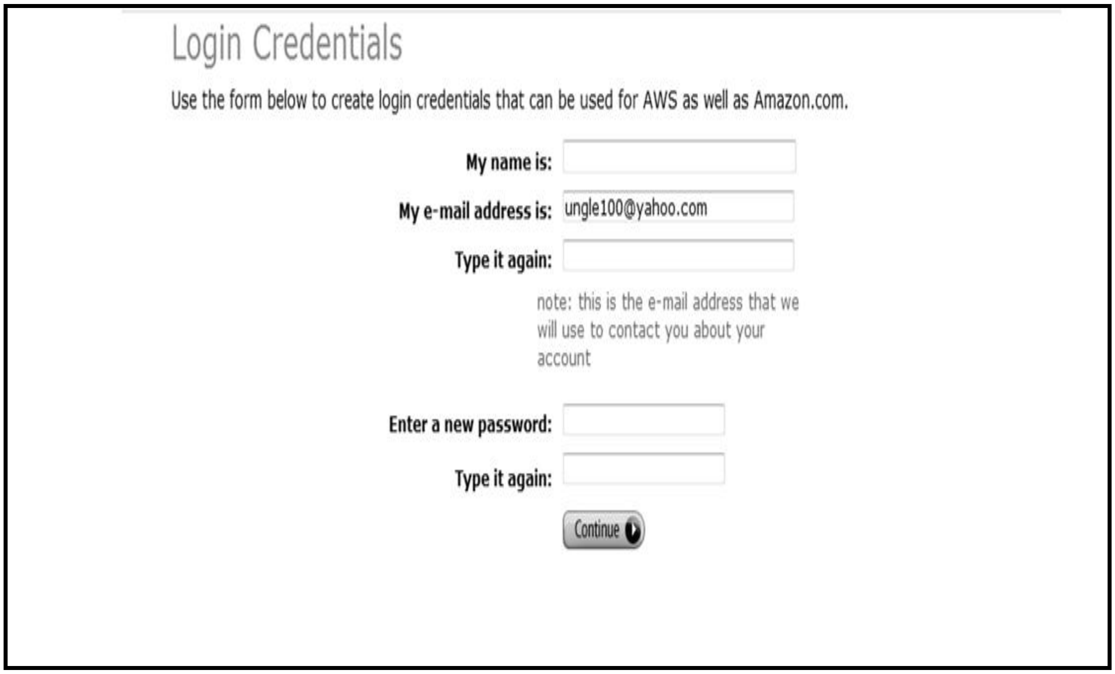
○ I am a new user.

● I am a returning user and my password is:

Sign in using our secure server
Forgot your password?
Has your e-mail address changed?

Figure 20. Create Account in AWS

The email address should be written, then I am a new user will be chosen. Next step is fill the fields about privacy information then click continue.



Login Credentials

Use the form below to create login credentials that can be used for AWS as well as Amazon.com.

My name is:

My e-mail address is: ungle100@yahoo.com

Type it again:

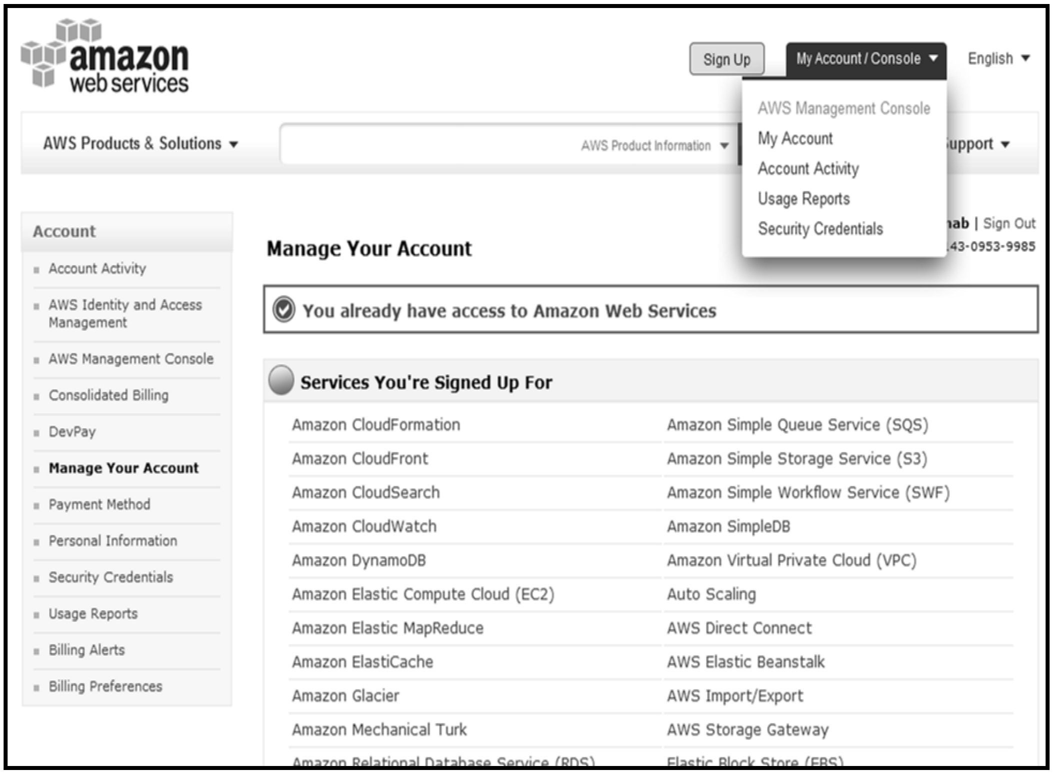
note: this is the e-mail address that we will use to contact you about your account

Enter a new password:

Type it again:

Figure 21. Information Fields for Create Account

After that page there is another page it should be filled then click create account and continue. Login to your account: after creating account and from same website click on Sign Up and choose “I am a returning user and my password is”, in the field write your password and click Sign In.



Manage Your Account

You already have access to Amazon Web Services

Services You're Signed Up For

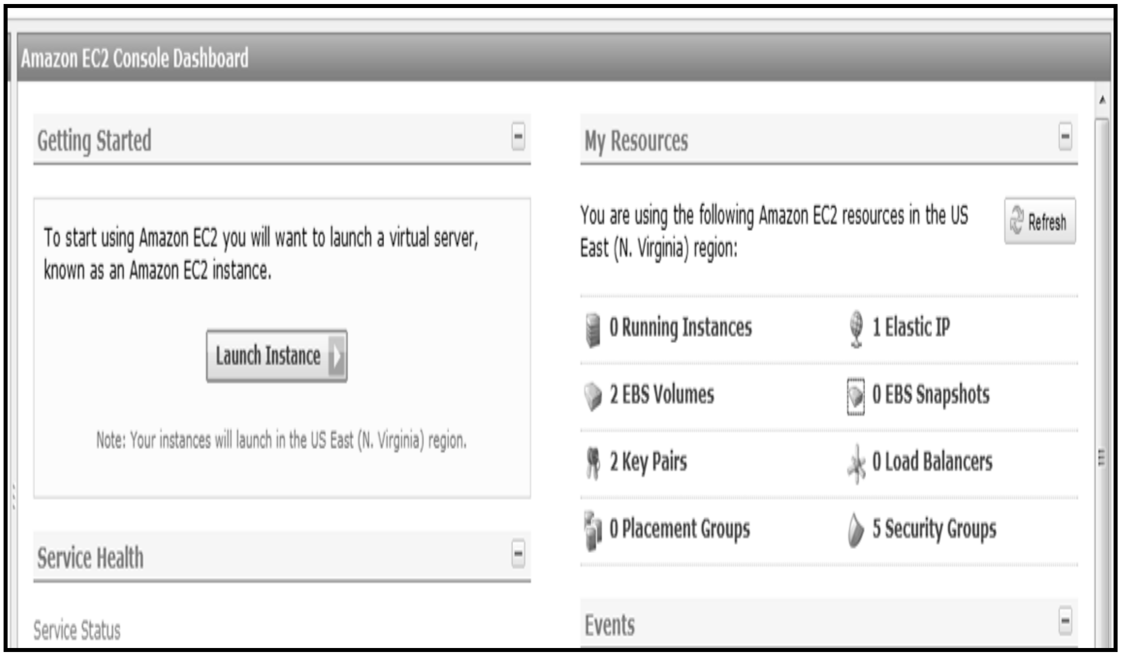
Amazon CloudFormation
Amazon CloudFront
Amazon CloudSearch
Amazon CloudWatch
Amazon DynamoDB
Amazon Elastic Compute Cloud (EC2)
Amazon Elastic MapReduce
Amazon ElastiCache
Amazon Glacier
Amazon Mechanical Turk
Amazon Relational Database Service (RDS)

Amazon Simple Queue Service (SQS)
Amazon Simple Storage Service (S3)
Amazon Simple Workflow Service (SWF)
Amazon SimpleDB
Amazon Virtual Private Cloud (VPC)
Auto Scaling
AWS Direct Connect
AWS Elastic Beanstalk
AWS Import/Export
AWS Storage Gateway
Elastic Block Store (EBS)

Figure 22. Services in AWS

From My Account choose “AWS Management Console” then all of services that AWS support them will be shown. For our purpose EC2 is the most important services because it can create virtual server which supports SQL Server and IIS.

- **Create Instance:** after creating account and spread out all of services that are available in AWS, EC2 is chosen. Then choose **Launch Instance** from EC2 page as it show in figure 23 below:



To start using Amazon EC2 you will want to launch a virtual server, known as an Amazon EC2 instance.

Note: Your instances will launch in the US East (N. Virginia) region.

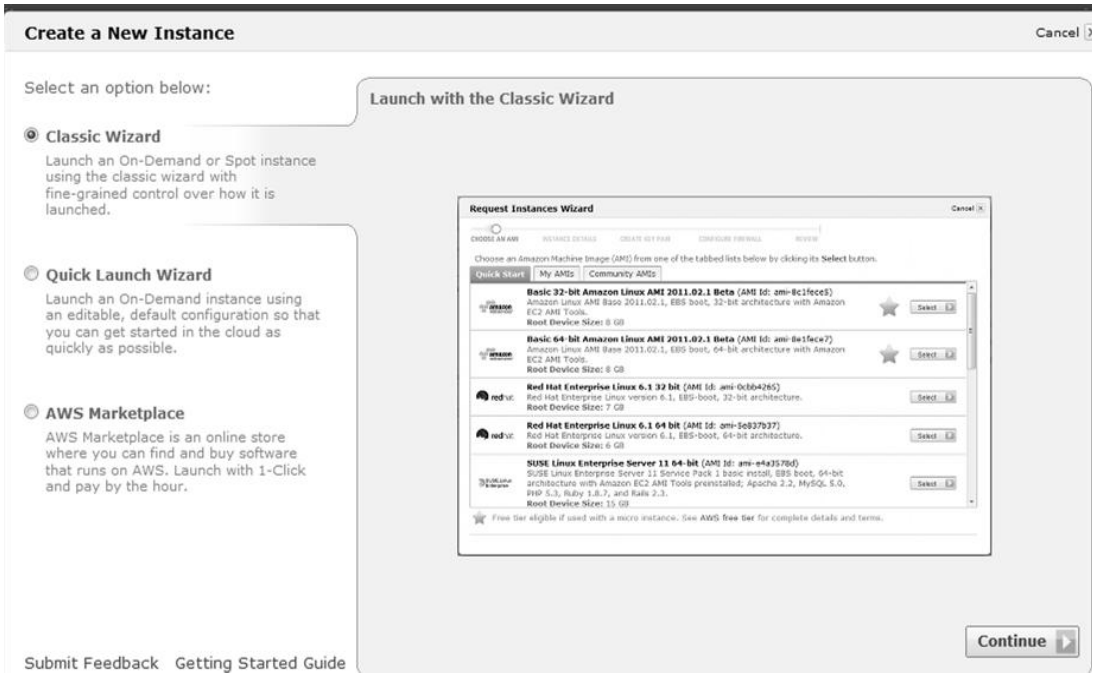
You are using the following Amazon EC2 resources in the US East (N. Virginia) region:

0 Running Instances	1 Elastic IP
2 EBS Volumes	0 EBS Snapshots
2 Key Pairs	0 Load Balancers
0 Placement Groups	5 Security Groups

Service Status

Figure 23. Instance in EC2

After pressing on **Launch Instance** the form below is shown:



Select an option below:

● Classic Wizard
Launch an On-Demand or Spot instance using the classic wizard with fine-grained control over how it is launched.

○ Quick Launch Wizard
Launch an On-Demand instance using an editable, default configuration so that you can get started in the cloud as quickly as possible.

○ AWS Marketplace
AWS Marketplace is an online store where you can find and buy software that runs on AWS. Launch with 1-Click and pay by the hour.

Choose an Amazon Machine Image (AMI) from one of the tabbed lists below by clicking its **Select** button.

Basic 32-bit Amazon Linux AMI 2011.02.1 Beta (AMI Id: ami-8c1fece5)
Amazon Linux AMI Base 2011.02.1, EBS boot, 32-bit architecture with Amazon EC2 AMI Tools.
Root Device Size: 8 GB

Basic 64-bit Amazon Linux AMI 2011.02.1 Beta (AMI Id: ami-8e1fece7)
Amazon Linux AMI Base 2011.02.1, EBS boot, 64-bit architecture with Amazon EC2 AMI Tools.
Root Device Size: 8 GB

Red Hat Enterprise Linux 6.1 32 bit (AMI Id: ami-0cbb4265)
Red Hat Enterprise Linux version 6.1, EBS-boot, 32-bit architecture.
Root Device Size: 7 GB

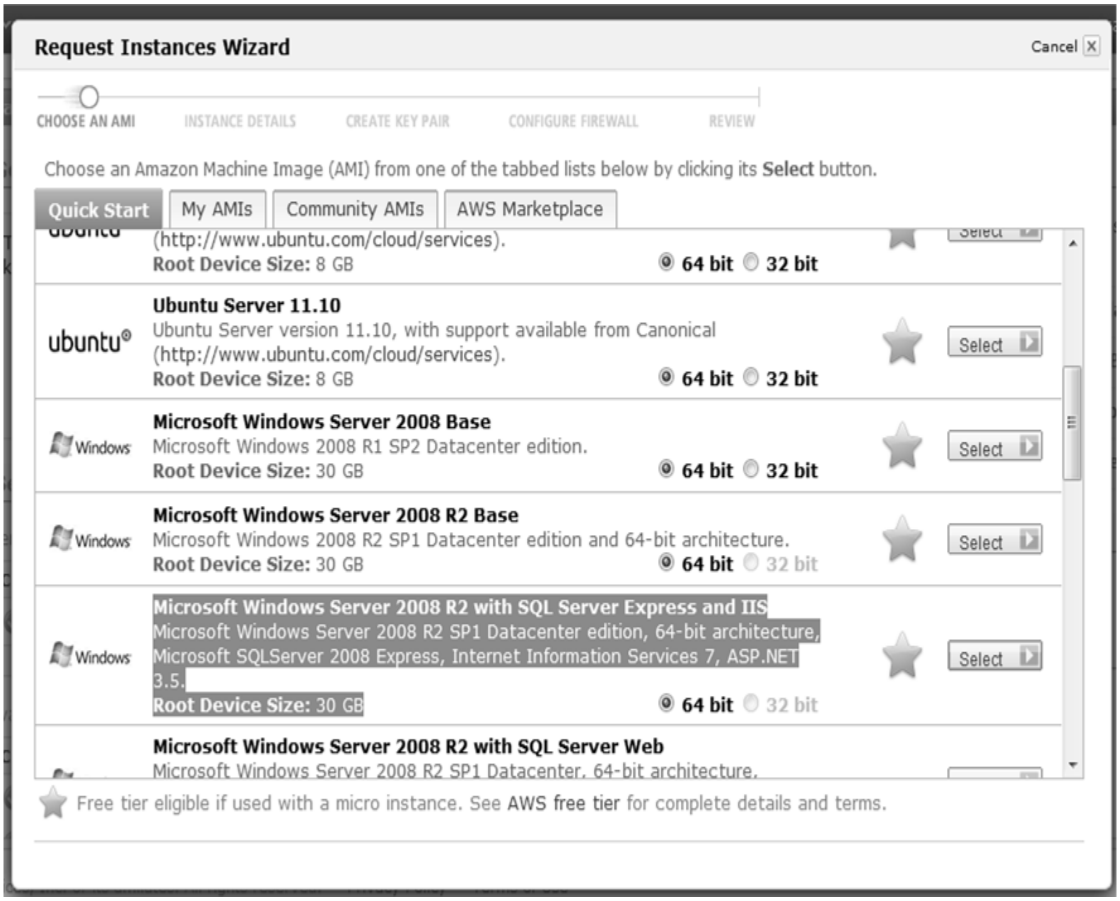
Red Hat Enterprise Linux 6.1 64 bit (AMI Id: ami-5e837b37)
Red Hat Enterprise Linux version 6.1, EBS-boot, 64-bit architecture.
Root Device Size: 6 GB

SUSE Linux Enterprise Server 11 64-bit (AMI Id: ami-e4a3578d)
SUSE Linux Enterprise Server 11 Service Pack 1 basic install, EBS boot, 64-bit architecture with Amazon EC2 AMI Tools preinstalled; Apache 2.2, MySQL 5.0, PHP 5.3, Ruby 1.8.7, and Rails 2.3.
Root Device Size: 15 GB

Free tier eligible if used with a micro instance. See **AWS free tier** for complete details and terms.

