E-health Web Application Framework and Platform Based On The Cloud Technology

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**Title:**  
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**Abstract:**  
This project deals with E-health web application framework, cloud platform and responsive web design which aim to adjust the presentation on mobile devices. This work presents the whole development process of the self-care management web-app framework which provides instructive supports for future other E-health field application. The report consists of the following main parts: analysis, design and implementation, and evaluation. Literature review and internet search are main methods for making an investigation on existing systems and related works. A prototype is developed by using .Net, CSS3, Java script and HTML5 technologies. The system test and evaluation is made to show the system's usability.

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XXX  Date  
Examiner
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1. Introduction

1.1 Background

With the rapid development of smart phones and mobile devices[1], it becomes very popular that people more prefer to access the information through this flexible way. So the requirement of proper interface according to different devices become a hot topic and the goal will motivate the use of RWD[2](Responsive Web Design). It aims at crafting sites to provide an optimal viewing experience in easy reading and navigation with a minimum of resizing, panning, and scrolling across a wide range of devices such as from desktop computer monitors to mobile phones. What’s more, now days E-health has gradually aroused great attention all over world. And the modern day healthcare needs and delivery is complex, and the use of ICT[3] has made some positive impact in attending to such needs that e-health applications require. The project is about E-health[4] web application framework and responsive web design which base on the cloud platform. This idea comes from instructor Dr. Eric Chen’s project proposal. Though there are some existing researches in above fields, there is less or almost none related work which combines these fields to provide a basic frame specifically focusing on the e-health. Right information at right time saves lives, So an E-health web application framework and platform based on the cloud is a part of information and communication technology supported self-care system for the diabetes. This project will closely collaborate with another group working data collection and presentation application. The new related work in above fields worth to be done from the view of reality and research.

1.2 Aim and purpose

The main purpose of the project is to develop an E-health-field system basic frame combined with the responsive web design technology based on the cloud server. It offers a basic common model which can be used by some special E-health application development in the future. It provides a worth guideline on E-health web application for people self-care management. And the model is designed to be applied to develop a specific application aiming to the diabetes self-care management. The project’s main work is as following:

1.2.1 Systematic literature review and Internet search:
We will do the literature review about the responsive web design in a systematic way, record the results and do the analysis on what others have done in the area, so that we can start the work based on the available results.
1.2.2 To establish an E-health web application frame:
This project mainly focus on establishing a responsive e-health system frame to offer a basic common model which can be used by some special e-health application in the future. On one hand, we should select a proper development platform and cloud platform. On the other hand, the frame should focus on the security problem such as the access control and data storage.

1.2.3 To design a reasonable responsive web design method:
The E-health frame will be developed by combining several technology (.NET, HTML5, JavaScript, CSS ). Among these technologies, CSS is responsible for the web visual style on the device. So we should improve and design a reasonable style transformation method through learning the existing related CSS method. And we try to ensure the style can be transformed automatically and well compatibly applied into different devices. Then, we will design a guideline about the it since the system will be extended in the future.

1.2.4 To Select the reasonable deployment vendor for E-health
Many of the associates identified that selection of good vendor is the critical step for the Health care before adopting cloud computing. Selection of vendor needs proper planning and analysis and hospital must have to check the vendor background, services they provided, from how long they are providing the services and customer satisfaction about the vendor. Good vendor will produce secure SLA[5]’s to the customer and it will produce good relationship between the customer and the vendor. If health sector selected good vendor, vendor can produce secure SLA’s to secure and share the data between the hospitals. So in this part, many interviews and survey will be done to help us to select a reasonable deployment model for E-Health.

Due to the limitation of the project time, the demo application is designed to be developed as a web-app. So the responsive web design part has been tried to fit with the smart embedded devices to a large extent. Some optimizations and the scope extent of the application should be further improved to fix with the different devices well. Moreover, more functions will be added to the diabetes application according to user’s requirements the in the future.

1.3 Report organization
The report is divided into 11 chapters. The first chapter introduces the background of the research and main purpose. And next Chapter 2 introduces the development state of the E-health and its advantage and disadvantage in detail. Then in the Chapter 3, a systematic Literature review about the responsive web design will be done and the result will be further analyzed to conclude a method to meet with the requirement of the framework. In Chapter 4, the security problem will be discussed. A flexible user management and access permission control will be introduced in detail to provide desired privacy and security. And in Chapter 5, a systematic comparison between
existing cloud platform and database will be done to select a most suitable vendor. Then the core part of the project will be introduced in Chapter 6. This part introduce the whole project development process in detail and some encountered problems and solutions. From Chapter 7 to 10, the application’s system test, evaluation, conclusion, some future works and quoted reference will be included. Lastly, in Charter 11 some core codes and other common infrastructure will be attached.

1.4 Acknowledgement

The special thanks will be expressed to the instructor Dr. Eric Chen, weekly meeting and patient conduct guide us to get a obvious understanding of the project work and a better application design. He also arranged some meetings with Kerstin Blomqvist, the expert in diabetes field, which help us to gain much professional advice and guide. In addition, he helps us to organize and modify the reports with great patience. Then we will express great thanks to the Dr. Kerstin, and her doctoral student for selfless professional guidance and helps. Moreover, thanks for the help and cooperation from another data collecting and presenting group, QunYing Song and JingJing Xu. Lastly, we will express our thanks to the examiner Dr. Dawit Mengistu for his advice and evaluation. The whole project can be realized successfully due to their inseparable efforts to a large extent.
2. Study on E-health

2.1 Introduction

There are many definitions for E-Health until now but still there is no consensus on one common definition. This is because of its ubiquitous and dynamic nature. The E-health information are widely used with different meanings and purposes. In our work, we develop the E-health application mostly used for diabetes patient.

Joaquin (2010), who is one of the World health organization members, defined E-health as the use of information and communications technologies (ICT) in favor of health and health-related fields, containing health-care services, health supervision, health literature, and health self-management education, knowledge and research and stated that E-health has the potential to greatly improve health service efficiency, it should expand or extend treatment delivery to more than thousands of patients in developing countries, and also improve patient results[6].

In another word, Mitchell defined that “the combined use of electronic communication and information technology in the health field need to be described by a new term. The use in the health sector of digital data transmitted, stored and retrieved electronically both at the local site and at a distance, for clinical, educational and administrative purposes”(Mitchell, 1999). [7].

Sweden, America, Britain and the rest of Europe has experienced a great proliferation of health care-related websites, most of which present disinformation and misleading guidance(Fogg et al. 2001)[8]. And research suggests that the E-health web users express the strong desire to own a online website which is used for their self-management and directly getting advice from the doctor. So the self-management and interoperability are mostly focused in our project.

2.2 Advantages of E-health

There are many advantages in using E-Health concepts. One key example is Electronic Health Records. Before E-health came into use, we used paper based system to record patient health data. These paper based system may have errors while entering the patient records into papers. Coming to E-health, data store electronically and it is more simpler and efficient way of data storing (Häyrinen, 2008)[9]. Grogan stated that there is an evidence to suggest that E-health provide more complete and error free methods for storing patient data. (Grogan, 2006)[10].

By using E-health, there are many benefits to different people such as doctors, patients, etc. For example, doctor’s orders can be placed electronically, which avoid wrong elucidation of hand wrote orders. And with the help of E-health, most doctors reduces the time of locating and reading patient health information. To the patient,
they can begin to be gradually aware of the importance of self-care management. Moreover, it is also convenient for maintaining only with some experts in medical and application developers.

2.3 Barriers to E-Health

The followings list are the main barriers to E-health.

2.3.1 Operational Barriers

This area of concern relates to the interoperability of systems which e-Health aims to provide (John, 2009)[11]. First, a system has to be developed with an interface allowing existing computer system to communicate with new system, which e-Health will introduce. Second, there must be a common standard electronic language to cross communicate between different healthcare organization about the medical data, such as patient records and hospital internal record. There must be formal agreement on what the best method to communicate such data between organizations (Hill et al. 2007)[12].

2.3.2 Cost/Benefit Barriers

As the name suggest it is the barrier related to the cost in implementing e-Health solutions, whether it is feasible in-terms of cost wise i.e. do the benefit of e-Health outweigh the cost required to implement E-health. From the technical side, the implementation of E-health solutions is clearly advantageous in comparison with past methods such as the paper-based record keeping systems but from the healthcare organization side these benefits may not outweigh the cost of implementing e-Health solutions. The cost of implementing e-Health solutions can be tens of thousands of dollars and this does not even include the requirement of hiring teams of IT professionals to support and maintain the software throughout its life cycle (Mearian, 2010)[13].

2.4 E-Health in EU

Most European governments have set up combined systems of healthcare insurance, in which public compulsory health insurance coexists with private companies (which are optional most of the time). Globally, the European population is aging, which translates into an increasing demand for healthcare, and an increased cost of treatment. On a global basis, many governments in Europe are transferring expenses from public insurance to private ones. The ongoing economic crisis leads both governments and private bodies to be in demand for better cost optimization, leading to a globally better governance of the healthcare system.[14]

The combination of social and policy factors described in the previous section have already created the basis for a strong European demand for E-Health services and
applications. Based on an analysis undertaken by Capgemini Consulting in the context of this project, the European E-Health market was about at EUR14.269 million in 2008 year and it is also projected to reach EUR15.619 million by 2012, it grows with a rate of 2.9%. A per-country analysis of the results confirms that France, Germany, Italy, Spain and the United Kingdom are the principal European E-Health markets. However, the analysis also confirms that over the next three years all national E-Health markets will experience some form of growth in this area. [15]

2.5 E-health Requirement

Aiming to the specific field, we should take the following main parts into account that is the designing, computing and data format.

**Interaction design**: The E-health frame should meet different roles’ requirement and access authority management which will be used as a basic model in some specific application in the future. For example different roles such as diabetes patients, doctors and administrator can be created, and the discussion between patients and doctors should be available. Moreover, the authenticated doctor can access the specified items of the patients which will solve the problem of security.

**UI design**: the E-health website page should be shown concise so that it should be comfortable for the users administrators and developers, and the responsive web design was used to fulfill the requirement which can be well suited to different type devices with flexible screen, such as the PC, mobile phone, etc.

**Mobility and powerful computing capabilities**: The E-health website should be visited at anyplace with anytime. So the real-time interaction should be an important issue and taken into account. Additionally, a powerful computing capability should be owned to solve the problem that if too many users access the website.

**Data Format**: The data in the system should follow the medical standard format and rules, such as the unit of glucose, it is mmol/L. The medical words should be used seriously.

**Data Storage**: Considering the security issue of the data storage, such as the storage format and privacy information data protection. A proper database with higher security level should be choose which will be further discussed in the Chapter 5.5.

**Data Presentation**: In order to provide a concise and beautiful view of the data. The data presentation can combine with different presentation formats such as histogram and table, etc according the medical data requirement.
3. **Literature Review on Responsive Web Design and RWD Guideline**

3.1 **Methods and Resources**

A systematic research is taken to generate meaningful result of our purpose. Two main steps were taken to search and evaluate the results:(1) Gathering sources, it contains a broad search using the most relevant key words for more potential hits and what’s more, a good literature review requires that you isolate key themes or issues related to your own research interests, so more restriction were added to filter the articles. (2) Evaluating sources, reading all the final articles with some questions kept in mind: Does the evidence support the conclusion? Is the argument or evidence complete? Does all research arrive at the same conclusion or are there differing? At last, eliminating unuseful articles with these merit and classifying all the remained articles.

In the first place, Springer database were chosen for this literature review study’s data source, it is widely used in the computer science research study and maintained by Springer-Verlag which is one of the most famous science and technology publish company. But in the Springer database, the articles which are related to Computer Science mostly are not related to E-health, so the Google Scholar were also chosen to do this research. All the key words were divided into four categories: “Topic”, “Technology”, “Programming Language”, “Device”.
3.2 Literature Search

The following flow diagram show the literature review process:

Springer database, Google Scholar database
Key words are divided into four categories:
(1) Topic: “responsive web design”
(2) Technology: “media-query”, “flexible grid”
(3) Programming Language: “.NET”, “HTML5”, “CSS3”
(4) Device: “handheld”, “smart-phone”, “laptop”

179 articles were found (73 articles from Springer database, 106 articles were found from Google) 43 articles discarded since no full text found

136 articles can find full text

65 articles discarded since no mention about computer technologies

71 articles were concerning about computer-based technologies

51 articles discarded since no met about responsive web design

20 articles were concerning about responsive web design

Figure 1. Articles Search Process

3.3 Analysis

3.3.1 Publishing year

Table 1. Table for count of each publishing year’s article

<table>
<thead>
<tr>
<th>Publishing year</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>2</td>
</tr>
<tr>
<td>2012</td>
<td>6</td>
</tr>
<tr>
<td>2011</td>
<td>6</td>
</tr>
<tr>
<td>2010</td>
<td>6</td>
</tr>
<tr>
<td>2000-2010</td>
<td>0</td>
</tr>
</tbody>
</table>

The table above shows the count of reports in each publishing year. The attention on responsive web design rises from year 2010 when Ethan Marcotte put forward the concept of RWD, then it keeps the main trend and become to be popular as the number remain stable per year until to now.
3.3.2 Publishing country

Table 2. Table for count of each country’s article

<table>
<thead>
<tr>
<th>Publishing country</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>1</td>
</tr>
<tr>
<td>Finland</td>
<td>2</td>
</tr>
<tr>
<td>Germany</td>
<td>5</td>
</tr>
<tr>
<td>Greece</td>
<td>1</td>
</tr>
<tr>
<td>USA</td>
<td>4</td>
</tr>
<tr>
<td>UK</td>
<td>3</td>
</tr>
<tr>
<td>Norway</td>
<td>1</td>
</tr>
<tr>
<td>Italy</td>
<td>1</td>
</tr>
<tr>
<td>Sweden</td>
<td>2</td>
</tr>
</tbody>
</table>

From table above, it indicates that Germany Smashing magazine put the most efforts on responsive web design among all countries. 5 related reports are published in Germany. It can be seen that USA and UK also work hard on responsive web design, with 4 and 3 research reports respectively. The number of reports which published in Europe and UK is 15. Especially Central European countries and Nordic countries have made a major contribution to improve responsive web development, 12 published research papers. However, looking back to Asia, no result are found in the result set.

3.4 Qualitative findings

With increasing Web users using handheld device to browse Web sites and apps, Web designers and developers must make sure that their creations look good and work well on mobile devices just like on traditional desktop computers.

3.4.1 The development of mobile device market

Nowadays, There is a large amount of site traffic comes from mobile devices—namely smart phones and tablets(mainly the iPhone and iPad)—in addition to traditional personal computers. Across the world, mobile devices now account for more than 12 percent of Internet traffic in 2012, and this is increasing much faster than desktop computer and laptop Internet traffic. In nations with high smart-phone penetration, the fraction of mobile Web traffic is sufficiently higher, What’s more, this data is expected to increase significantly over the next 10 years, as smart-phones develop and mature both in hardware and software and adoption which picks up in South America, Asia and Africa.[16]

Google company predicts that mobile devices will drive travel searches up by 15 - 25% in 2013"[17]
NASDAQ: SCOR has reported that in the United State 51% of smart-phone owners are using these handheld devices to access travel information.[18]

Responsive Web Design has been cited as the No.1 web design and development trend for 2013 by the .net magazine.[19]

It is a real fact that the Smart-phone sales surpassed PC throughout the decade. All of these are secondary in comparison to the fact that simple and clearly view in handheld device is needed to exist in the market of the future. The figure 1 below shows the development of the mobile market.

![Mobile Web Traffic](image1)

**Figure 2. The Development Of Mobile Market.[20]**

From figure 1, we can draw the conclusion that mobile traffic is increasing incredibly fast. People check their email on mobile device first, more and more people would like to use high end and fast system/devices(it is clear that the user of iPad and iPhone occupied the most proportion.)

**3.4.2 Survey of the E-health user's requirement**

People are increasingly viewing their connection to the internet, including their gadgets, as their lifeline. Your patients keep their address book, calendar, and more on their mobile devices. They rely on them. Ensuring that your website is easily accessible and properly optimized for mobile devices just makes sense. The trend towards patients using their mobile devices to access information will only continue to grow. In fact, some sources claim that by 2015, nearly everyone will access the internet from a mobile device. With such a trend, it makes sense to consider responsive web design for your medical or dental website. [21]
As it is in our E-health model, the patient prefer text in large font and input data without typing manually. A simple and straightforward user interface design is significant factor for the patient. Furthermore, specially for the diabetes patient’s in our application, it can not only help user easier to learn how to use the website to record their daily indicators but also delight the patients because they don’t need zoom the website surface to a proper size.