Figure 24. Choosing the Wizard for Instance

Then continue to choose operating system and softwares required for our application, for this windows server 2008 R2 with SQL server and IIS is chosen as the figure 10 describe:



Choose an Amazon Machine Image (AMI) from one of the tabbed lists below by clicking its **Select** button.

(http://www.ubuntu.com/cloud/services).
Root Device Size: 8 GB ● **64 bit** ○ **32 bit**

Ubuntu Server 11.10
Ubuntu Server version 11.10, with support available from Canonical (http://www.ubuntu.com/cloud/services).
Root Device Size: 8 GB ● **64 bit** ○ **32 bit**

Microsoft Windows Server 2008 Base
Microsoft Windows 2008 R1 SP2 Datacenter edition.
Root Device Size: 30 GB ● **64 bit** ○ **32 bit**

Microsoft Windows Server 2008 R2 Base
Microsoft Windows 2008 R2 SP1 Datacenter edition and 64-bit architecture.
Root Device Size: 30 GB ● **64 bit** ○ 32 bit

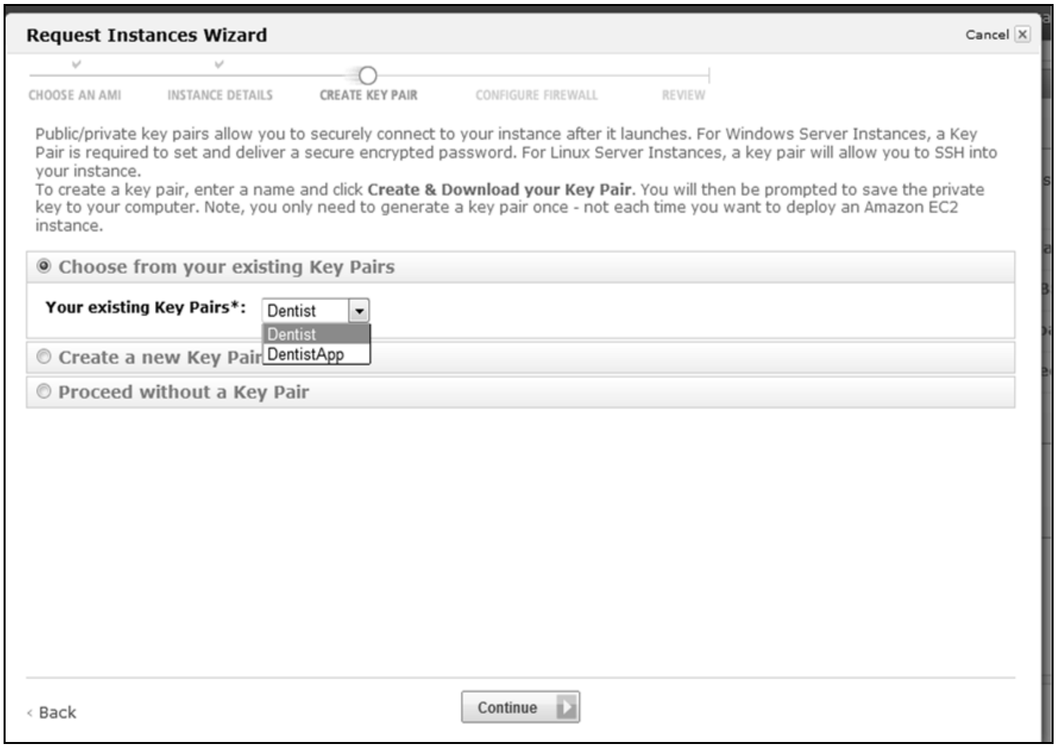
Microsoft Windows Server 2008 R2 with SQL Server Express and IIS
Microsoft Windows Server 2008 R2 SP1 Datacenter edition, 64-bit architecture, Microsoft SQLServer 2008 Express, Internet Information Services 7, ASP.NET 3.5.
Root Device Size: 30 GB ● **64 bit** ○ 32 bit

Microsoft Windows Server 2008 R2 with SQL Server Web
Microsoft Windows Server 2008 R2 SP1 Datacenter, 64-bit architecture,

☆ Free tier eligible if used with a micro instance. See **AWS free tier** for complete details and terms.

Figure 25. Operating System with Software

Then continue to create instance. During the wizard it ask to create of select key, this key is required when the developer want to entrance to instance, it need to create it just one time and save it on your computer. Because the key is created before then it will be chosen from list as figure below illustrate:



Request Instances Wizard

Public/private key pairs allow you to securely connect to your instance after it launches. For Windows Server Instances, a Key Pair is required to set and deliver a secure encrypted password. For Linux Server Instances, a key pair will allow you to SSH into your instance.
To create a key pair, enter a name and click **Create & Download your Key Pair**. You will then be prompted to save the private key to your computer. Note, you only need to generate a key pair once - not each time you want to deploy an Amazon EC2 instance.

● Choose from your existing Key Pairs

Your existing Key Pairs*: Dentist

○ Create a new Key Pair

○ Proceed without a Key Pair

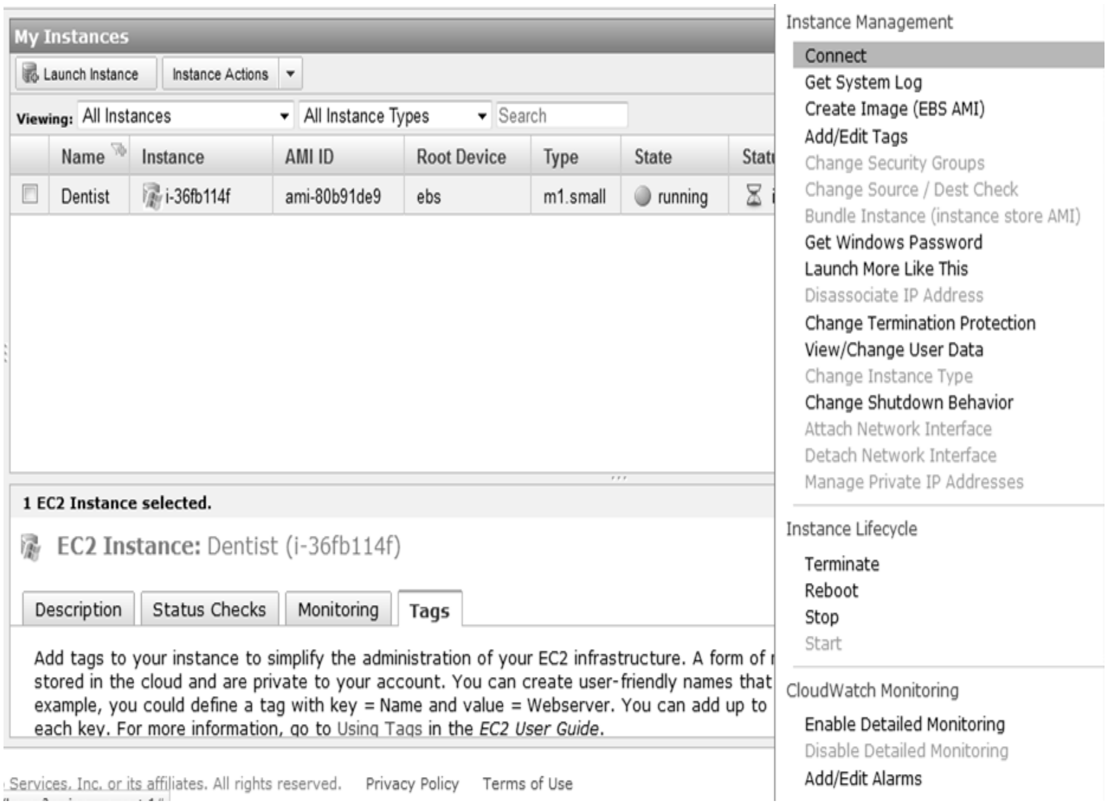
Figure 26. Key Pair in Instance

Continue then press launch to create the instance.

- **Create Elastic IP:** while the instance is connected then the server name is public DNS. Public DNS is changing each time after connect and disconnect the instance, hence server name in database connection will be changed every time and it could be problem, but associate the instance with one IP address make the server name as that IP address which it is static.

  For creating Elastic IP; from Elastic IPs press **Allocate New Address** then associates that IP with instance which is created before.

- **Instance Connect:** for connecting instance right click on instance then choose connect and from remote desktop connection open the virtual windows wich is created by instance. Figure below shows that:



Name	Instance	AMI ID	Root Device	Type	State	Stat
Dentist	i-36fb114f	ami-80b91de9	ebs	m1.small	running	

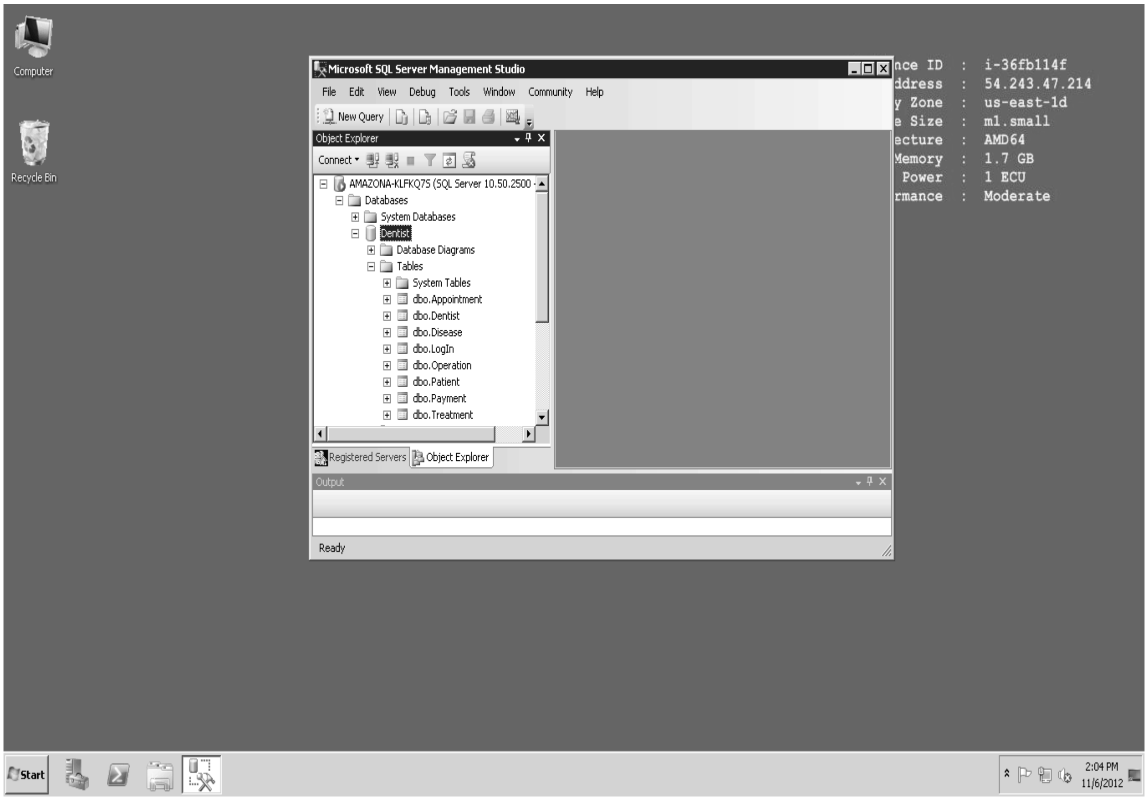
1 EC2 Instance selected.

EC2 Instance: Dentist (i-36fb114f)

Add tags to your instance to simplify the administration of your EC2 infrastructure. A form of
stored in the cloud and are private to your account. You can create user-friendly names that
example, you could define a tag with key = Name and value = Webserver. You can add up to
each key. For more information, go to Using Tags in the *EC2 User Guide*.

Figure 27. Instance Connection

After connect choose the pair key which is created before and decrypted it to show the password then open remote server and paste the password on it to show virtual windows server as below:



```
nce ID    :  i-36fb114f
ddress    :  54.243.47.214
y Zone    :  us-east-1d
e Size    :  m1.small
ecture    :  AMD64
Memory    :  1.7 GB
 Power    :  1 ECU
rmance    :  Moderate
```

```
AMAZONA-KLFKQ7S (SQL Server 10.50.2500 -
  Databases
    System Databases
    Dentist
      Database Diagrams
      Tables
        System Tables
        dbo.Appointment
        dbo.Dentist
        dbo.Disease
        dbo.LogIn
        dbo.Operation
        dbo.Patient
        dbo.Payment
        dbo.Treatment
```

Figure 28. Virtual Server with SQL Server

In the figure 28 as it can be seen the database is saved in SQL Server on windows server and remotely connecting to this data it need to create account in SQL Server.

- Upload the website into that server and run the system from internet network.

5.4.2 Client Implementation

ASP.NET program language is used for implement the system on client side as illustrated above. This program is developed by Microsoft for website purpose, the first version of ASP.net is innovated on 2002. Common Language Runtime (CLR) is used to build ASP.NET[24].

With ASP.NET, a website can be created and each page on this website is conceder as web form which allows user to send information to an application running on the server. The web forms’ code is generated by default with static XHTML in ASP.NET [25]. When web form is created, there are many components that can be used on it such as text box, label, grid view, list box and etc. each component has several properties and methods to all the developer to control the component (enable, visible, text, id, etc.). All of those components are used in this thesis. For instance multi view component is used in patient operation to separate show for each operation. Multi view component is compound control which can contain any number of view controls but one view is visible at the time. In this thesis, three view controls are generated inside of multi view, each view show one operation (one view for diseases, one for treatment, and another for payment).

Some components are installed as advance component and used them to implement the system such as calendar component which is installed into ASP.NET and use it for data purpose. Another component that used for appointment table is called DayPilot. This component gives ready weekly time table to allow the user to have appointment by reserve one cell on that table. Code project website offers this component as free. Also for calendar that used with appointment weekly time table is DayPilot.MothPicker which is found from code project website. This component is an outlook like days/week view which sports context menu and integrated message bar [25].

There is another component that used to develop reports which dentists need. This component is crystal report which needs to install compatible one into visual studio.

That component allow user to view, print, or export the report into pdf file or any other extensions.