3.4.3 Responsive web design

It is known to us that there are many well-known website organization have launched dedicated website for iPhone or smart phone. For example, 3g.qq.com, m.taobao.com, ipad.xxx.com and so on. The question comes that is it necessary for us to design separate website for each device? Certainly, it is very complex too many website for each smart phone.

In 2010, Ethan Marcotte wrote an introductory article about the Responsive Web Design. Responsive web design refers to the ability of a web page to respond and adapt to whatever device on which the page is being viewed. It aimed at providing an optimal viewing experience: easy reading with the proper resizing, panning, and scrolling.

There are Four principle methods to realize the responsive design when building a website: the media query, view-port, fluid grids and flexible images. These four are the key point to realize the responsive web design.

1. Media query

As a web designer or front-end developer, we all wish that our website can always easily adapt the screen size of the device, regardless of whether the user use the 21-inch desktop, 13-inch laptop or 10-inch iPad or smart phone. To design a responsive web, we should use the @media queries technique to change the layout of the page based on the width of browser and CSS. Media query are a bits of CSS in a web page that can inspect the physical characteristic(i.e., the width and height of the screen in pixels) of the device which request service.

We added a few media queries to provide an improved experience on smaller screens, like those on a tablet or smart phone. Instead of targeting specific device resolutions we went with a relatively broad set of breakpoints based on each handheld resolutions as it shown in the figure 3:

<table>
<thead>
<tr>
<th>Model</th>
<th>Generations</th>
<th>Diagonal cm (in)</th>
<th>Resolution</th>
<th>ppm (PPI)</th>
<th>Aspect ratio</th>
<th>CSS pixel ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPhone 4 / iPad Touch</td>
<td>4 / 4th Gen</td>
<td>10.9 (4.3)</td>
<td>960x640</td>
<td>2048 x 1536</td>
<td>3:2</td>
<td>2</td>
</tr>
<tr>
<td>iPhone 5 / iPad Touch</td>
<td>5 / 5th Gen</td>
<td>10 (4)</td>
<td>1120 x 600</td>
<td>2048 x 1536</td>
<td>3:2</td>
<td>2</td>
</tr>
<tr>
<td>iPad Mini</td>
<td>1st Gen.</td>
<td>7.9</td>
<td>1024 x 768</td>
<td>220 x 152</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>iPad</td>
<td>1st Gen.</td>
<td>10 (4)</td>
<td>1024 x 768</td>
<td>180 x 120</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>iPad</td>
<td>2nd Gen.</td>
<td>9.7</td>
<td>1536 x 1024</td>
<td>220 x 152</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>iPad</td>
<td>3rd Gen.</td>
<td>12 (5)</td>
<td>2048 x 1536</td>
<td>220 x 152</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3. Physical pixels on the screen for apple product[22]
Moreover, we find that we use different breakpoints also depending on how we view various devices, for example portrait and landscape. However, some browser don’t support detecting orientation and motion events, as it is shown in figure 4:

Based on the figure3, we choose the most popular browser for apple product IOS Safari 6.0 and chrome 26.0 for our testing.

Moreover, there is another way worth mentioned regarding the responsive web design is that different CSS style sheet can be chosen based on the function characteristic of the request device.

This is an old way which based on the media attribute with such references as media=”screen” or media=”print”. But it can’t realize static responsive web design.

The media queries allowing us to target styles based on a number of device attributes, including screen width, orientation, resolution, and so on. Media queries allow us to target not only certain devices and classes of devices, but also allows us to actually inspect the physical characteristics of the device.

2. View-port
The media query can already do a good job when we adjust the size of the browser, but it does not meet the mobile browser’s requirement, this is because the mobile client browser(iPhone,iPad/Safari, Android/Chrome) will default the page is designed for wide-screen, so it will shrink the entire page to fit the small screen. This indicated that just media query technology is inadequate to realize responsive web design, the solution is to combine the media query with Apple’s viewpoint mega tag in the head of the document.

<meta name="viewport" content="...">
There are two ways to type in the content, “width=device-width” is available, but it will just meet the requirement when the device is portrait, but when the device is rotated to landscape, the screen will not responsive. We use the second method which set the content attribute value to “initial-scale=1.0, maximum-scale=1.0”, the setting of initial-scale=1.0 means that initializing the page without zooming, the effect of maximum-scale=1.0 is to prevent the page zoom in rotation. But it also brought a more serious problem: preventing the user to manually zoom in or out on the page.

3. Fluid grids
When design a responsive web, It’s your decision to choose between a fixed or fluid grid to design the layout. Throughout this tutorial we are going to focus on the difference between fluid grids and fixed grids and our selection in responsive design.

A fluid is a substance that continually deforms (flows) under an applied shear stress[24], generally, web pages are made up of columns and rows. Traditionally, this is always done with the use of fixed widths, like width: 20px; Responsive web design make the size of these pages relative to the screen size, rather than a fixed width. Without setting specific number of pixels wide, the container is instructed to occupied 25% percent of the width of the screen. If different device request service from the website, the block will change relatively. Fluid grid layout is constructed by percentage, instead of pixel. Following is an example of fluid grid:

```html
div
{
    width: 90%;
}
```

To determine the percentage of the fluid grid, you have to calculate the proportions for each page element, you must divide the target element by its context, we can calculate the extents for each page element with the formula given below: target / context = result

It is easy to understand this formula with the example “body{ font: normal 100%;}” Let us assume that the font default width size to be 10px, we can apply such font-size on the formula. We have to divide the target value (20px) by the font-size of its container (10px): 20 ÷ 10=2

So header h1 is two time of its default body font. We can denote it by em, then we can put into our CSS style sheet with “.h1{font-size: 2em; }”(1em is equal to the current font size).

While fixed-width layout is constructed by specific pixel measurement. This type of layout is commonly used for web design. Following is an example of fixed grid.

```html
div
{
    width: 900px;
}
Fixed grid seems more intuitive to set the div width-size with practical value;

When selecting which method to be used in our E-health model, we take these two into consideration, after reading many articles and discussion, we draw a conclusion based on the E-health situation. In reality, from the conclusion we get above, more and more people would like to use high end and fast system/devices( it is clear that the user of iPad and iPhone occupied the most proportion.), so our E-health Website will mainly suitable for the mainstream handhelds such as iPhone and iPad users. With this precondition, four CSS style sheet are enough for our E-health website application. There is no doubt that fluid grid works better than fixed grid, but when applying fluid grid in the model, some shortcomings come out, for example, when design a new web page, we should first assign the whole layout of each module for every handheld device and compute the relative percentage size of the component, it would take much time and energy on the overall design. It is indeed that fluid grid display perfectly on most of the device, but in some specific condition such as when we have already arranged an font size proportion and it will change relatively between the scope from 0-300px, it also display suitable for the device whose resolution is 200px but not perfect because of the deforming image or font-size, which will not meet the user’s aesthetic feeling, while fixed grids becomes more simple, just setting the practical value will be more convenient, and it looks more intuitive. Considering all of these practical situation, we combine the fixed grids with fluid grids method together.

4. **Flexible images**
When a grid scales in size, then generally the images and text inside it also need to scale. Originally, if the actual width of the image is wider than the width of the device, this will distract the container, to slove this problem, just the same as fluid grids, images (or any content in a grid) are instructed to take up a certain percentage of pixel space relative to the container they are in. When the container changes, the images inside change, too. Following is an example of flexible images, the principle is same as fluid grids and use the same formula to calculate the percentage too.