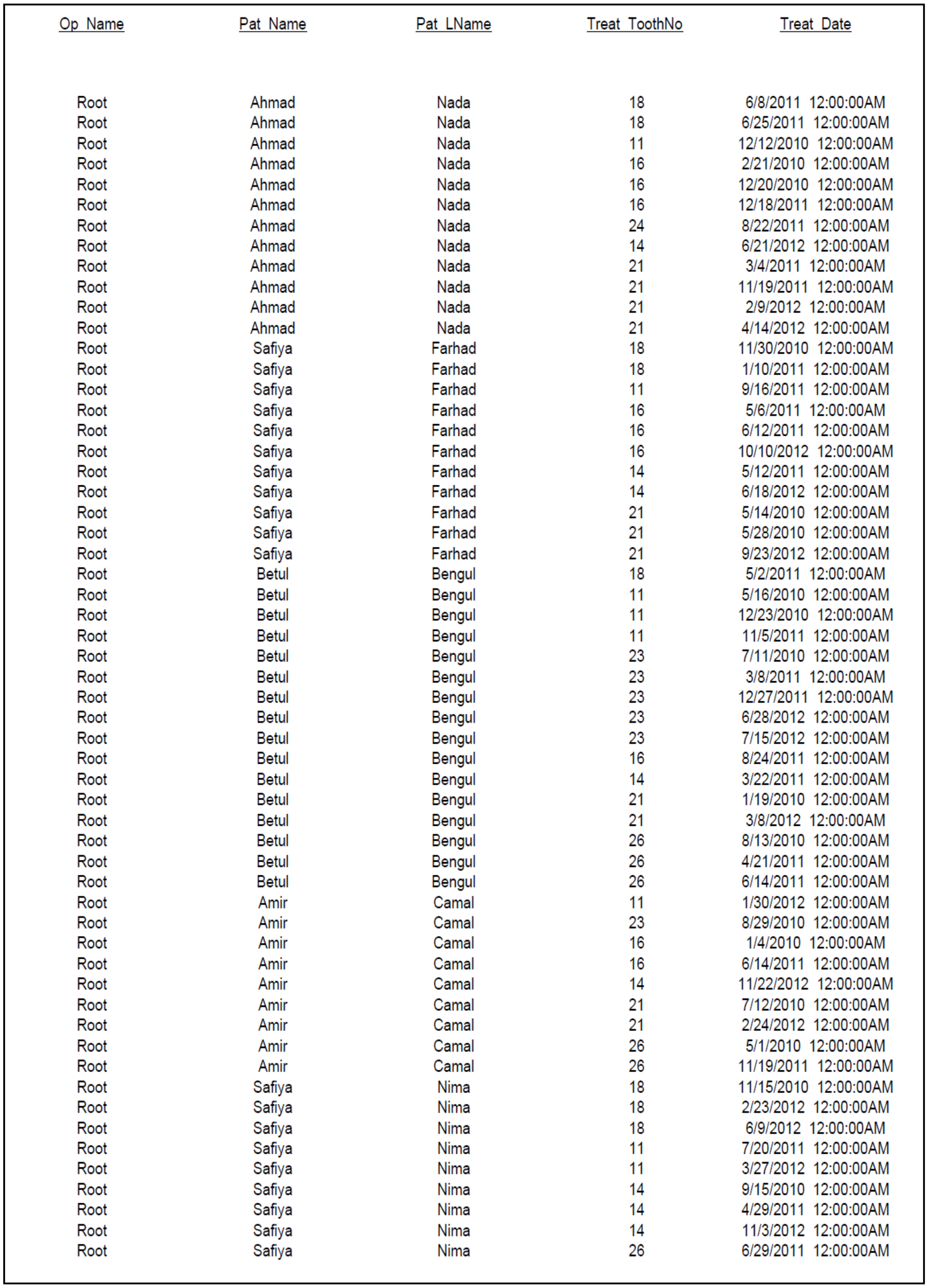
As for page layout, master page is used in this thesis. Master page is a way of providing a common template for multiple web pages. Two master pages are created in the system; one for dentist's pages, and another for patient's pages [26].

To allow the application run on EC2, AWS Toolkit for Microsoft Visual Studio (AWSToolsAndSDKForNet) should install and Amazon.SQS.dll will be found in Bin folder. AWS Toolkit is extension of visual studio to allow the developer to run, debug, and deploy .NET application using amazon web services [27].

As for connect the system with server to use the database from it, firstly provider should create connection with SQL server and use the server name as "54.243.47.214" which refers to ip address for website. And the user name as "zainab" which is created on server, and password as "JAA%**Ht)kr". Once s/he has done that, s/he can seek to the database and use any table s/he wants.

The system which is created has many input actions that can be done by dentist or patient. These actions are explained before (create dentist, create patient, login, appointment, operation, active patient, and treatment). On the other hand there are some useful reports that can be pointed out by dentist such as:

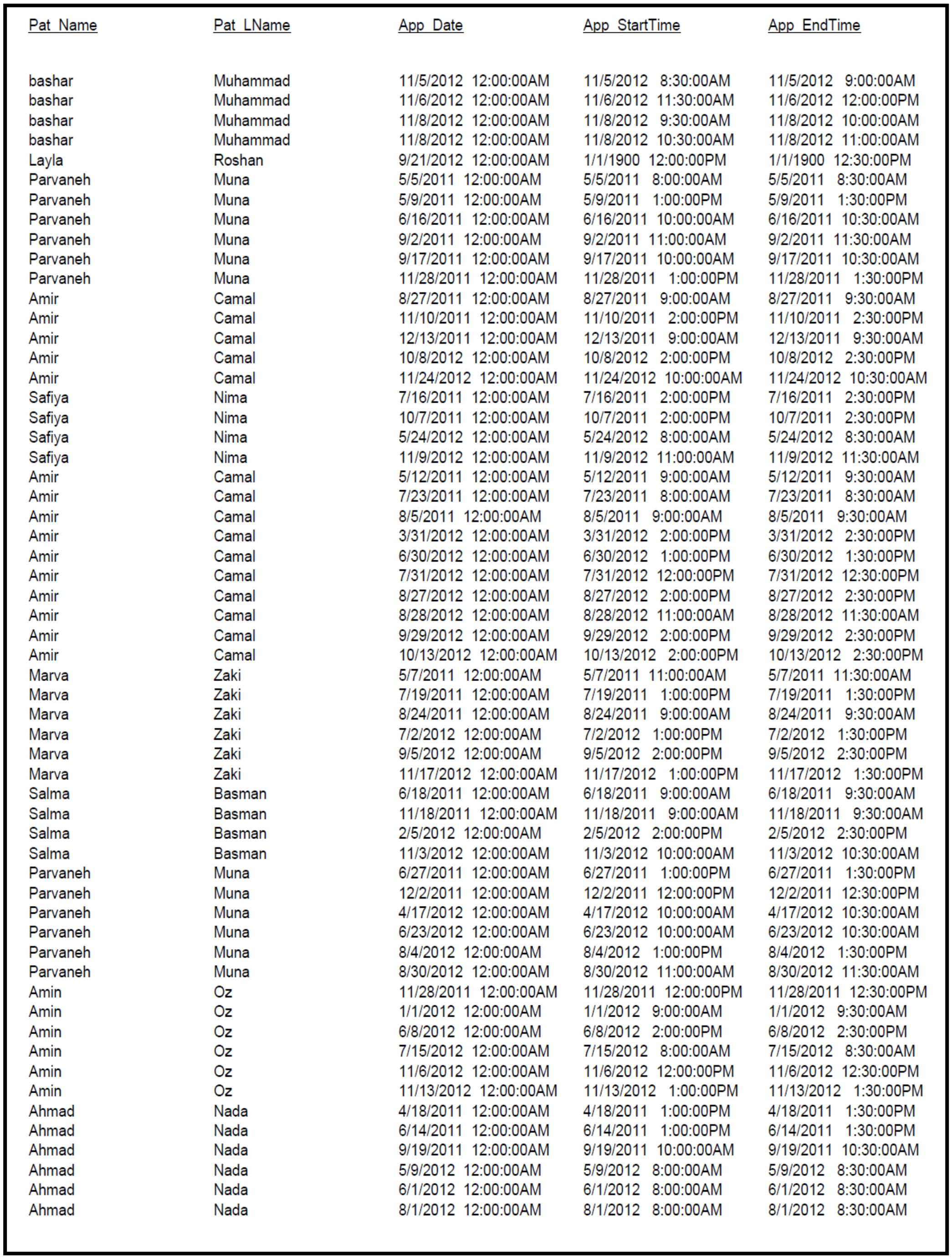
- **list of Treatments for specific date:** the list will show for date start from 1/1/2010 up to 1/1/2013:



Op_Name	Pat_Name	Pat_LName	Treat_ToothNo	Treat_Date
Root	Ahmad	Nada	18	6/8/2011 12:00:00AM
Root	Ahmad	Nada	18	6/25/2011 12:00:00AM
Root	Ahmad	Nada	11	12/12/2010 12:00:00AM
Root	Ahmad	Nada	16	2/21/2010 12:00:00AM
Root	Ahmad	Nada	16	12/20/2010 12:00:00AM
Root	Ahmad	Nada	16	12/18/2011 12:00:00AM
Root	Ahmad	Nada	24	8/22/2011 12:00:00AM
Root	Ahmad	Nada	14	6/21/2012 12:00:00AM
Root	Ahmad	Nada	21	3/4/2011 12:00:00AM
Root	Ahmad	Nada	21	11/19/2011 12:00:00AM
Root	Ahmad	Nada	21	2/9/2012 12:00:00AM
Root	Ahmad	Nada	21	4/14/2012 12:00:00AM
Root	Safiya	Farhad	18	11/30/2010 12:00:00AM
Root	Safiya	Farhad	18	1/10/2011 12:00:00AM
Root	Safiya	Farhad	11	9/16/2011 12:00:00AM
Root	Safiya	Farhad	16	5/6/2011 12:00:00AM
Root	Safiya	Farhad	16	6/12/2011 12:00:00AM
Root	Safiya	Farhad	16	10/10/2012 12:00:00AM
Root	Safiya	Farhad	14	5/12/2011 12:00:00AM
Root	Safiya	Farhad	14	6/18/2012 12:00:00AM
Root	Safiya	Farhad	21	5/14/2010 12:00:00AM
Root	Safiya	Farhad	21	5/28/2010 12:00:00AM
Root	Safiya	Farhad	21	9/23/2012 12:00:00AM
Root	Betul	Bengul	18	5/2/2011 12:00:00AM
Root	Betul	Bengul	11	5/16/2010 12:00:00AM
Root	Betul	Bengul	11	12/23/2010 12:00:00AM
Root	Betul	Bengul	11	11/5/2011 12:00:00AM
Root	Betul	Bengul	23	7/11/2010 12:00:00AM
Root	Betul	Bengul	23	3/8/2011 12:00:00AM
Root	Betul	Bengul	23	12/27/2011 12:00:00AM
Root	Betul	Bengul	23	6/28/2012 12:00:00AM
Root	Betul	Bengul	23	7/15/2012 12:00:00AM
Root	Betul	Bengul	16	8/24/2011 12:00:00AM
Root	Betul	Bengul	14	3/22/2011 12:00:00AM
Root	Betul	Bengul	21	1/19/2010 12:00:00AM
Root	Betul	Bengul	21	3/8/2012 12:00:00AM
Root	Betul	Bengul	26	8/13/2010 12:00:00AM
Root	Betul	Bengul	26	4/21/2011 12:00:00AM
Root	Betul	Bengul	26	6/14/2011 12:00:00AM
Root	Amir	Camal	11	1/30/2012 12:00:00AM
Root	Amir	Camal	23	8/29/2010 12:00:00AM
Root	Amir	Camal	16	1/4/2010 12:00:00AM
Root	Amir	Camal	16	6/14/2011 12:00:00AM
Root	Amir	Camal	14	11/22/2012 12:00:00AM
Root	Amir	Camal	21	7/12/2010 12:00:00AM
Root	Amir	Camal	21	2/24/2012 12:00:00AM
Root	Amir	Camal	26	5/1/2010 12:00:00AM
Root	Amir	Camal	26	11/19/2011 12:00:00AM
Root	Safiya	Nima	18	11/15/2010 12:00:00AM
Root	Safiya	Nima	18	2/23/2012 12:00:00AM
Root	Safiya	Nima	18	6/9/2012 12:00:00AM
Root	Safiya	Nima	11	7/20/2011 12:00:00AM
Root	Safiya	Nima	11	3/27/2012 12:00:00AM
Root	Safiya	Nima	14	9/15/2010 12:00:00AM
Root	Safiya	Nima	14	4/29/2011 12:00:00AM
Root	Safiya	Nima	14	11/3/2012 12:00:00AM
Root	Safiya	Nima	26	6/29/2011 12:00:00AM

Figure 29. Treatments Report for Specific Date

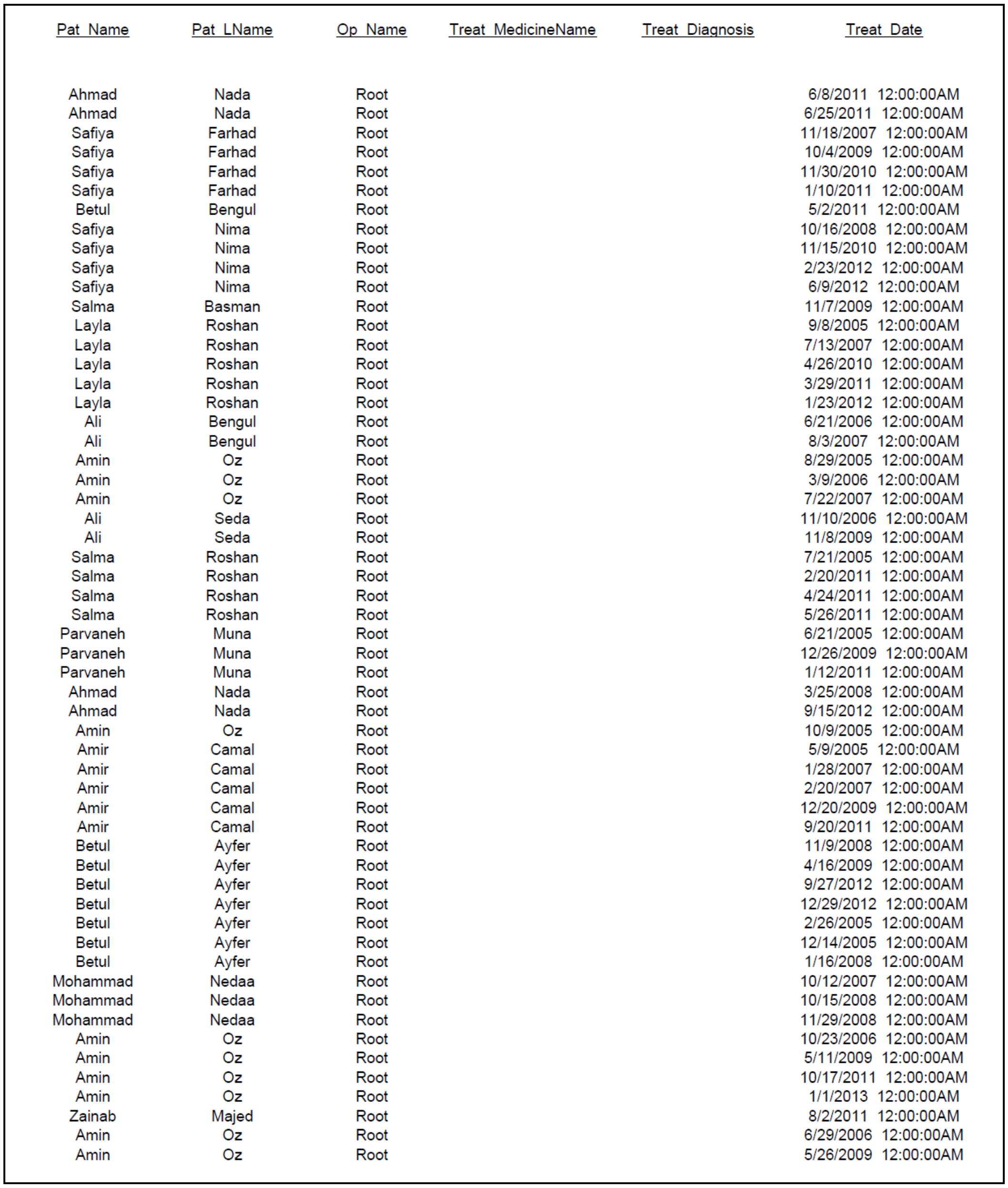
- **list of Appointments for specific date:** the date was chosen from 4/4/2011 until 28/11/2012 and the result like below:



Pat_Name	Pat_LName	App_Date	App_StartTime	App_EndTime
bashar	Muhammad	11/5/2012 12:00:00AM	11/5/2012 8:30:00AM	11/5/2012 9:00:00AM
bashar	Muhammad	11/6/2012 12:00:00AM	11/6/2012 11:30:00AM	11/6/2012 12:00:00PM
bashar	Muhammad	11/8/2012 12:00:00AM	11/8/2012 9:30:00AM	11/8/2012 10:00:00AM
bashar	Muhammad	11/8/2012 12:00:00AM	11/8/2012 10:30:00AM	11/8/2012 11:00:00AM
Layla	Roshan	9/21/2012 12:00:00AM	1/1/1900 12:00:00PM	1/1/1900 12:30:00PM
Parvaneh	Muna	5/5/2011 12:00:00AM	5/5/2011 8:00:00AM	5/5/2011 8:30:00AM
Parvaneh	Muna	5/9/2011 12:00:00AM	5/9/2011 1:00:00PM	5/9/2011 1:30:00PM
Parvaneh	Muna	6/16/2011 12:00:00AM	6/16/2011 10:00:00AM	6/16/2011 10:30:00AM
Parvaneh	Muna	9/2/2011 12:00:00AM	9/2/2011 11:00:00AM	9/2/2011 11:30:00AM
Parvaneh	Muna	9/17/2011 12:00:00AM	9/17/2011 10:00:00AM	9/17/2011 10:30:00AM
Parvaneh	Muna	11/28/2011 12:00:00AM	11/28/2011 1:00:00PM	11/28/2011 1:30:00PM
Amir	Camal	8/27/2011 12:00:00AM	8/27/2011 9:00:00AM	8/27/2011 9:30:00AM
Amir	Camal	11/10/2011 12:00:00AM	11/10/2011 2:00:00PM	11/10/2011 2:30:00PM
Amir	Camal	12/13/2011 12:00:00AM	12/13/2011 9:00:00AM	12/13/2011 9:30:00AM
Amir	Camal	10/8/2012 12:00:00AM	10/8/2012 2:00:00PM	10/8/2012 2:30:00PM
Amir	Camal	11/24/2012 12:00:00AM	11/24/2012 10:00:00AM	11/24/2012 10:30:00AM
Safiya	Nima	7/16/2011 12:00:00AM	7/16/2011 2:00:00PM	7/16/2011 2:30:00PM
Safiya	Nima	10/7/2011 12:00:00AM	10/7/2011 2:00:00PM	10/7/2011 2:30:00PM
Safiya	Nima	5/24/2012 12:00:00AM	5/24/2012 8:00:00AM	5/24/2012 8:30:00AM
Safiya	Nima	11/9/2012 12:00:00AM	11/9/2012 11:00:00AM	11/9/2012 11:30:00AM
Amir	Camal	5/12/2011 12:00:00AM	5/12/2011 9:00:00AM	5/12/2011 9:30:00AM
Amir	Camal	7/23/2011 12:00:00AM	7/23/2011 8:00:00AM	7/23/2011 8:30:00AM
Amir	Camal	8/5/2011 12:00:00AM	8/5/2011 9:00:00AM	8/5/2011 9:30:00AM
Amir	Camal	3/31/2012 12:00:00AM	3/31/2012 2:00:00PM	3/31/2012 2:30:00PM
Amir	Camal	6/30/2012 12:00:00AM	6/30/2012 1:00:00PM	6/30/2012 1:30:00PM
Amir	Camal	7/31/2012 12:00:00AM	7/31/2012 12:00:00PM	7/31/2012 12:30:00PM
Amir	Camal	8/27/2012 12:00:00AM	8/27/2012 2:00:00PM	8/27/2012 2:30:00PM
Amir	Camal	8/28/2012 12:00:00AM	8/28/2012 11:00:00AM	8/28/2012 11:30:00AM
Amir	Camal	9/29/2012 12:00:00AM	9/29/2012 2:00:00PM	9/29/2012 2:30:00PM
Amir	Camal	10/13/2012 12:00:00AM	10/13/2012 2:00:00PM	10/13/2012 2:30:00PM
Marva	Zaki	5/7/2011 12:00:00AM	5/7/2011 11:00:00AM	5/7/2011 11:30:00AM
Marva	Zaki	7/19/2011 12:00:00AM	7/19/2011 1:00:00PM	7/19/2011 1:30:00PM
Marva	Zaki	8/24/2011 12:00:00AM	8/24/2011 9:00:00AM	8/24/2011 9:30:00AM
Marva	Zaki	7/2/2012 12:00:00AM	7/2/2012 1:00:00PM	7/2/2012 1:30:00PM
Marva	Zaki	9/5/2012 12:00:00AM	9/5/2012 2:00:00PM	9/5/2012 2:30:00PM
Marva	Zaki	11/17/2012 12:00:00AM	11/17/2012 1:00:00PM	11/17/2012 1:30:00PM
Salma	Basman	6/18/2011 12:00:00AM	6/18/2011 9:00:00AM	6/18/2011 9:30:00AM
Salma	Basman	11/18/2011 12:00:00AM	11/18/2011 9:00:00AM	11/18/2011 9:30:00AM
Salma	Basman	2/5/2012 12:00:00AM	2/5/2012 2:00:00PM	2/5/2012 2:30:00PM
Salma	Basman	11/3/2012 12:00:00AM	11/3/2012 10:00:00AM	11/3/2012 10:30:00AM
Parvaneh	Muna	6/27/2011 12:00:00AM	6/27/2011 1:00:00PM	6/27/2011 1:30:00PM
Parvaneh	Muna	12/2/2011 12:00:00AM	12/2/2011 12:00:00PM	12/2/2011 12:30:00PM
Parvaneh	Muna	4/17/2012 12:00:00AM	4/17/2012 10:00:00AM	4/17/2012 10:30:00AM
Parvaneh	Muna	6/23/2012 12:00:00AM	6/23/2012 10:00:00AM	6/23/2012 10:30:00AM
Parvaneh	Muna	8/4/2012 12:00:00AM	8/4/2012 1:00:00PM	8/4/2012 1:30:00PM
Parvaneh	Muna	8/30/2012 12:00:00AM	8/30/2012 11:00:00AM	8/30/2012 11:30:00AM
Amin	Oz	11/28/2011 12:00:00AM	11/28/2011 12:00:00PM	11/28/2011 12:30:00PM
Amin	Oz	1/1/2012 12:00:00AM	1/1/2012 9:00:00AM	1/1/2012 9:30:00AM
Amin	Oz	6/8/2012 12:00:00AM	6/8/2012 2:00:00PM	6/8/2012 2:30:00PM
Amin	Oz	7/15/2012 12:00:00AM	7/15/2012 8:00:00AM	7/15/2012 8:30:00AM
Amin	Oz	11/6/2012 12:00:00AM	11/6/2012 12:00:00PM	11/6/2012 12:30:00PM
Amin	Oz	11/13/2012 12:00:00AM	11/13/2012 1:00:00PM	11/13/2012 1:30:00PM
Ahmad	Nada	4/18/2011 12:00:00AM	4/18/2011 1:00:00PM	4/18/2011 1:30:00PM
Ahmad	Nada	6/14/2011 12:00:00AM	6/14/2011 1:00:00PM	6/14/2011 1:30:00PM
Ahmad	Nada	9/19/2011 12:00:00AM	9/19/2011 10:00:00AM	9/19/2011 10:30:00AM
Ahmad	Nada	5/9/2012 12:00:00AM	5/9/2012 8:00:00AM	5/9/2012 8:30:00AM
Ahmad	Nada	6/1/2012 12:00:00AM	6/1/2012 8:00:00AM	6/1/2012 8:30:00AM
Ahmad	Nada	8/1/2012 12:00:00AM	8/1/2012 8:00:00AM	8/1/2012 8:30:00AM

Figure 30. List of Appointment.

- **List of treatments for one tooth number:** the tooth 18 is used to give the result as below:



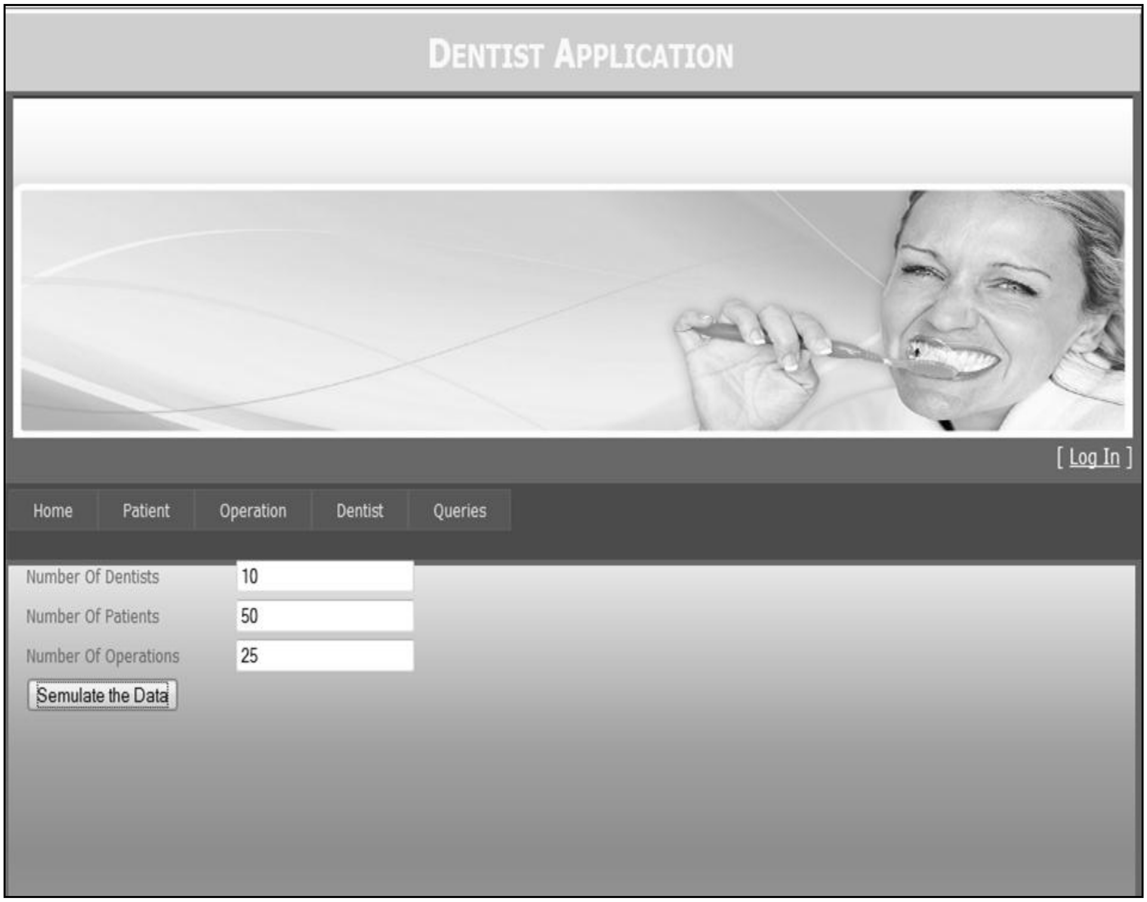
Pat_Name	Pat_LName	Op_Name	Treat_MedicineName	Treat_Diagnosis	Treat_Date
Ahmad	Nada	Root			6/8/2011 12:00:00AM
Ahmad	Nada	Root			6/25/2011 12:00:00AM
Safiya	Farhad	Root			11/18/2007 12:00:00AM
Safiya	Farhad	Root			10/4/2009 12:00:00AM
Safiya	Farhad	Root			11/30/2010 12:00:00AM
Safiya	Farhad	Root			1/10/2011 12:00:00AM
Betul	Bengul	Root			5/2/2011 12:00:00AM
Safiya	Nima	Root			10/16/2008 12:00:00AM
Safiya	Nima	Root			11/15/2010 12:00:00AM
Safiya	Nima	Root			2/23/2012 12:00:00AM
Safiya	Nima	Root			6/9/2012 12:00:00AM
Salma	Basman	Root			11/7/2009 12:00:00AM
Layla	Roshan	Root			9/8/2005 12:00:00AM
Layla	Roshan	Root			7/13/2007 12:00:00AM
Layla	Roshan	Root			4/26/2010 12:00:00AM
Layla	Roshan	Root			3/29/2011 12:00:00AM
Layla	Roshan	Root			1/23/2012 12:00:00AM
Ali	Bengul	Root			6/21/2006 12:00:00AM
Ali	Bengul	Root			8/3/2007 12:00:00AM
Amin	Oz	Root			8/29/2005 12:00:00AM
Amin	Oz	Root			3/9/2006 12:00:00AM
Amin	Oz	Root			7/22/2007 12:00:00AM
Ali	Seda	Root			11/10/2006 12:00:00AM
Ali	Seda	Root			11/8/2009 12:00:00AM
Salma	Roshan	Root			7/21/2005 12:00:00AM
Salma	Roshan	Root			2/20/2011 12:00:00AM
Salma	Roshan	Root			4/24/2011 12:00:00AM
Salma	Roshan	Root			5/26/2011 12:00:00AM
Parvaneh	Muna	Root			6/21/2005 12:00:00AM
Parvaneh	Muna	Root			12/26/2009 12:00:00AM
Parvaneh	Muna	Root			1/12/2011 12:00:00AM
Ahmad	Nada	Root			3/25/2008 12:00:00AM
Ahmad	Nada	Root			9/15/2012 12:00:00AM
Amin	Oz	Root			10/9/2005 12:00:00AM
Amir	Camal	Root			5/9/2005 12:00:00AM
Amir	Camal	Root			1/28/2007 12:00:00AM
Amir	Camal	Root			2/20/2007 12:00:00AM
Amir	Camal	Root			12/20/2009 12:00:00AM
Amir	Camal	Root			9/20/2011 12:00:00AM
Betul	Ayfer	Root			11/9/2008 12:00:00AM
Betul	Ayfer	Root			4/16/2009 12:00:00AM
Betul	Ayfer	Root			9/27/2012 12:00:00AM
Betul	Ayfer	Root			12/29/2012 12:00:00AM
Betul	Ayfer	Root			2/26/2005 12:00:00AM
Betul	Ayfer	Root			12/14/2005 12:00:00AM
Betul	Ayfer	Root			1/16/2008 12:00:00AM
Mohammad	Nedaa	Root			10/12/2007 12:00:00AM
Mohammad	Nedaa	Root			10/15/2008 12:00:00AM
Mohammad	Nedaa	Root			11/29/2008 12:00:00AM
Amin	Oz	Root			10/23/2006 12:00:00AM
Amin	Oz	Root			5/11/2009 12:00:00AM
Amin	Oz	Root			10/17/2011 12:00:00AM
Amin	Oz	Root			1/1/2013 12:00:00AM
Zainab	Majed	Root			8/2/2011 12:00:00AM
Amin	Oz	Root			6/29/2006 12:00:00AM
Amin	Oz	Root			5/26/2009 12:00:00AM

Figure 31. Treatments for Tooth Number 18

5.4.3 Populating Database by a Simulator Program

To test the implemented system needs amount of data. Because of that reason, I populated database tables by writing simulator program.

The important actions that can be done in the system are; create dentist table, create patient table, create treatment table for patients, and create appointment table. For that reason one program was created to simulate those data for number of dentists, number of patients, number of treatments, and number of appointments. On the other words when the system runs, the user should specify number dentists and for each dentist specify number of patients and for each patient specify number of treatment and appointment. Then simulate the program which will insert all of these data into database as figure below shows.



Number Of Dentists 10

Number Of Patients 50

Number Of Operations 25

Figure 32. System Simulation.

For more illustration, flow-chart diagram is designed for simulation on figure 32.