```javascript
image
{
    width: 30%;
}
```

3.5 **RWD Guideline**

To design a responsive web page, we should use the technologies we have already mentioned above. Following will be the detail guideline of how to use the responsive web design in a E-health application. And we will also give a basic framework structure of the responsive UI designing according to the different devices, such as the
PC, iPad, and iPhone.

1. In the structure, no matter which type of the devices you use, firstly we should initialize the page without zooming when the devices is portrait or landscape as the following:

```xml
<meta name="viewport" content="initial-scale=1.0, maximum-scale=1.0"/>
```

2. Secondly, for the different devices, the media query has been used for its display. In the structure, four basic ranges for the device width has been defined as the following:

```javascript
/* Default wide-screen styles */
@media all and (max-width: 1024px) {
  /* styles for narrow desktop browsers and iPad landscape */
}
@media all and (max-width: 768px) {
  /* styles for narrower desktop browsers and iPad portrait */
}
@media all and (max-width: 480px) {
  /* styles for iPhone/Android landscape (and really narrow browser windows) */
}
@media all and (max-width: 320px) {
  /* styles for iPhone/Android portrait */
}
```

Then for a screen resolution max width within 1024 pixels, we present the page as the PC and iPad landscape originally designed. For max width within 768px, the page can get the styles for narrower desktop and iPad portrait. For max width within 480px, the page can get the styles for mobile phone landscape. And for max width within 320px, the page can get the styles for mobile phone portrait.

3. In the structure, for different size devices with the same page, four basic modules with the initial width and height have been defined. And at the same time, endue all the style of each module with “float:left “style. For the PC and iPad (no matter portrait or landscape), each module width will be pre-defined as 50% relative to the width of the screen.
4. And for mobile phone (no matter portrait or landscape), considering the module’s presenting possible smaller if four modules arranged as the PC or iPad, so each module width will be pre-defined as 100% relative to the width of the screen as following. It will be more suitable for the mobile phone device with smaller screen.

5. Once having the basic framework, some development workload and time will be saved if a new application can directly and well use this framework. In addition, the
developer can do some proper modifications according the real requirements of a specific application. For example, three modules can be arranged in one row and set the corresponding width as the fluid grids method has been introduced.

6. Lastly, continuous testing and change the style of the element in CSS with proper size and location.

3.6 Conclusion of RWD

From all of the work we have done in the responsive web design, we have summarized up the conclusion and got some personal understanding of this technology. Firstly, It’s worth bearing in mind that there’s no simple solution to making sites responsible on mobile devices. Liquid layouts are a great starting point, we should combine all of the existing technology together rely on the actual condition. Media queries and the other three are useful ways of adapting your website responsively. Secondly, remember that there are also a certain number of browsers that do not currently support the technique and there are some performance implications, this is the main disadvantage of current responsive web design technology. Thirdly, when applying a responsive web design, the key is to test early and test often on the handheld device with the Android SDK or iOS Simulator when the real devices are not available. The last is that many current website have already set the attributes of each element for a few years, it would be a huge work to alter all the component into a relative size, it is worth researching in the future to design a responsive browser which will automatically make the accessible website responsive.
4. Security and privacy

Interoperability of E-health model system allows people store large amount of information in different place. In many of the developed countries, healthcare has evolved to a point where patients can have many different providers— including primary care physicians, specialists, therapists, and even alternative medicine practitioners – to service their diverse medical needs, There comes a big problem that the information sharing increase the risk of medical misuse and data theft. The E-health record may include the patient personal information, like telephone number, age and so on, even more, the diabetes patients’ glucose, exercise information which are private, sometimes, the patients just want to share their relative information to their physician. Data theft can invade to patients medical records and stole patients records to do financial fraud. In order to forbidden this crime, how to keep the privacy and security becomes the key point in our project.

4.1 Introduction

Privacy: It means that the user can make the deessions by themselves when, how, and to what personal information is authorized to others. [25]

Security: It is designed that the personal information can be stored and transmitted in a proper manner limited to the authorized roles which well offers the protection of the data integrity and availability, etc.[25]

Through the systematic literature review and internet searching, we found that there is a set of national existing standards named HIPAA security rules(Health Insurance Portability and Accountability Act)[26], which is proposed by the U.S. Department of Health and Human Services in 2005 to offer administrative, technical and physical standards to ensure the security of protected health information (PHI) in the E-health IT system. Combining this rules, some proper rules’ modification will be done to be suitable for the E-health security framework in our project.

4.2 Physical Safeguards

In this part, it offers a reference measure to protect the hardware and facilities to the stored PHI. And this is an quite important point for the pre-protection of the security and privacy. The detail considerings will be listed as the bellowing:[27]

- **Facility access controls** – The Limitations for physical equipments access to the facilities where health information system is housed, to ensure that the authorized personnel are allowed to access the system.

- **Workstation use** –Some specifications rules for the proper use of workstations and the characteristics of the physical environment of workstations that can access physical health information.
• **Workstation security** – Restrictions on access to workstations with physical health information.

• **Device and Media Controls** – It means the receipt and removal of the device and media which will contain the physical E-health information into and out of the facility, for example, disposal, reuse of media, accountability, and data backup and storage.

### 4.3 Technical Safeguards

As it is defined in The Security Rule “Technical safeguards are safeguards that are built into your health IT system to protect health information and to control access to it.” The technical safeguards contains many security rules, such as measures to limit the access the electronic information, the way to encrypt and decrypt the electronic information, and to make the information safe against unauthorized person to access.

[27]

• **Audit controls** - It contains recording and examining activity in health IT systems. Enables the user to generate the audit log entry with a particular time period to sort.

• **Integrity** - Protecting PHI from improper alteration or destruction, including implementation of mechanisms to authenticate PHI such as Encryption for general information.

• **Person or entity authentication** - Verifying that who is the person to access the physical health information.

• **Transmission security** - Protecting the information against unauthorized person to access to physical health information when the information is transmitted over an electronic communications network.

### 4.4 Security and privacy Guideline

Based the above physical safeguards and technical safeguards, a systematic guideline about the security and privacy will be designed and created in the framework as the bellowing:

#### 4.4.1 Account Management

1. Determine which individuals are authorized to work with electronic physical health information in accordance with a role-based access approach, in general, there are three basic roles in the framework which are users, doctors and administrators.

2. Establish security training for all members who are involved in the creation, transmission, and storage of e-PHI. Ensure that training program includes periodic security reminders and is updated to take into account current vulnerabilities and threats.

3. To make sure that each account specified for unique users with correctly bounded.

4. To offer a proper way for the authorized users’ access to any electronic physical
health information. For the systems which need a strong electronic authentication like sufficiently complex password. [25]
5. Establish account maintenance procedures that make sure some terminated account will have no access control to the information.
6. The system administrator’s number should be carefully managed and kept the minimum number and provided only to personnel authorized to perform identified functions.
7. The Log activities will be monitored by system administrator logs on a regular basis.

4.4.2 Information Management
1. Conduct the risk assessments to identify the electronic information resources, and to understand the document risks from security failures that may cause loss of confidentiality, integrity, or availability. The risk assessments should include analysis of situations which may led to modification of e-PHI by unauthorized sources. [28]
2. Select the appropriate mechanism to protect sensitive or critical relative data which is determined by risk assessment.
   1) The e-PHI system need to be hardened against known operating system vulnerabilities.
   2) At some appropriate situations, installing the firewalls and intrusion detection software to reduce threat form unauthorized resource.
   3) Protect sensitive data with using appropriate strategies, such as the use of web browser security standards, virtual private networks, and encryption
   4) Protect all devices against the malicious software, like computer viruses, Trojan horses, etc
   5) Run versions of operating system and application software with security patches and installed in a timely manner on networked devices.
3. Implementation appropriate logical security measures such as encryption to protect data from unauthorized access if the system or workstation including e-PHI can not be housed in a professionally managed in a secure location.
4. Implementing procedures to ensure periodic review of logs, including inconsistencies in the report.
5. Conduct back up of data and software on an fixed timetable. Back up copies should be stored in a physically separate location from the data source.
6. If it is possible, terminate the electronic sessions after a period of inactivity

4.4.3 Data Centers
1. The data center should be established in a safe place timely detection and prevention of emergency situations created by earthquake, fire, water leakage or flooding and so on.
2. The physical access controls are needed in these secure locations, such as locks, electronic key readers, or other access control mechanisms.[28]
3. Record all the facilities after the maintenance the equipment after modifying, such as hardware, walls, doors, and locks.
4.Assign the appropriate person to record the hardware and software maintenance after equipment removal.
5.Ensure backup of data before the moving of equipment

4.4.4 Information for Users
1. You should use a complex password to access the information system that containing the e-PHI, the password is very secret so that others can’t get the it.
2. All devices can install firewalls and intrusion detection software to protected against malicious software, such as computer viruses, Trojan horses, spy-ware, etc. These devices includes servers, workstations. Laptops, tablets, smart phones, etc
3. Portable devices, such as laptops, if containing e-PHI, the password should be protected or encrypted, since they cannot be physically secured.
4. It is necessary for all devices which contain e-PHI be backed up on an established schedule.