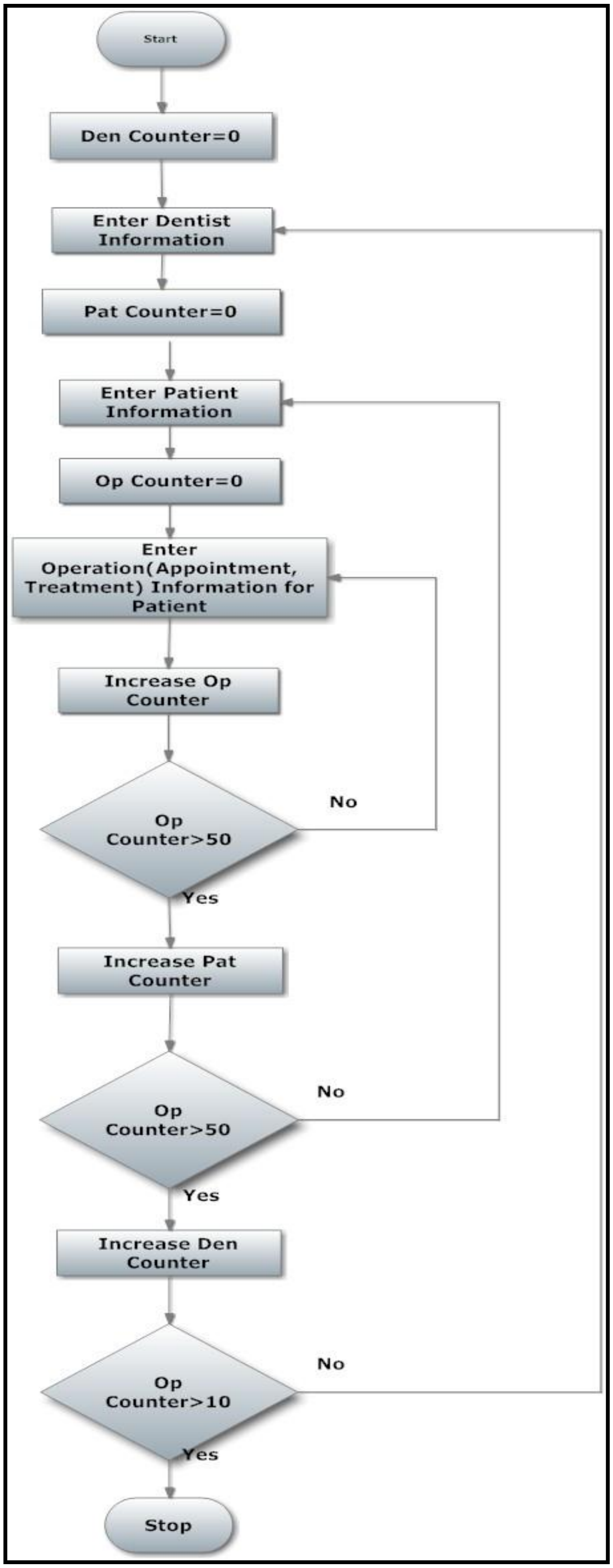


Figure 33. Simulation Flow-Chart.

On figure 32 as it can be seen there are three loops one to create dentists, another to create patients for each dentist and the last loop to create treatments and appointments for each patient. In the figure ten dentists is assumed to create, fifty patients for each dentist, and fifty operations for each patient. Hence ten records will be created in dentist table, 50*10 records will be created in patient table, and 50*50*10 will be created on treatment table and appointment table.

5.5 Database

Depending on analysis the data and generated ERD in chapter 4, the database and its relations is created by SQL Server 2008. The database diagram is designed as figure below show:

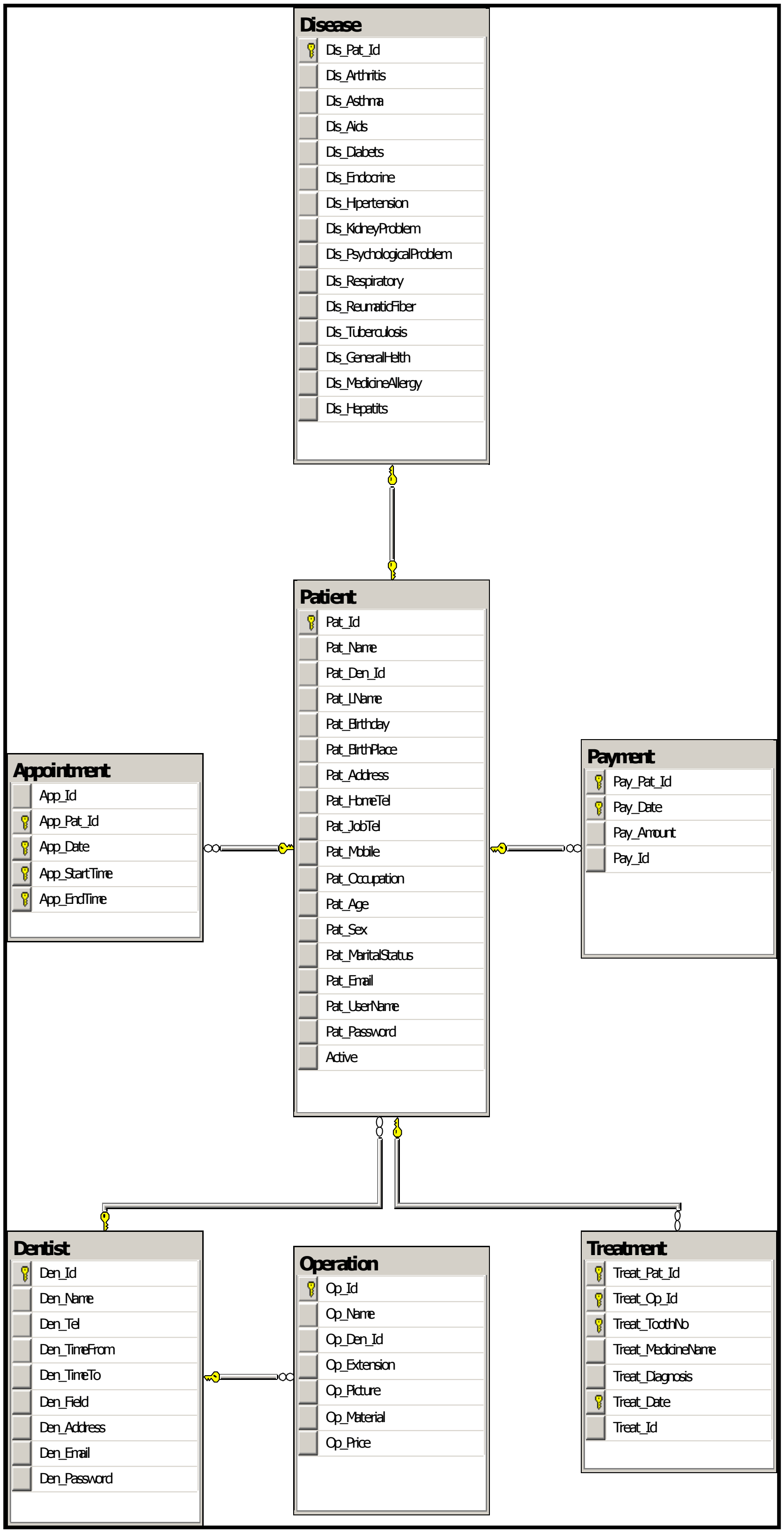


Figure 34. Database Diagram

According to the figure 32, there are eight tables to serve the application. These tables are:

Table 18. Patient Table with Its Attributes

Table Name	**Patient**		
Attribute Name	**Type**	**Required**	**Primary Key**
Id	Int	yes	Yes
Name	Varchar(50)	Yes	No
Last Name	Varchar(50)	Yes	No
Birthday	DateTime	No	No
Birth Place	Varchar(50)	No	No
Address	Varchar(100)	Yes	No
Home Tel	Varchar(50)	Yes	No
Job Tel	Varchar(50)	Yes	No
Mobile	Varchar(50)	Yes	No
Occupation	Varchar(50)	Yes	No
Marital Status	Varchar(50)	Yes	No
Sex	Bit	Yes	No
Email	Varchar(50)	Yes	No
Username	Varchar(50)	Yes	No
Password	Varchar(50)	Yes	No
Active	Bit	No	No

Table 19. Dentist Table with Its Attributes

Table Name	**Dentist**		
Attribute Name	**Type**	**Required**	**Primary Key**
Id	Int	yes	Yes
Name	Varchar(50)	Yes	No
Telephone	Varchar(50)	Yes	No
Email	Varchar(50)	Yes	No
Time From	DateTime	Yes	No
Time To	DateTime	yes	No
Password	Varchar(50)	Yes	No
Address	Varchar(100)	Yes	No
Field	Varchar(5)	No	No

Table 20. Operation Table with Its Attributes

Table Name	**Operation**		
Attribute Name	**Type**	**Required**	**Primary Key**
Id	Int	yes	Yes
Name	Varchar(50)	Yes	No
Picture	Image	Yes	No
Email	Varchar(50)	Yes	No
Price	Float	Yes	No

Table 21. Diseases Table with Its Attributes

Table Name	**Disease**		
Attribute Name	**Type**	**Required**	**Primary Key**
Id	Int	yes	Yes
Arthritis	Bit	No	No
Asthma	Bit	No	No
Aids	Bit	No	No
Diabetes	Bit	No	No
Endocrine	Bit	No	No
Hypertension	Bit	No	No
Kidney Problem	Bit	No	No
Psychological Problem	Bit	No	No
Respiratory	Bit	No	No
Rheumatic Fiber	Bit	No	No
Tuberculosis	Bit	No	No
Hepatitis	Bit	No	No
General Health	Varchar(50)	No	No
Medicine Allergy	Varchar(50)	No	No

Table 22. Appointment Table with Its Attributes

Table Name	**Appointment**		
Attribute Name	**Type**	**Required**	**Primary Key**
Patient_Id	Int	yes	Yes
App_Date	Datetime	Yes	Yes
App_TimeFrom	Time	Yes	Yes
Appo_TimeTo	Time	Yes	Yes

Table 23. Payment Table with Its Attributes

Table Name	Payment		
Attribute Name	**Type**	**Required**	**Primary Key**
Patient_Id	Int	yes	Yes
Pay_Date	Datetime	Yes	Yes
Pay_Amount	Float	Yes	No

Table 24. Treatment Table with Its Attributes

Table Name	**Treatment**		
Attribute Name	**Type**	**Required**	**Primary Key**
Patient_Id	Int	yes	Yes
Treat_Op_Id	Int	Yes	Yes
Treat_ToothNb	Int	Yes	Yes
Treat_Date	DateTime	Yes	Yes
Treat_MidicineName	Varchar(100)	No	No
Treat_Diagnosis	Varchar(100)	No	No

5.6 Performance Comparison

Using cloud computing as a server to host the web site may perform the best performance while the location is near to the host location otherwise is less. For comparing the cloud computing performance with other server, the website is hosted into both EC2, and Eastern Mediterranean University server, then compare some result from those servers.

Table 25. Compare EC2 and EMU Servers

	EC2 Server	EMU Server
Speed of finding whole treatments which have done by dentist(fix amount of data) for specific date(1/11/2011-4/1/2013)	0.261 ms	0.09016 ms
Server controlled	Completely control by developer by rent virtual server	Controlled by server's administrator
Payment	Pay for the services that is used by hours	Free for student
Program language support	Any kind of language	Limit types of program language(ASP.NET, PHP).
Operating system	It can be any kind of operator (windows or linux)	Windows Server 2008
Hosting Server	Each server host just one website.	Maximum 500 website can be hosted in the same server

Due to complete controlled by user and the flexibility of EC2 (use any kind of operating system, any kind of language), EC2 is the better selection for developer to build the system. In adition using one sever for each website by EC2, make it more perform than other convential servers.

As for the performance for using EMU server and EC2 server the system will be tested for response time to retrieve the data when the number of users start from one up to 900 and then drawn the charts for those experiments.

The program used to find the limitation of website is "**Web Server Stress tools 7"** (for both servers EMU and EC2) which simulate the website with specific users and regular time click for each user. This tool allows the developer to test website and check how many users can be used the website in the same time. By this program, the first page of system was clicked each 7 second (click delay) by increasing the number of users from 0 up to 900 users(each 5 second, 51 users increase as figure 55 shows). The setup of testing the system while the server used is EC2 server illustrated in the table 26 below:

Table 26. Test Setup for EC2 Server

Test Type	RAMP (number of users increases during the test time) [Appendix B]
Number of Users	900
Click Delay	7 sec.
Server	Intel(R) xeon(R) CPU E5430@ 2.66GHz 2.79 GHz, 1.66GB RAM, Windows server 2008 R2 46 bit
Client	Intel Core 2 Duo CPU T6670 @ 2.20Ghz , RAM 4 GB, Windows 7 Ultimate 32 bit

On the other hand, the setup used for EMU server is shown in the table 27.

Table 27. Test Setup for EMU Server

Test Type	RAMP (number of users increases during the test time) [Appendix B]
Number of Users	900
Click Delay	7 sec.
Server	Intel Xeon E7430 2.13GHz 4 Core, 4GB RAM, Windows 2008 64 bit
Client	Intel Core 2 Duo CPU T6670 @ 2.20Ghz , RAM 4 GB, Windows 7 Ultimate 32 bit

Then the results of those test show in the charts below:

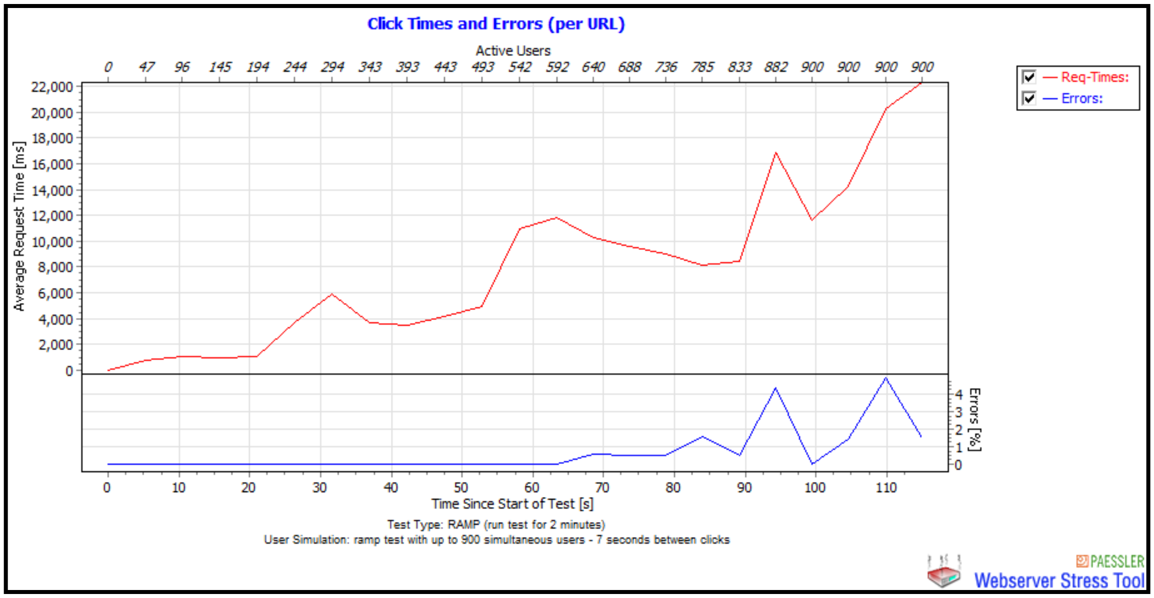


Figure 35. Test Result with 900 Users for EC2 Server

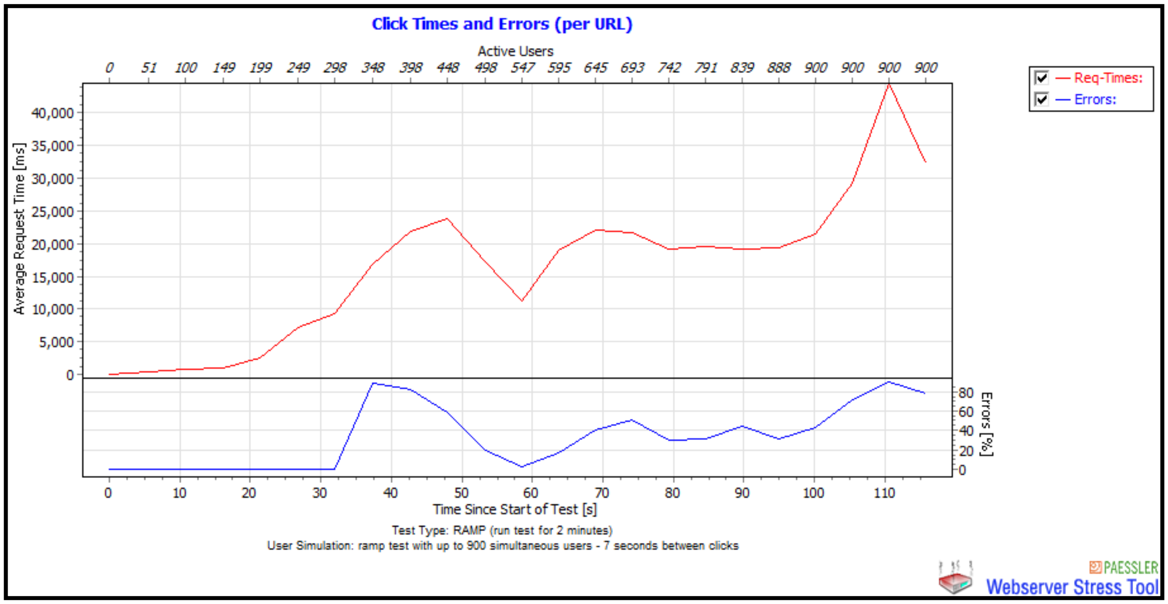


Figure 36. Test Result with 900 Users for EMU Server

In these chart (figure 35, 36) the horizontal axis is divided in two parts, the below part shows the test time which start from 0 up to 110 seconds, and above part shows the active users at this time (start from 0 up to 900 users); on the other word increase the number of users during the time until 900 users; Vertical axis shows the average of response time.

If we take alook to first chart in figure 35 which belobg to EC2 server, we can see that the test went well until about 600 simultaneous users, but could not get any more clicks from this webserver while we increased the number of users further to 900 users. This result shows that the website is work well for about 600 users maximum which is mean less than 600 users can use the website easily at the same time with good performance but more than 600 users the performance become unacceptable. While for using EMU server as figure 36 shows,the system can serve about 300 users maximum, more than this amount of users, the website will have error which is mean can not get any more click from the webserver then the performance become less. Hence the website can be used by 300 users at most simultaneously with using EMU server to host the website. Hence using EMU server can serve about half of the number of users when the EC2 was used.

Chapter 6

CONCLUSION

6.1 Conclude the Work:

Cloud computing become the most important field in IT nowadays. Most of organizations like migrate their data into cloud to reduce the cost needed for those data, get rid of hardware infrastructure and using network instead.

On this thesis cloud computing was used to host dentist, patient information system. The provider for cloud computing used in this thesis was Amazon Web Service and using EC2 service to create a server for host the application on it. EC2 is a public cloud which is available for any kind of customer. The system which implemented in this thesis is designed to serve both patient and dentist. Dentist can do all the necessary patient's operations such as create patient, modify patient information, save the treatment information for each patient, approve the account for patient who register, and give appointment for the patient. As for patient can either create account for him/her self or have appointment while s/he has account before.

The benefit of using cloud computing look like this system is creating one database for several dentists which they can use it separately, and also keeping memory space on dentists computer because they don't need to save their data on local, everything will be saved on cloud. On the other hand the dentists need very good network connection to easy use the system.

The system was analyzed and designed previously to implement it. For implement the system ASP.NET was used then uploads the system into EC2 server to use it via network connection.

6.2 Challenges Work:

There are many challenges was faces to implement this application. Firstly choosing the provider of cloud computing and try to understanding how it work, duo to the starvation of information about cloud computing. Secondly the price used for AWS, database was created on RDS which charge amount of money, then changed the database into SQL server which is founded on server that the EC2 instance given. As for third challenges which was faced is compatible between server and client for instance using crystal report on client, doesn’t work on server until install one program which is call crystal report server on runtime.

6.3 Future Work:

This thesis represents the data services in the cloud, and dentist patient information system was implemented and hosted in cloud. This application can be as e-health application which is means using the system for whole hospital with all of departments and save entire data for hospital into cloud. E-health Application can be used by more than one hospital and all of these hospitals will transfer their data into cloud and use just one database but separate by program from one hospital to another. For implementing this system, the memory size should be big enough to serve all of requested from all of doctors in one hospital and also all of hospitals simultaneously. Hence using large instance or maybe x-large could be suitable while the price of serve will be increase with increasing the size of instance.

Mobile application can be adopted for appointment part of the system, geographical system can be integrated to the system for finding location of the doctors using address information and etc.

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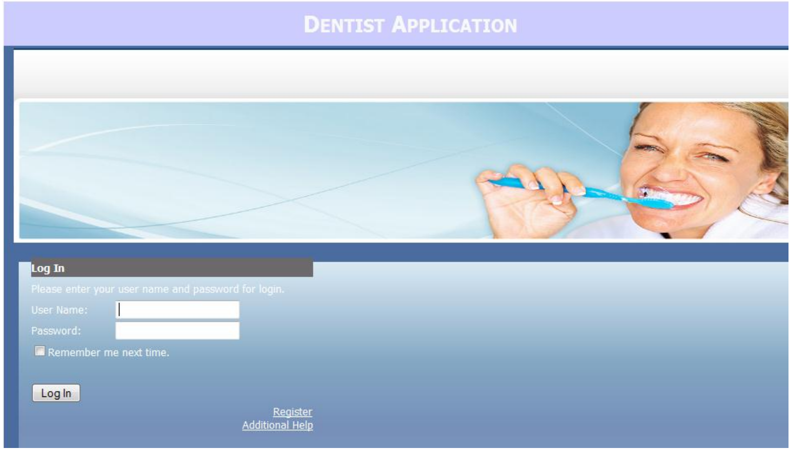
APPENDICES

Appendix A: User Documentation

In this section, the way of using the system will be described either the user is patient or dentist.

First of all when the user entering to the system, login page will be shown:



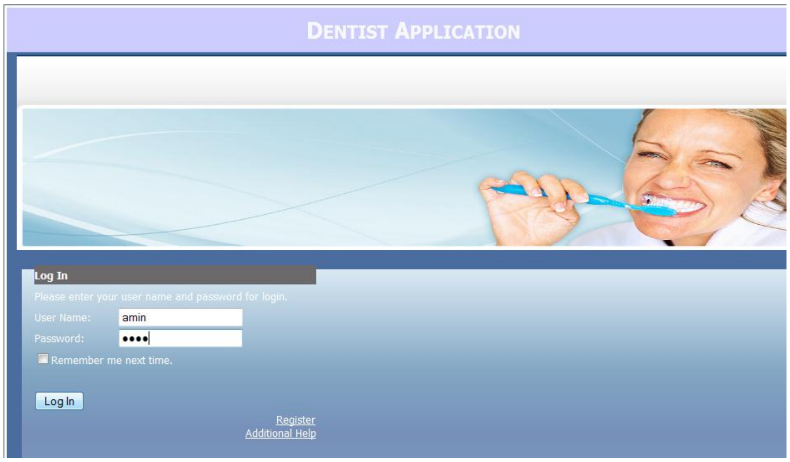
DENTIST APPLICATION

Log In

Please enter your user name and password for login.

Figure 37. Login Page

While the user who enters the system is dentist then as illustrated before, s/he should have the system user name and password to enter to the system.



Log In

Please enter your user name and password for login.

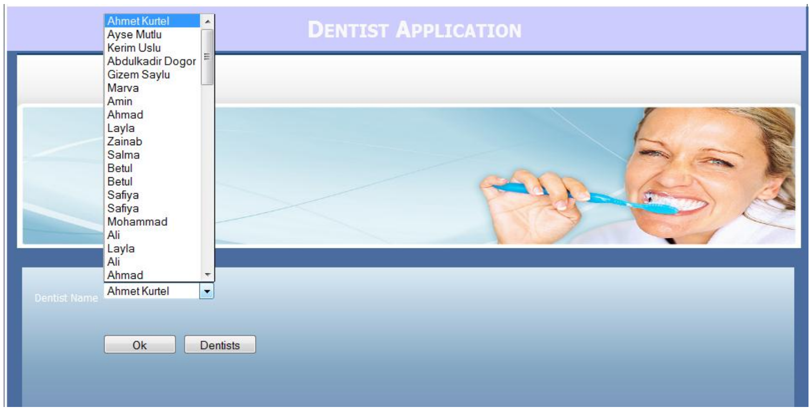
User Name: amin

Password: ••••

□ Remember me next time.

Figure 38. Dentist Login

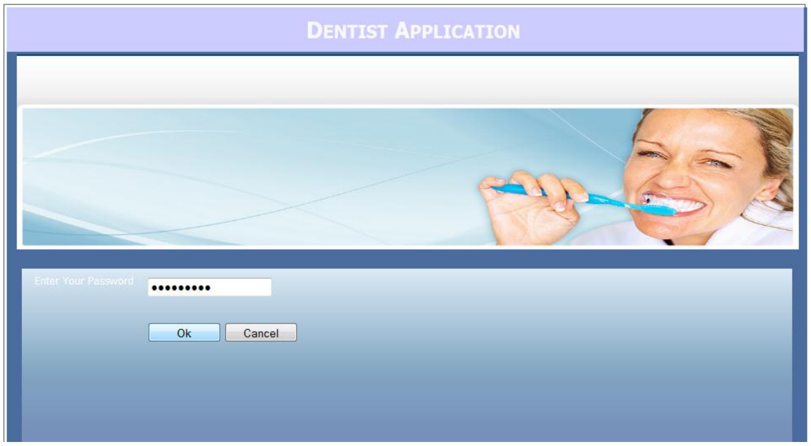
Figure 38 shows that dentist use “amin” as user name and “1234” as password then click “Login”. Once s/he has done that, another page will be appeared to choose the name of dentist from list of dentist as figure 39 shown.



Dentist Name: Ahmet Kurtel

Figure 39. Choose Dentist Page

When the dentist choose his/her name from the list, then s/he should write his/her password to allow him/her to enter to the system as shows in figure 40.



Enter Your Password •••••••••

Figure 40. Dentist Password Page

Then the dentist can enter to the system and use any action s/he wants. Figure 41 illustrated that.

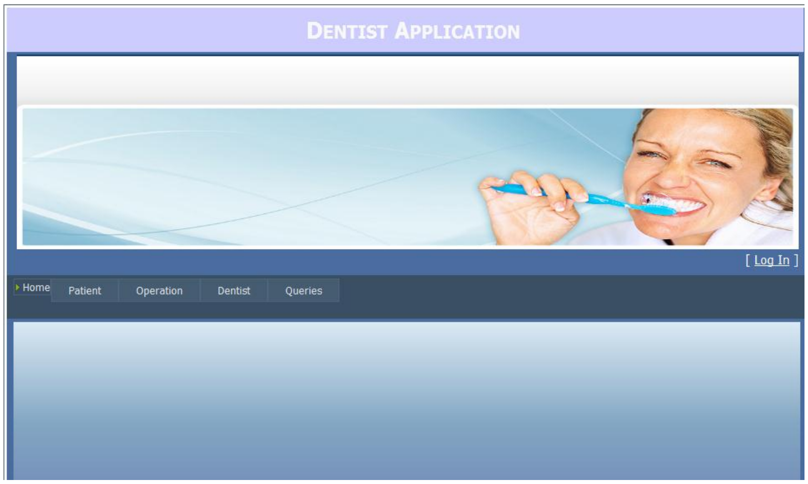


Figure 41. Main Page with Menu

The dentist for instance s/he wants to insert new patient firstly should click on patient in the menu then choose patient information from it as it shows on figure 42 below.

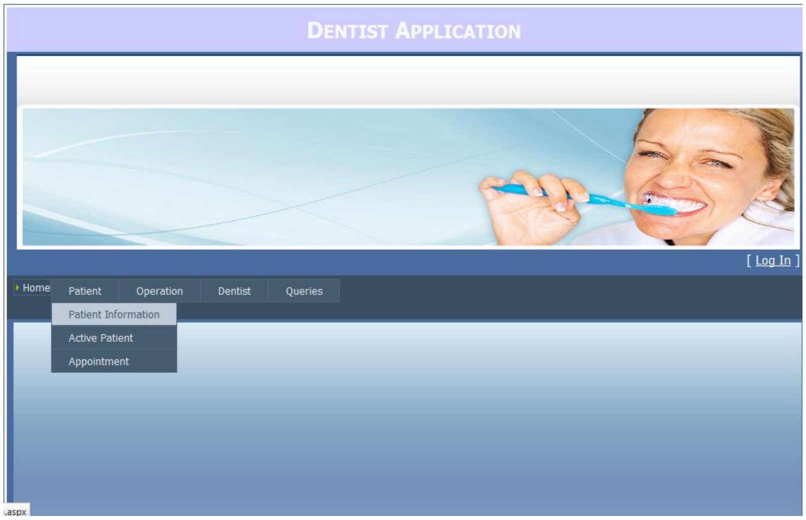
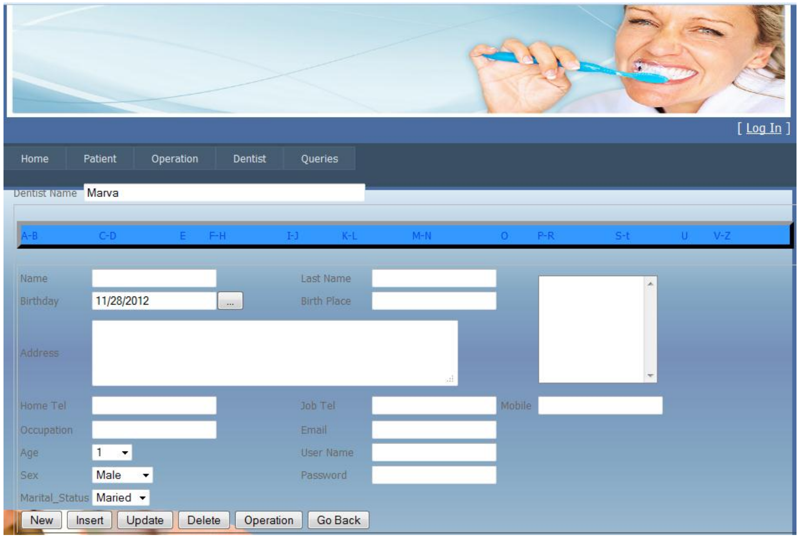


Figure 42. Choose Patient Information

After that one page will be shown to fill some information about the patient. Like that in figure 43.



Dentist Name Marva

Birthday 11/28/2012

Age 1

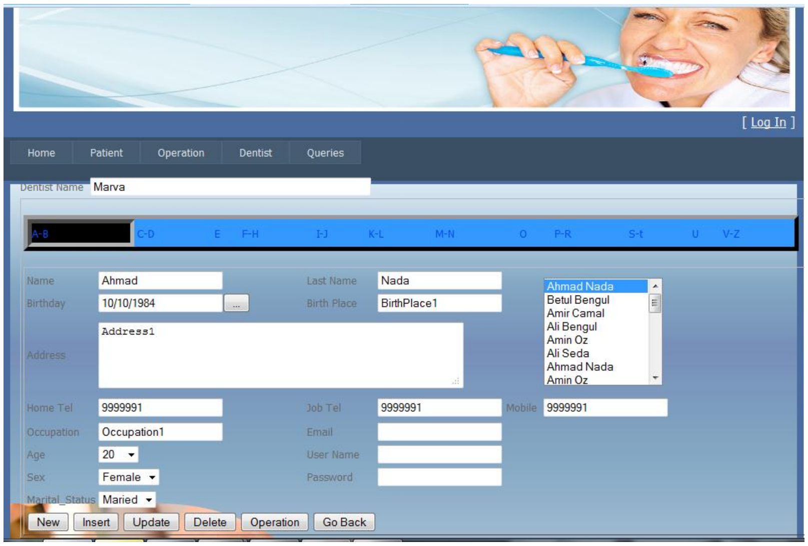
Sex Male

Marital_Status Maried

Figure 43. Patient Information Page

The dentist will fill all of these fields and then click insert to insert new patient.