5. You must maintain the security of the information after removing electronic media that may contain e-PHI when you are planning dispose according to established procedures. This includes tape drives, tapes, portable hard drives and so on.
6. Encrypt electronic transmissions containing EPHI whenever deemed possible (like email containing e-PHI). If the encryption is not possible, just considering email a public document.[28]

4.4.5 Other related
1. Establish procedures to ensure that electric protected health information can be accessed if an emergency happens.
2. All confidential emails must be sent via secure channels.
3. Remind the patients the risks of unsecured emails.
4. All remote facility access into UC networks must be by secure methods, for example the authorized VPNs.

4.5 General Login and Access Control Structure

4.5.1 Login Structure
1. Allow the user to login with either his username or his e-mail address.
2. Allow the user to determine his own password.
3. Allow the user to login at once.
4. Offer a login form on access denied pages for the user who are not login.
5. Using two e-mail fields to ensure accuracy when registered.
6. The page will redirect to a specific page when the user login.
7. The page will redirect a specific page after the validation of user’s e-mail address.
8. A user message will be displayed when the user successfully login.
9. Provide a Public Key encryption for password and related information such as e-mali, etc
4.5.2 Access Control Structure

There are many existing access control models can be used to meet the legal requirement such as: Role-Based Access Control (RBAC), Digital Right Management (DRM), Usage Control (UCON), Mandatory Access Control (MAC). According to the specific E-health field, a systematic comparison will be done to choose a proper model and make appropriate adjustment to be suited to our frame.

RBAC: A prospect sucedaneeum of traditional access control (Autonomic Access Control, Mandatory Access Control). In our model, the authorities are directly related to roles. When a user registered, the user can set a role for himself when they become a member of it, users are assigned to corresponding role based on their responsibility and qualification, and the diabetes patients and physicians can access their related page with specify role.[29]

DRM: Pair of keys was generated, including public key and private key. The key pair is distributed by a third part called digital authorization center which is trusted by users. Public key is used to encrypt while private key is used to decrypt. The message can be read only by the private key holder. The key pair is generated by the record creator.[30]

MAC: In the MAC model, the administrator manages the access control and design the basic strategy. And the other role such as user can not change the rules. Once the strategy is defined, the object access authorization has been assigned to a fixed subject. Though owning a higher security level, this kind of access control model is possible to cause some problems such as the flexible roles' authority. The other roles can only follow the strategy the administrator made instead of flexible role authorization. [31]

UCON: The UCON is made up by eight elements: subject, object and right, object attribute, right, authentications, obligations, conditions, it is different with traditional model which has not just subject, object and right, three elements. The authority is based on the attributions of subject and object, and authority requirement. Access right can be assigned before or being the access actions. Mutable attribute is the most different quality compared with other access control models. Mutable attribute can change along with the change of access result. UCON model includes RBAC, MAC and DRM. It’s a new generation of accessing to control model.[32]

Compared with all the access control models, UCON is a more potential model for future design. It’s a new generation of access control model. But A UCON based system is more complex than others. It not only costs more money, but also spends more time to design and implement such a system. The MAC’s disadvantage is not flexible: access rights are defined for different users; this mechanism implies many administrative operations. At the same time , RBAC model is much easier to design than UCON model. It has the attributes of efficient security and flexibility in E-health
system. Based on all the advantages and disadvantages of all the model and considering the specific characteristic of multiple-roles and user-oriented as the following figure shows.

![Diagram](image)

**Figure 5. The RBAC model[33]**

The RBAC is relative suitable for the E-health frame model. In our frame, the RBAC model divides all the users into three basic parts: Administrator, user and doctor. According the different requirement of each roles, we set up the different corresponding permissions and actions in the basic frame. The following part will introduce the different roles' authorities in detail.

1) **Patient's requirements**

The patients need an E-health model which they can view their electric record and get self-care education, moreover, the patients need advice from specify doctors, so they hope that they can manage the access authority. The patient need to have the right to assign some specific authorities for the doctors, for example when a diabetes patient want to share their medical record like glucose, exercise, weight vary and daily diet during some periods, sometimes, they just want to share part of their informations like glucose, and they don’t want the doctor to see the others’ privacy data. When the patients don’t want the doctor to access their medical record, they can cancel the doctors’ authorities. A authorities record history is needed to remind the patients whom they has given the authorities to. Search function is also needed in this system, the patients can find the registered doctor as they want to give access control. In our E-health model, the patient can view the record whenever they want and also share their own thought with other patients in the communication platform.

2) **Doctor's requirements**

To the doctor, they would like the system to be flexible that they can also access the website at anywhere and get the information from the patients who they give the authority, they also don’t want to view a handwritten record because of it will always led some mistakes and wastes time, which can reduce the medical accident caused by misunderstanding, the doctors hope that they can share their experience and view
the patients record clearly.

3) Administrator’s requirements
The E-health model need a administrator, who can manage and monitor the website. To the administrator, he would like to monitor the model in case of some criminals stole and change the patient information for illegal purpose and also has the power to manage the register users, in our model, the administrator can delete some illegal users who always publish the advertisement in the forum and also can publish a global notification to all the users to remind some important things. The administrator also can view all the information of the registered users except password.

4) Security requirements
To avoid abusive registration, all the users in this system can register only one account for each person, and we need also set the security mechanism for the users when they want to change the password or forget their password. In our model, they need to answer the security questions and give the email so that when he want to change their password he needs to select the right security questions and answers when he registered and give the old password, when he forgets his password, he will receive the original password from an official email in the mailbox when they registered. Moreover, it is general idea that only the person who knows the password can login the account. The password is encrypted during the transmission. In the transmission of medical records and personal information, those information are encrypted.
5. Study on Cloud Platform

5.1 Introduction

Cloud Platform is largely a combination of existing technologies which have already been around since the early 1990’s. These technologies include: grid computing; utility computing and most recently virtualisation. It is an emerging computing example aimed at running the services over the internet flexibility and scalability. With the development of cloud platform. The advantage has been shown outweigh the disadvantage.

Cloud computing is a framework that make convenient, on-demand network access to a shared pool of configurable computing resources enable. (for example, networks, servers, storage, applications, services and so on ) which can be released with minimal management effort or service provider interaction and rapidly supplied and published. [34](Peter et al. 2009).

Cloud is a combination of hardware and software, which are being delivered through Services. There is three service models provided by cloud computing which offer different levels of control and security. These level are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) which are in decreasing order of control and increasing order of security[35]:

![Cloud Service Models Diagram](image)

Figure 6. Cloud service models related to security and user control[35]
5.2 Cloud benefit

Cloud computing benefits can be categorized under Technical, Users, Quick deployment aspects and they are listed as follows:

5.2.1 Technical Advantages
Following are the technical advantages of cloud computing [36](Weiss, 2007).

- **Power Management:** It is much easier to manage virtual server when compared with physical server.
- **Scalability:** It is one of the main positive aspects of cloud computing. If peak load and high traffic for a website happens, cloud can handle easily without need of any additional hardware.
- **Data Storage:** there are various kinds of data need to be stored all around the world, and it makes easy for any data to be deployed and to get fast and easy access with ultimated data storage.
- **Efficiency and reliability:** Applications and website in cloud are so vital that these are available and reliable for all services, it makes the service efficiency and reliability with powerful computing capability and ultimated storage.

5.2.2 User Advantages
When considering users advantages, cost reduction is the major advantage[36] (Weiss, 2007).

- **Cost Reduction:** If peak load and high traffic happens, most traditional computing need additional hardware to fulfill the requirement, while with the development of cloud computing, The consumer does not need to take much money on updating the software and hardware as they can get the latest resources and services relatively in less time. The consumers do not need to worry much about the configuration of the system, storage capacity and capability because these will be handled by the cloud provider.

5.2.3 Quick deployment
Lastly and most importantly, the cloud platform gives the advantage of quick deployment, once you select the method of the function, the whole model will be built in a few minutes, certainly, the amount of time taken will also base on the exact technology which you need for the business.

5.3 Cloud limitation

In spite of its many benefits, as mentioned above, cloud platform also has limitations .Some limitations of the cloud computing are listed as following.

5.3.1 Bandwidth limitation
There's the very real issue of bandwidth limitation, If you have any sizable data wait
for upload, you're going to have big problems with upload speed. Unless you have the resources to afford a really big pipe to the Internet, or it will take you a long time.

5.3.2 Data security
Now from Sony to Google, various corporations have at various times considering the problem about their services being hacked and user data compromised. For the users, if they upload the data on the cloud and is not at their own control, so at most situation people don’t want to place their secret information into the cloud.

5.3.3 The Offline cloud
As we know, the cloud computing is fully relying on the internet connection. If the customer put all the data into the cloud, when the internet connection problem happens, he is unable to access the application or the data.

5.3.4 Control
It means when the application developer put all the data on the cloud platform, it means he gives up control of all the data, if the cloud provider is no longer profitable or go out of business, you should address these considerations into the case for cloud computing when you plan to use them.

5.4 Cloud Platform selection