While the dentist wants to insert operation to one of his/her patient firstly s/he should choose one from the list of letters which the patient name start with that letter, secondly all of patients that their name start with this letter will be shown in list box in the right side. Thirdly the dentist should choose the patient name from that list box. Finally click operation. Figure 44 will be illustrated that explanation.



Dentist Name: Marva

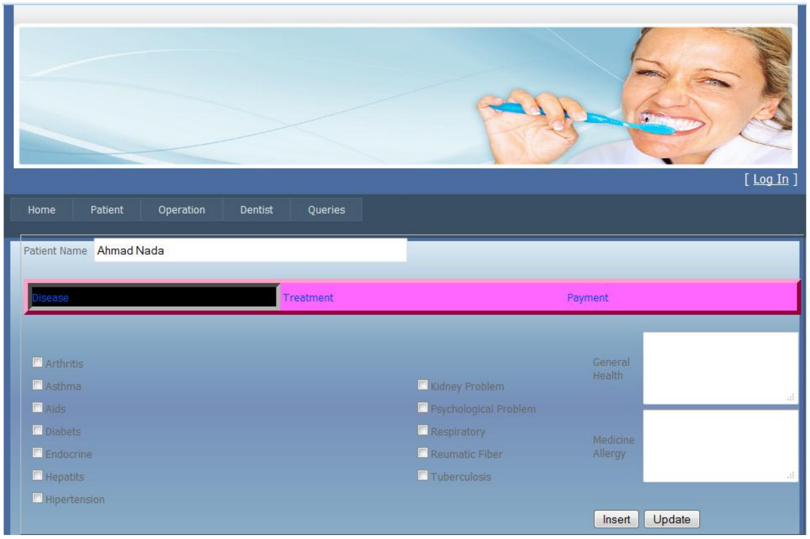
Name	Ahmad	Last Name	Nada		
Birthday	10/10/1984	Birth Place	BirthPlace1		
Address	Address1				
Home Tel	9999991	Job Tel	9999991	Mobile	9999991
Occupation	Occupation1	Email			
Age	20	User Name			
Sex	Female	Password			
Marital_Status	Maried				

Ahmad Nada
Betul Bengul
Amir Camal
Ali Bengul
Amin Oz
Ali Seda
Ahmad Nada
Amin Oz

Figure 44. Choose Patient

There are three operations available in the system diseases, treatment, and payment. The dentist can choose any of them and insert that operation for that patient.

First operation is diseases which allow the dentist to choose any disease that the patient has then click insert for the first visit or update for next visit as figure 45 shows.



Patient Name: Ahmad Nada

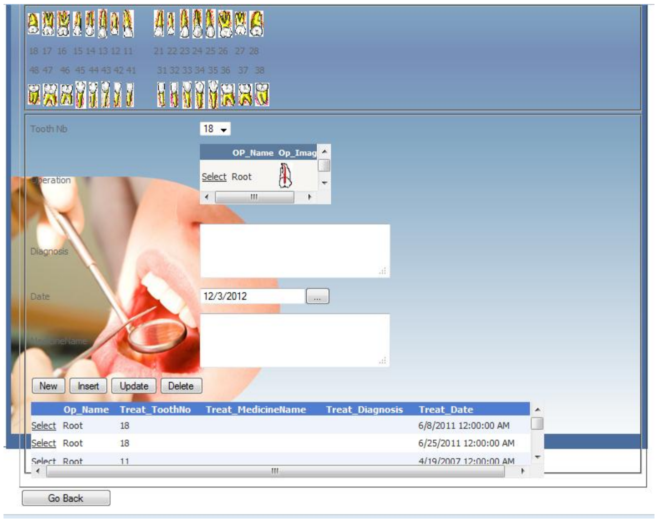
□ Arthritis
□ Asthma
□ Aids
□ Diabets
□ Endocrine
□ Hepatits
□ Hipertension
□ Kidney Problem
□ Psychological Problem
□ Respiratory
□ Reumatic Fiber
□ Tuberculosis

General Health

Medicine Allergy

Figure 45. Operation Page

The second operation is treatment which allow dentist to save all of treatment information for patient with specific date. The system allows to insert, update, and delete treatment as figure 46 shows.



Tooth Nb: 18

Operation:

	OP_Name	Op_Imag
Select	Root	

Diagnosis

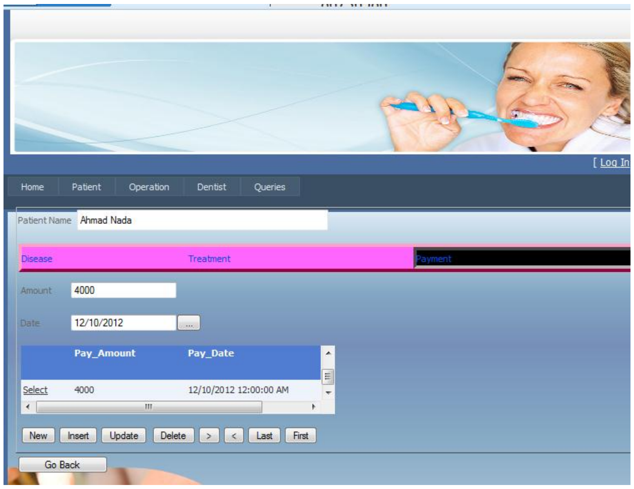
Date: 12/3/2012

MedicineName

	Op_Name	Treat_ToothNo	Treat_MedicineName	Treat_Diagnosis	Treat_Date
Select	Root	18			6/8/2011 12:00:00 AM
Select	Root	18			6/25/2011 12:00:00 AM
Select	Root	11			4/19/2007 12:00:00 AM

Figure 46. Treatment Page

As for third operation is related with payment that the patient pays to dentist for treatment. By this action, the dentist keeps each payment amount with its date and patient id as figure 47 is shown.



Patient Name Ahmad Nada

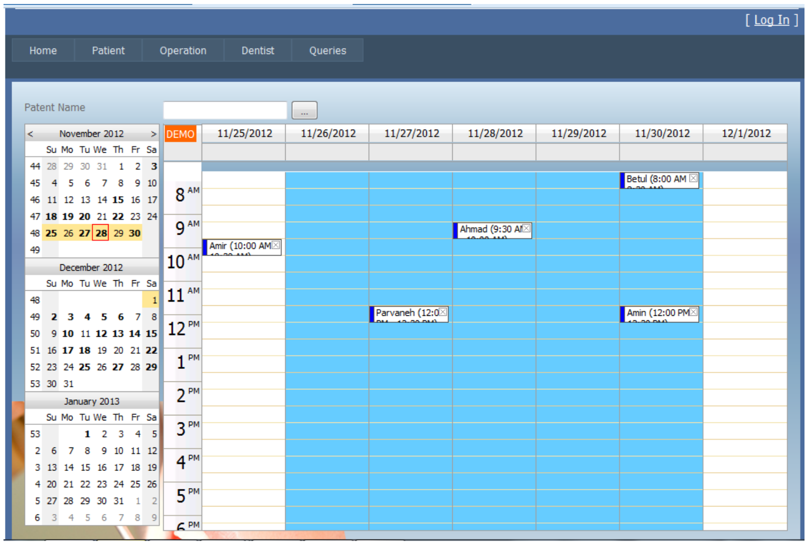
Amount 4000

Date 12/10/2012

	Pay_Amount	Pay_Date
Select	4000	12/10/2012 12:00:00 AM

Figure 47. Treatment Page

On the other hand while the dentist choose from patient list, appointment then the page in the figure 48 below will be shown.



Patent Name

November 2012

	Su	Mo	Tu	We	Th	Fr	Sa
44	28	29	30	31	1	2	3
45	4	5	6	7	8	9	10
46	11	12	13	14	15	16	17
47	18	19	20	21	22	23	24
48	25	26	27	28	29	30	
49							

December 2012

	Su	Mo	Tu	We	Th	Fr	Sa
48							1
49	2	3	4	5	6	7	8
50	9	10	11	12	13	14	15
51	16	17	18	19	20	21	22
52	23	24	25	26	27	28	29
53	30	31					

January 2013

	Su	Mo	Tu	We	Th	Fr	Sa
53			1	2	3	4	5
2	6	7	8	9	10	11	12
3	13	14	15	16	17	18	19
4	20	21	22	23	24	25	26
5	27	28	29	30	31	1	2
6	3	4	5	6	7	8	9

11/25/2012	11/26/2012	11/27/2012	11/28/2012	11/29/2012	11/30/2012	12/1/2012
Amir (10:00 AM		Parvaneh (12:0	Ahmad (9:30 AI		Betul (8:00 AM Amin (12:00 PM	

Figure 48. Appointment Page

If the dentist wants to insert new appointment then firstly s/he should choose the patient name from the text box up then right click on the table and choose "create new event" as figure 49 shows.

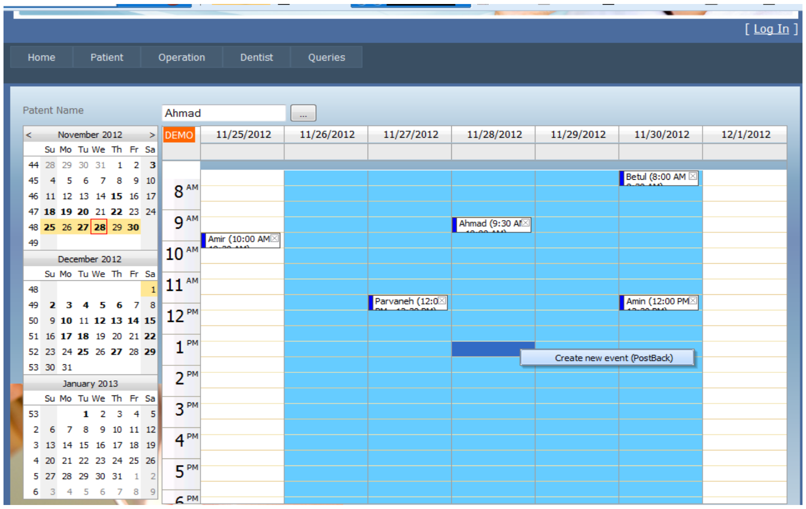
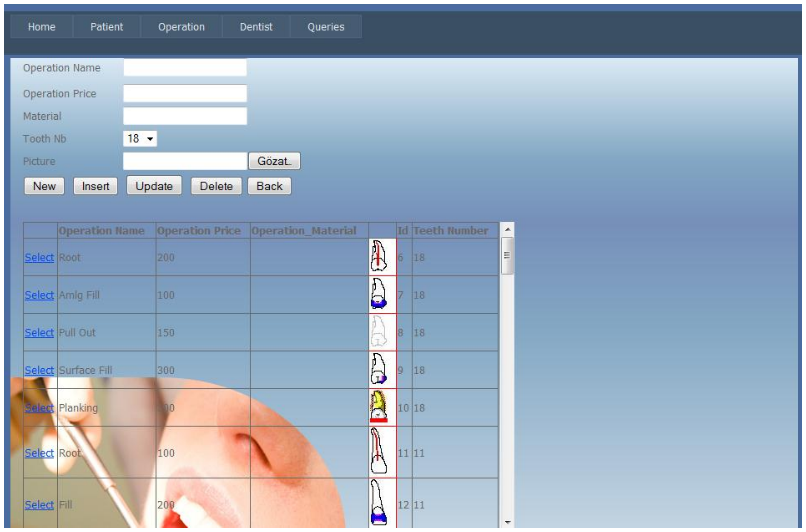


Figure 49. Create New Appointment

For another action which is available in the system is operation as explained before, each dentist has his/her own operations for each tooth, so when the dentist click on operation s/he can insert, update, and delete an operation as figure 51 below shows:



Operation Name

Operation Price

Material

Tooth Nb 18

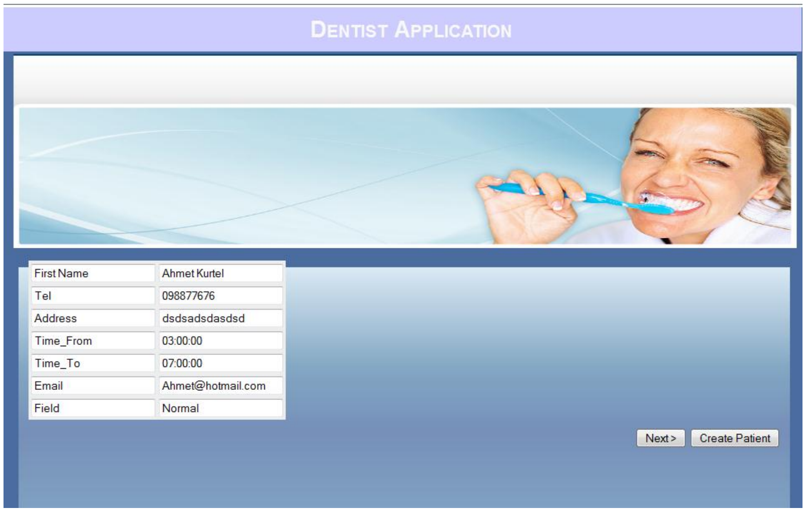
Picture

	Operation Name	Operation Price	Operation_Material		Id	Teeth Number
Select	Root	200			6	18
Select	Amlg Fill	100			7	18
Select	Pull Out	150			8	18
Select	Surface Fill	300			9	18
Select	Planking	[illegible]			10	18
Select	Root	100			11	11
Select	Fill	200			12	11

Figure 50. Operation Page

Figure 50 shows the list of operations for special dentist and image for each operation to each tooth. As explained previously the dentist can do require modification on his/her operations.

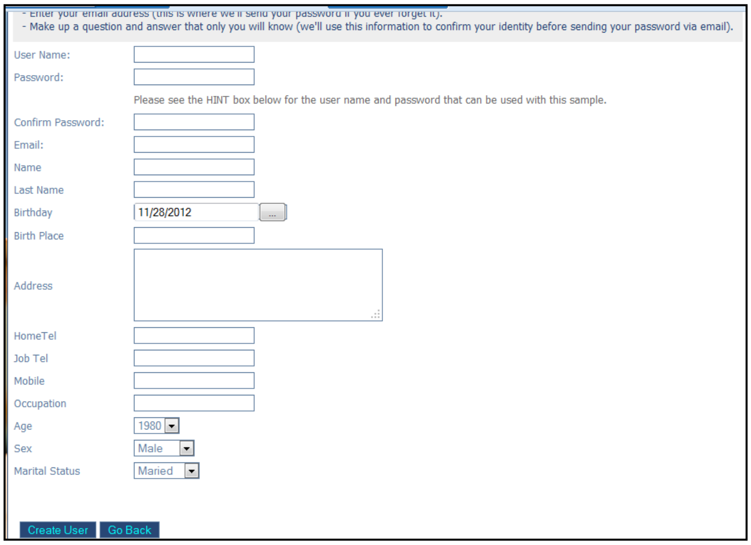
Finally queries button which allow dentist to show some report about his/her job. As for patient as a user, firstly the patient can register into system by click on register link as figure 38 was shown then the page below will be appeared:



First Name	Ahmet Kurtel
Tel	098877676
Address	dsdsadsdasdsd
Time_From	03:00:00
Time_To	07:00:00
Email	Ahmet@hotmail.com
Field	Normal

Figure 51. Choose Dentist

In figure 51 the patient should choose his/her dentist and then click “Create Patient”.


- Enter your email address (this is where we'll send your password if you ever forget it).
- Make up a question and answer that only you will know (we'll use this information to confirm your identity before sending your password via email).