According to the requirement and characteristic of the E-health field, we choose the PaaS layer as the basic service model which has a relative complementary between the control and security. In this level, the user has the ability to develop and deploy the custom applications to the cloud platform. And now days there are three main cloud platform providers which are Microsoft Windows Azure (MWA), Google App Engine (GAE) and GroundOS (GOS) in the PaaS level. Among these platform, MWA and GAE are the proprietary clouds, whereas the GOS is an open source cloud. Through a systematic comparison with the providers’ general offerings and security protection, some important aspects will be listed in detail as the following table.

<table>
<thead>
<tr>
<th></th>
<th>GAE</th>
<th>MWA</th>
<th>Ground OS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Availability</strong></td>
<td>No SLA and no mention of guaranteed uptime.</td>
<td>Provided by SLA</td>
<td>Problem of user</td>
</tr>
<tr>
<td><strong>Integrity</strong></td>
<td>Encryption Authentication</td>
<td>Encryption Authentication</td>
<td>Problem of User Encryption</td>
</tr>
<tr>
<td><strong>Confidentiality</strong></td>
<td>Privacy policy Encryption Authentication</td>
<td>Privacy policy Encryption Authentication</td>
<td>Problem of user Encryption</td>
</tr>
<tr>
<td><strong>Authentication</strong></td>
<td>Single-sign on Username &amp;</td>
<td>Username &amp; password</td>
<td>Username &amp; password</td>
</tr>
<tr>
<td></td>
<td>SLA</td>
<td>Automated Fall-over System</td>
<td>Price</td>
</tr>
<tr>
<td>----------------</td>
<td>-----</td>
<td>-----------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>password</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>normal</td>
<td>normal</td>
<td>normal</td>
</tr>
<tr>
<td></td>
<td>normal</td>
<td>easy</td>
<td>normal</td>
</tr>
</tbody>
</table>

**Availability:** It is usually guaranteed in the SLA (Service-Level Agreement). And it is often considered as the uptime which is defined as how long the service could be available or online. From investigating, we found that MWA can realize an annual uptime of 99.95% for computational operations. And this percentage uptime level can totally meet any type of business.

**Integrity, Confidentiality and Authentication:** The data stored in cloud platform is protected by encryption and password authentication. And it ensures that only authorized users can be access to the data.

**SLA (Service-Level Agreement):** It provides an agreement between the client and the provider to guarantee the quality of service (QOS) with the measurable network quality. Once some system failures happen in the cloud platform and it cannot meet the agreement level of QOS, the client could require some compensation from the provider according to the SLA. So MWA well guaranteed the interests of the users.

**Automated Fall-over System:** MWA provide the automated fail-over system and it allows the user’s data move to another data center when the current database suffers some disaster of failure. And it also provides regular backups mechanism for the users.

**Price:** The price is another considered issue for the client. Among these three cloud providers, the MWA has a relative higher price, but it is completely acceptable for the client comparing with the high quality service provided by the vendor. For example, the bandwidth fee of the MWA has the free inbound and $0.12/GB to $0.05/GB out.

**Operability:** Through comparison, we found the MWA has a more easier operability with a friendly interface. The user can easily deploy and design the website and database. So it can help the new learner to grasp the method step by step quickly.
6. Design and Implementation

6.1 Introduction

In this part, we will explain how to use the E-health frame above defined to develop a demo application about the diabetes self-care management web application to explain how the model is to be implemented. From the above introduction, the RBAC model in security and access control part, MWA cloud platform selected as the deployment platform, azure cloud database as the data storage and responsive web design technique used to realize automatical transferring from PC or tablet to handheld devices with concise and comfortable view. Then the rest part of this chapter will introduce each step of the development process from the requirement analysis, system architecture design to the function module implement.

6.2 System description&Requirement analysis

In the diabetes self-care management web application, some basic modules which common E-health field needed will be designed and implemented. The most important point and initial idea of the whole application aims to offer a platform where the user can realize self-care management and health self-education. In addition, the application will include three different basic roles according to the RBAC model introduced in Chapter 4. For different roles, the system developers set corresponding authorities according the reality requirement. Then some basic function modules will be developed, such as the Home page Introduction, Forum page offering a platform to communicating and getting the admin’s global notifications and different roles’ function modules, etc. The next step is to apply the responsive web design technique to realize the proper view and layout transferring from the PC or tablet to handheld devices automatically. Then another important part about the diabetes patients’ data collecting and presentation will be involved in this system to offer a longtime recording and checking for specific properties such as glucoses, weight, exercises and diets, etc. Once referencing to the data storage, the database selection and designing will be considered. Moreover, the personal privacy and data security will be solved in the system. Lastly, the whole will be deployed on the MWA web server to serve for the user and make its sense. The system function and modules designing will be introduced in detail as the following:

1. Self-care education: The application should offer a education tour platform where the user can obtain some basic information what they want for the diabetes such as the diabetes influence factors, diabetes treatment, diabetes types and nursing method, etc

2. Communication platform: The application should offer a communication platform where different roles can share the resources what you have and get the
informations what they want. In this part, the user can create a subject and read the
existed content and the admin can publish the global notification to all the users.

3. **Authorities assigning:** The application should offer different roles management
which are the user, doctor and admin. For different roles, they will have
corresponding authorities.
   - The user can login in its specific page to record and present its own data.
     Moreover, the user can assign some specific permission to the other users or doctors
     who they want to share the personal information with.
  
  - The doctor also has its authorities that they can access the specific user’s
    information according to the awarded authorities.
  
  - The admin has the authority to view all the user and doctor’s information such
as the username, e-mail except login password.

4. **data collecting and presentation:** Aiming at the user’s personal data, the
application should offer an easier method to record their personal data and offer a
concise presentation. The presentation should include the query to different data
according to the record date time with different presentation format such as,
histogram, line chart and pie chart, etc.

5. **Concise view:** Due to this application mainly serve for the diabetes, and the major
crowds of the diabetes patients are the older people. So the application should
have a concise view both on the PC and handheld by responsive web design method.
Bigger text and more figure presentation will be preferred by the users.

6. **Security:** It’s a quite important point for any user due to the privacy data existing.
Nobody want its personal information exposed to the public. So it requires the
protection measures such as access control and database selection and management.

7. **Reliability:** The application will offer a longtime service for self-care, education
and personal diabetes data storage and checking. So the system should have a relative
reliable performance. So it references to the database and cloud platform selection,
etc.

### 6.3 Investigation and previous preparation

Aiming at this diabetes application, a systematic survey has been done through
different methods including meeting with related medical expert, doctoral student of
this specific field and internet search. Firstly, through investigation, an initial
understanding of diabetes has obtained. Diabetes is the most main disease in the
chronic and it needs a long period care and repetitive tests. And the detail information
will be introduced as the following:
• **Diabetes Type:** There are two kinds of diabetes, one is Type 1 and the other is Type 2. For T1, it causes mainly due to the family history that there are family members having the T2 diabetes. It has a high probability for the generations suffered from the diabetes. For T2, it usually happens due to the acquired factors.

• **Parameter:** Glucose is the most important and directly index to measure the extent of the diabetes. For different types diabetes, there will be different corresponding standard values, even different ages and gender with different standard.

• **Factors:** There are many factors causing the diabetes except the inheritance such as the physical exercise, weight loss and diet, etc.

The above learning is an initial learning regarding the diabetes to help to quickly start the application development. And the specific work will be done by another group which is responsible for the data collecting and research.

### 6.4 Selection of operating systems, tools and database

#### 6.4.1 Win7, ios&Android system

This application aims to be developed as a web-app and the reason why we choose the above system as the application developed and applied system are present as follows:

Win7: Now days Win 7 is the mainstream operating system all over the world. And its powerful performance can meet all kinds of requirements such as the common users or business. And it is usually used by the developer as a development environment, and moreover, it has quite friendly interface.

ios & Android: In smart phone market, ios system and android system has occupied a large part of the market share. These two system has become the mainstream operating system for the smart phone and other handheld devices (such as iPhone and iPad). So the web-application’s responsive web design will mainly focus on these systems.

#### 6.4.2 HTML5&CSS3.0

HTML5: HTML5 is the latest version of HTML or Hypertext Markup Language. why it has been chosen will be presented as follows:[37]

• It loads much quicker than the older version because it equipped with the WebSockets.
• More accessible on mobile phone applications when written in HTML5 because you need’t write applications for a specific smart phone but create commonly used applications for all phones.
• More flexibility in creating the website.
• It is easy to and video, audio and images modules, and need’t any other third party software.
• It simply bases on HTML4, so the old version can well be used when developing the new features in HTML5.

CSS3 (Cascading Style Sheets): The presentation of website view can be realized with its flexibility and it makes content more prettier. Since CSS3 is not supported by all the browsers yet, but it cannot block its increasingly popular. Comparing with trying to obtain the same effect by using some plugin such as Java script or offering several different versions of the same image, CSS3 seems much more easier to accomplish. Combining the HTML5 with CSS3 together will help you to gain more measures for the responsive web design technique.

6.4.3 PHP&ASP.NET

The requirements usually decide the choice of the technology. The factors which influence the decision of choice are listed as following:[38]

1. Feasibility: PHP can be installed on any operating system and Web server other than ASP.NET is only recommended for Windows IIS. In our frame designing, MWA cloud platform and Windows cloud database have been chosen as prior chapter introducing, so considering the uniformity, asp.net is more preferred in this specific application.

2. Development cost: For the development cost, both are same, but asp.net more focus on rapid-application-development and PHP is more on coding. For the E-health frame designing, Rapid development will be more preferred.

3. Mode of source: asp.net is the closed source, and the PHP is the open source. But anyway, application developers have not huge benefits for either it is closed or open. The developers just focus on how to use the tool to develop their application rather than whether the tool is closed or open source.

4. Languages: For the asp.net, it support much more language such as the C#, Java Script, etc rather than the PHP. Aiming to the web-app, much more language means more development methods.

5. Speed: Though investigation, it found that PHP is recommended for small-to-medium projects and asp.net for medium-to-big applications. Considering the expanding of the application application in the future, asp.net is more better.

6. Security: asp.net, PHP and its servers are mostly secure. And the developers need to make sure their coding is secure. In this way, both are basically the same.

7. Advancement: Constantly developing and integrating the new features will be insisted by Microsoft’s team. And it will take more time for PHP to reach the level.
To sum up, ASP.NET has been chosen as the server side programming language. Development tools’uniformity, speed and security are the main reasons why it has been selected between the both.

6.4.4 Cloud database & Local database

Cloud Computing can be defined as a service or a platform, or an operating system over the Internet to perform tasks. Database has become a part and parcel of life and is being used in almost every computer application. As it is considered the most basic thing, Cloud Computing also offers this database service. There are two different database now available in our project which is Azure cloud database and Microsoft SQL server database server. Each of them has their own merits and demerits.

**Azure cloud database:** the Azure cloud database is typically running on Azure cloud computing platform, There are two common deployment models: the first way is that users can run databases on the cloud independently, using a virtual machine, while the second way is that they can also purchase access to a database service, managed by a cloud database provider. [39]

**Local SQL server database:** Microsoft SQL Server is a relational database management system which is developed by Microsoft. As a database, it is a software product whose basic function is to store and retrieve data with requests by other software applications. Nowadays, there are many different editions of SQL Server aimed at different audiences and for different usages, Its basic query languages are T-SQL and ANSI SQL.[40]

In our project, when we have already put the website on the cloud, there are two ways available to store the data, one is storing on the cloud and another is storing the data in local SQL server, we take these two ways into comparison and get the result that the Azure cloud database is better because of four advantage parts: the most important point is that the access speed for the website request with the cloud database will be more faster than the local database when the website has been published on the cloud platform. The second is that it will be flexible and reliable on the cloud platform, the third is that the customer will cost less but own a rapid computation capability and ultimated storage. The last reason is that we don’t need keep the local SQL server online all the day but the cloud platform will satisfy the demand, at any place and any time, the user can access the website as they like. In the E-health website, the data storage will be huge and the situation will also happen that too many users login in the record, it may led to the bottleneck. Although it is also feasible with local SQL server, Azure Cloud SQL server appears much more outstanding.
6.5 System Architecture Design

![B/S architecture diagram](image)

The whole E-health application frame applies the B/S (Browser/Server) architecture which the mainstream web architecture model. The web browser is the most important application of the client. This model simplify the client’s task and put the core part of the system functions to the server to largely simplify the system development, maintenance and use. Just install a Browser on the client such as Internet Explorer, server install the database such as SQL server, The browser data interaction can be realized with the database through the web server. This greatly simplifies the client computer loads and reduce system maintenance and upgrade cost and effort, reducing the overall cost of ownership.

B/S structure of the biggest advantages is that you can doing some operating without installing any special software in any place as long as there is a computer with internet access. The client almost need none maintenance. In case of above advantages of the B/S model, the whole application will apply it as prior introduced that the MWA IIS and database has been selected as the server and data storage.

6.6 System functions and Module implementation

Based on the design frame defined in previous chapter, a demo web-application aiming to the diabetes self-management will be developed to display how the model can be used into a specific application. The system’s functions can be mainly divided into the below several categories: Self-care education, forum platform, data collecting and presentation and security authority setting.
6.6.1 Self-care management

The above figures are the home page and tour page in the web-app on PC. The home page mainly offers a simple introduction and an initial idea of the diabetes and its harm. And the tour page mainly introduces the causing factors such as the exercise, diet, glucose, etc and how to protect the diabetes. Due to these two page just make a role of presentation of some information, what needed to do is make the front-end design more proper and beautiful. In order to make the page more diversification, the video and google map modules have been add to the page and all the work has been done in the front-end design.

6.6.2 Communication Platform

In the forum page, it offers a public communication platform for all the users sharing
the information and publish the topic they concern about. In order to fulfill the page, two basic modules, Grid-view and Detail view has been selected to use.

1. Grid-view: Grid-view table are used for combining the corresponding data from the database and organize with some format to present the information what the users care about.

2. Text-box: It is the basic components in web-application. The user can put what they want to publish in the text-box and the content can be store into the corresponding table in the database through the back-end operation.

3. Buttons: Once fulfilling the text, the users can decide whether to send or cancel sending data to server by clicking the Submit button and Cancel button. And some actions of the buttons will be done in the back-end programming.

4. Detail-view: Detail-view table is used for view the user’s detail information rather than the grid-view. Once the user want to view a detail information of a record from the grid-view, it can be easily realized by clicking the Select link. Certainly, corresponding data combining will be done.

**6.6.3 data collecting and presentation [41]**

**E-HEALTH WEBSITE**

<table>
<thead>
<tr>
<th>Record</th>
<th>Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>Exercise</td>
</tr>
<tr>
<td>Glucose</td>
<td>Weight</td>
</tr>
<tr>
<td>Exercise</td>
<td>Diet</td>
</tr>
<tr>
<td>Weight</td>
<td>Food Setting</td>
</tr>
<tr>
<td>Diet</td>
<td>Permission</td>
</tr>
</tbody>
</table>

![E-Health Website](image)

Figure 9. Record page

The above page present what information is needed to be recorded into the database
for the user. What’s more, through the Calendar module, each record of the user can be stored according to the date and now-time.

**6.7 Security and Privacy**

**6.7.1 Password Security**

Due to the web-app references to the personal data storage and presentation, so the security issue is an important point for the user. Nobody wants privacy information exposed to the public without any protection measures. The following part will illustrate the implementation of the security rules introduced before:
The above figures are the register and login interfaces. When a new user surf the website, he needs register a new unique account for himself which can be used to identify who is him when he surfs the site again later. And the user should offer his e-mail address, age, and protecting answer, etc some basic information which is possible to be used in password setting and getting back pages. Through password verification, the user’s information can be well protected.

**E-HEALTH WEBSITE**

<table>
<thead>
<tr>
<th>Home</th>
<th>Tour</th>
<th>Forum</th>
<th>My Account</th>
<th>About</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record</td>
<td>Present</td>
<td>Glucose</td>
<td>Exercise</td>
<td>Weight</td>
</tr>
<tr>
<td>Security Question:</td>
<td>Whats your current job?</td>
<td>Answer:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Password:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified Password:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confirm Password:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[SUBMIT] [CANCEL]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The answer you type in should be the same with the previous answer when you registered
- Correct old password should be offered
- The modified password should be the same with the confirm password

---

**Figure 12. Change password page**

**E-HEALTH WEBSITE**

<table>
<thead>
<tr>
<th>Home</th>
<th>Tour</th>
<th>Forum</th>
<th>My Account</th>
<th>About</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sec Question:</td>
<td>Whats your current job?</td>
<td>Sec Answer:</td>
<td>Username:</td>
<td></td>
</tr>
<tr>
<td>[SUBMIT] [CANCEL]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Figure 13. Forget password page**

The above two figures are the password setting and forgotten page. Through answer
the security question and fulfill the right now password registered before, the user can 
realize the password changing to improve the password security. What’s more, in the 
password forget page, the user only needs to answer the security question and 
username, the password will be sent to the his personal e-mail box automatically.

6.7.2 Authority management
This is the model what has been discussed in previous chapter. And in this section, a 
detail process will illustrate how to apply the RBAC model. The below three figures 
are the user page, doctor page and admin page.

![E-HEALTH WEBSITE](image)

Figure 14. Permission page

Through setting three different roles according the RBAC rules, the whole website 
can realize the access control and privacy security. As you can see in the above figure, 
the user can access his own personal data collecting and presentation, moreover, he 
can set some specific permissions for the specific user and doctor. Only those 
authority granted information such as glucose, diet, etc, can be viewed by the 
specified doctor. It well protects the user’s privacy data and offer a better mechanism 
to give the permissions to the doctor and the other user.
Figure 15. Doctor page

The above figure is the doctor page, the doctor can view some specific information of the patient only when the user grants the permission. Then the doctor can offer some professional advice and the other user having a relationship with the user can observe and take care of the patient.

Figure 16. Admin page

The above figure is the administrator page. In this page, the admin has the permission to view the user and doctor’s detail register information except the password. It is a
good measure to protect the user information security without arbitrary changing. In addition, the admin also has the permission to delete a specific user or doctor, once he confirms the user is a malicious or false user. Publishing a global notification permission is also granted to the admin to give some important notes in the forum platform.

To sum up, the above illustration presents the basic applying process with the basic model, and more security measures can be added in the future work.

### 6.8 Responsive Web design methods application

The page displays differently to different devices, following are the three different views when laptop, iPad and iPhone visit the website.

#### Figure 17. when the laptop visit the website
We will give an example of our home page to introduce how to use the framework defined before to realize the responsive web design.

1. Firstly we should change the header to