User Name:	
Password:	
	Please see the HINT box below for the user name and password that can be used with this sample.
Confirm Password:	
Email:	
Name	
Last Name	
Birthday	11/28/2012
Birth Place	
Address	
HomeTel	
Job Tel	
Mobile	
Occupation	
Age	1980
Sex	Male
Marital Status	Maried

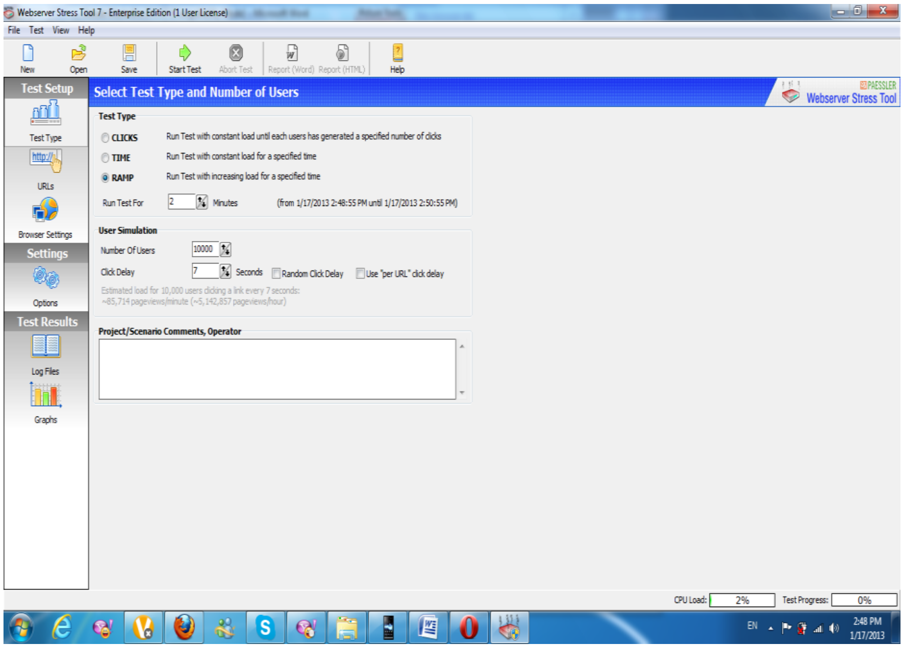
Figure 52. Register Patient Page

After the patient fill all of fields in the figure 52 and then click “Create user”. One he has done that; one page will be shown to tell the patient that s/he register correctly and s/he should wait until his/her account be approved. After that s/he can login to his/her account and have appointment with the dentist.

Appendix B: Webserver Stress Tools 7 Documentation

Using this tools for simulate the website to know what is the performance of the website while huge amount of users use the site for same time.

For using this tool to simulate the website some setting should be choosen for run the test.



Select Test Type and Number of Users

Test Type

○ CLICKS Run Test with constant load until each users has generated a specified number of clicks

○ TIME Run Test with constant load for a specified time

● RAMP Run Test with increasing load for a specified time

Run Test For 2 Minutes (from 1/17/2013 2:48:55 PM until 1/17/2013 2:50:55 PM)

User Simulation

Number Of Users 10000

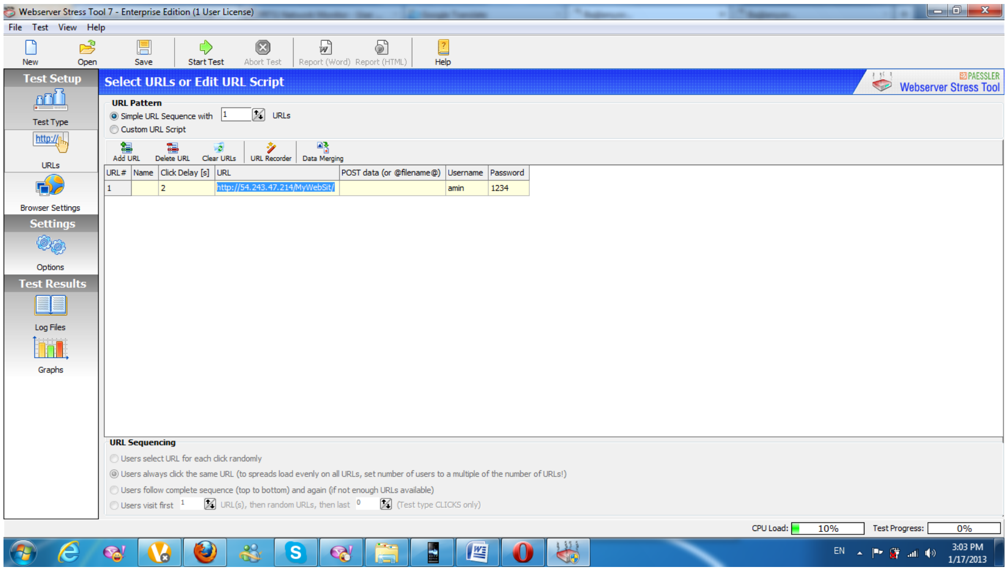
Click Delay 7 Seconds □ Random Click Delay □ Use "per URL" click delay

Estimated load for 10,000 users clicking a link every 7 seconds:
~85,714 pageviews/minute (~5,142,857 pageviews/hour)

Project/Scenario Comments, Operator

Figure 53. Webserver Stress Tools First Page

In figure 53 first setting is choosen type of test (there are three types of test ; click, time, and ramp) in here RAMP type is choosen which refer to run the test with increasing the load during the time. Second setting is choosen the number of users who they used the site simultaneously (in our thesis the number of user is 900). Third setting is chosen click delay which is mean how many seconds between each click and for here 7 second is used. Finally insert the address of the website as figure 54 shown and then click start test to run the program.



Select URLs or Edit URL Script

URL Pattern

● Simple URL Sequence with 1 URLs

○ Custom URL Script

URL #	Name	Click Delay [s]	URL	POST data (or @filename@)	Username	Password
1		2	http://54.243.47.214/MyWebSit/		amin	1234

URL Sequencing

○ Users select URL for each click randomly

● Users always click the same URL (to spreads load evenly on all URLs, set number of users to a multiple of the number of URLs!)

○ Users follow complete sequence (top to bottom) and again (if not enough URLs available)

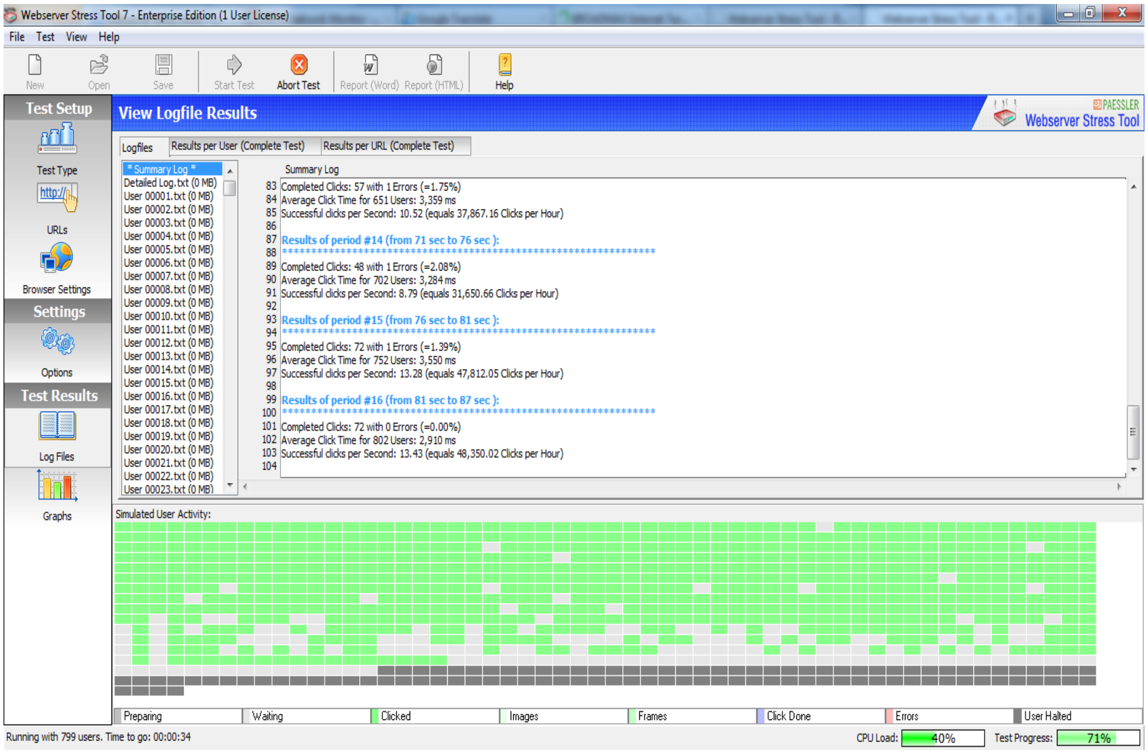
○ Users visit first 1 URL(s), then random URLs, then last 0 (Test type CLICKS only)

CPU Load: 10% Test Progress: 0%

EN 3:03 PM 1/17/2013

Figure 54. Insert Website Address

During the test, the program shows how many click finished during some seconds for some users as figure 55 shows.



```
* Summary Log *
Detailed Log.txt (0 MB)
User 00001.txt (0 MB)
User 00002.txt (0 MB)
User 00003.txt (0 MB)
User 00004.txt (0 MB)
User 00005.txt (0 MB)
User 00006.txt (0 MB)
User 00007.txt (0 MB)
User 00008.txt (0 MB)
User 00009.txt (0 MB)
User 00010.txt (0 MB)
User 00011.txt (0 MB)
User 00012.txt (0 MB)
User 00013.txt (0 MB)
User 00014.txt (0 MB)
User 00015.txt (0 MB)
User 00016.txt (0 MB)
User 00017.txt (0 MB)
User 00018.txt (0 MB)
User 00019.txt (0 MB)
User 00020.txt (0 MB)
User 00021.txt (0 MB)
User 00022.txt (0 MB)
User 00023.txt (0 MB)
```

Summary Log

```
Completed Clicks: 57 with 1 Errors (=1.75%)
Average Click Time for 651 Users: 3,359 ms
Successful clicks per Second: 10.52 (equals 37,867.16 Clicks per Hour)

Results of period #14 (from 71 sec to 76 sec ):
*****************************************************************
Completed Clicks: 48 with 1 Errors (=2.08%)
Average Click Time for 702 Users: 3,284 ms
Successful clicks per Second: 8.79 (equals 31,650.66 Clicks per Hour)

Results of period #15 (from 76 sec to 81 sec ):
*****************************************************************
Completed Clicks: 72 with 1 Errors (=1.39%)
Average Click Time for 752 Users: 3,550 ms
Successful clicks per Second: 13.28 (equals 47,812.05 Clicks per Hour)

Results of period #16 (from 81 sec to 87 sec ):
*****************************************************************
Completed Clicks: 72 with 0 Errors (=0.00%)
Average Click Time for 802 Users: 2,910 ms
Successful clicks per Second: 13.43 (equals 48,350.02 Clicks per Hour)
```

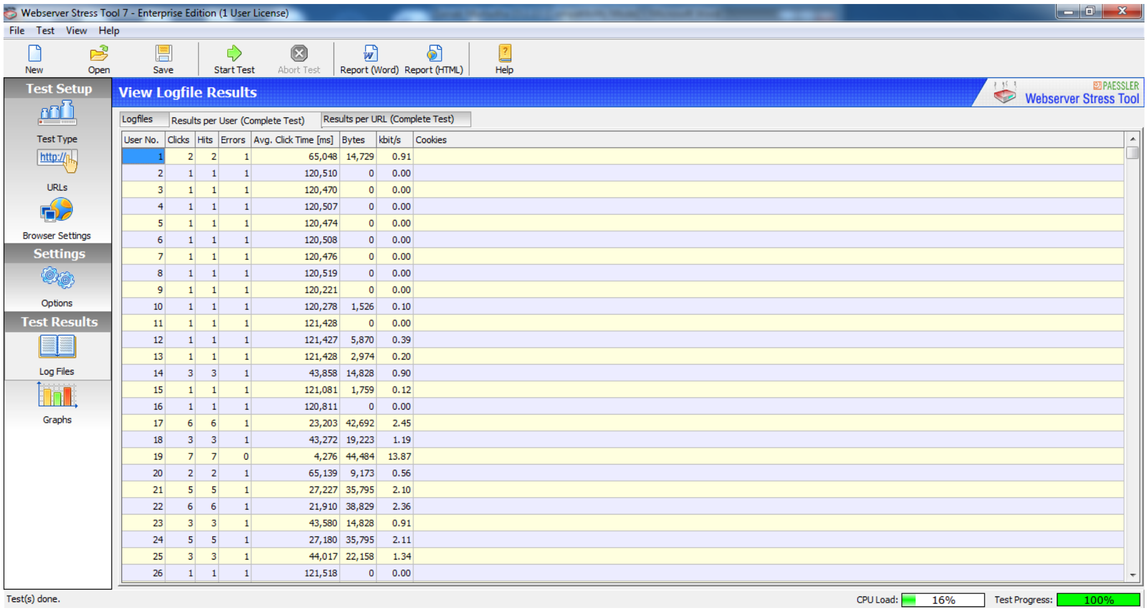
Running with 799 users. Time to go: 00:00:34

CPU Load: 40%

Test Progress: 71%

Figure 55. Runing Test Website

After running the test, this program will give some detail of result. For instance the result related with each user (average of error, number of click, average of click) as figure 56 below shows.



User No.	Clicks	Hits	Errors	Avg. Click Time [ms]	Bytes	kbit/s	Cookies
1	2	2	1	65,048	14,729	0.91	
2	1	1	1	120,510	0	0.00	
3	1	1	1	120,470	0	0.00	
4	1	1	1	120,507	0	0.00	
5	1	1	1	120,474	0	0.00	
6	1	1	1	120,508	0	0.00	
7	1	1	1	120,476	0	0.00	
8	1	1	1	120,519	0	0.00	
9	1	1	1	120,221	0	0.00	
10	1	1	1	120,278	1,526	0.10	
11	1	1	1	121,428	0	0.00	
12	1	1	1	121,427	5,870	0.39	
13	1	1	1	121,428	2,974	0.20	
14	3	3	1	43,858	14,828	0.90	
15	1	1	1	121,081	1,759	0.12	
16	1	1	1	120,811	0	0.00	
17	6	6	1	23,203	42,692	2.45	
18	3	3	1	43,272	19,223	1.19	
19	7	7	0	4,276	44,484	13.87	
20	2	2	1	65,139	9,173	0.56	
21	5	5	1	27,227	35,795	2.10	
22	6	6	1	21,910	38,829	2.36	
23	3	3	1	43,580	14,828	0.91	
24	5	5	1	27,180	35,795	2.11	
25	3	3	1	44,017	22,158	1.34	
26	1	1	1	121,518	0	0.00	

Test(s) done. CPU Load: 16% Test Progress: 100%

Figure 56. Result Per User

Also the program show configuration used for this test as figure 57 below shows:

Project and Scenario Comments, Operator	
Test Setup	
Test Type:	RAMP (run test for 2 minutes)
User Simulation:	ramp test with up to 900 simultaneous users - 7 seconds between clicks
Logging Period:	Log every 5 seconds
URLs	
URL Sequencing:	Users always click the same URL (to spreads load evenly on all URLs, set number of users to a multiple of the number of URLs!)
URLs:	Click here
Browser Settings	
Browser	User Agent: Mozilla/5.0 (compatible; Webserver Stress Tool 7; Windows)

Simulation:	
Browser Simulation:	HTTP Request Timeout: 120 s
Options	
Logging:	Write detailed log(s)
Timer:	not enabled
Local IPs: Automatic	URL#1: GET http://students.emu.edu.tr/105072/ POSTDATA= Click Delay=2
Client System	
System	Windows NT V6.1 (Build 7600) , CPU Proc. Lev. 686 (Rev. 5898) at 2200 MHz,
Memory	1964 MB available RAM of 2147 MB total physical RAM, 4294 MB available pagefile, 35453 MB free disk space on C:
Test Software	
Webserver Stress Tool:	7.2.2.262 Enterprise Edition (1 User License)

Figure 57. Test Configuration