```html
<meta name="viewport" content="initial-scale=1.0, maximum-scale=1.0">
```

2. Secondly we put all the words and image in div container with HTML programming language. And enduing all the style of the div with “float:left “style. In the application, four basic modules has been used. But some modifications has been done because the page will has more contents and information, so more modules have been added into the structure according to the requirement. Moreover set all the
element in the div container with flexible size or fixed size as follows:

<div class="honeyupright" id="2" style="display:none">

  <asp:Image ID="Image1" runat="server" ImageUrl="/picture/logo.png" Height="223px" Width="358px" style="display:none" />
  <asp:Image ID="Image2" runat="server" ImageUrl="/picture/dia.jpg" Height="223px" Width="358px" />
  <asp:Image ID="Image3" runat="server" ImageUrl="/picture/oldpeople.png" Height="223px" Width="358px" style="display:none" />

</div>

It contain many images in the div container and give them initiate CSS style like width or height.

3. Thirdly with the help of the media query technology, affording another CSS style which has already set breakpoint of the scope for different device. And enduring another CSS style with the flexible and fixed technology like following shows:

```html
@media (max-width: 320px) { /*mobile phone, orientation:portrait*/
  .page {width:320px;}
}
```

4. Lastly, continuous testing and change the style of the element in CSS with proper size and location.

## 6.9 Encountered problems and solutions

### 6.9.1 How to bind the data to the grid-view component by back-end operation?

Solution: The data source can be appointed through one SQL statement getting needed data fields from the database. When binding the data with the grid-view, a problem happens. Since each data field from the SQL statement is an object and each grid-view can only bind a corresponding object, so we create a class to realize the several objects encapsulation to a object with the constructor function.

### 6.9.2 Problem with IIS deployment?

We have taken several days to initialize, install the IIS and deploy the website on the IIS, but one problem happens when we change the page name of the default page, at first we set the name of homepage “default page”, but when we change the name to “homepage”, the homepage of the website comes to be IIS directory page. This is because the default document in IIS is setting to be Default.aspx, when we have
changed the name of the page, the default attribution is not effective. The solution is we should modify the IIS default document properties, resetting the inheritance relationship.

6.9.3 Display problem with the detail-view, diagram and line chart component.
At first, when trying to realize resizing the size of the detail-view, diagram and line chart, we found that it does not work by setting the corresponding size in different media query style. In order to solve this problem, we have tried many ways such as moving the components position and so on, but all failed. Through internet search, in the end, we found it can only be solved through the CSS method “overflow style: scroll”, the effect as the blew figure shows:

![Figure 29. The Solution Of scrolling](image)

6.9.4 Language problem with the MS cloud database table design
After we created the tables on the MS cloud database, website can’t realize the correct connecting with the cloud database. We have tried many ways to solve the problem such as checking whether the connect-string and SQL statement is correct, etc. At last, through internet search we found when you create the database in the cloud at the first time, the default language should be chosen. And due to the system and version problem, the language can only be chosen as the Latin instead of the English or Chinese we previous selected.
7. System Test and Evaluation

7.1 Performance Testing

Page loading time is an important part of providing a responsive user experience, and extensive web research suggests that it correlates to how long users will stay on a website and how satisfied they are with the interaction. It also directly determine the search engine ranking of this website.[42]

![Page Load Time Distribution](image)

Figure 30. Correlating page load time and user patience. Most users will wait only 6 to 10 seconds for a site to load. [43]

Figure 3 shows the time users are willing to spend on waiting for a web page loading. According to surveys conducted by Akamai and Gomez.com, there exist 40 percent of users will abandon the website if page load time exceeds three seconds. And a one-second delay in page response can even reduce conversion by seven percent. The most serious event is that it would led to the economic losses, for example, an e-commerce site may making $100,000 per day, a one-second delay would cause $2.5 million loss in annual sales. [43]

As page load speed is very important, we have to consider about how to improve the speed, the download speed of the network would be considered first, according to a study by PCWorld, the average download speed for 3G networks in the US is 2 Mbps, and 6.2 Mbps for 4G networks. A study by Ofcom found that the average download speed for 3G in the UK to be 2.1 Mbps. Outside of North America and Europe, connection speeds are generally slower. Because 1 Mbps equals 122 KB/s (or 0.12 MB/s), this translates into the following: 244 KB/s on average for 3G users (0.24 MB/s),
756 KB/s on average for 4G users (0.76 MB/s).[44]
However, download speed is not the bottleneck. The bottleneck is the network latency, when visiting a website, only 20% of the time it takes to display a Web page comes from downloading files. The rest of the time is spent processing HTTP requests and loading style sheets, script files and images. So will a responsive web design will improve the speed of visiting website? would it provide a better user experience and even recoup their economic losses?

We separately test our two websites with responsive and no responsive technology, with the chrome browser. When testing the speed of these two website, we use the page speed tool comes from google and www.webpagetest.org, these two tools are very useful which would generate the report of testing. With the help of these report, we can directly recognize the advantage of responsive web design. The figure shown below give the detail report of using the same device to detect the website which are with and without responsive web design. The detail report of waterfall view are added in Enclosure 2.

![Figure31. The connection view without using the responsive web design](image-url)
Result from google page speed tool:
The page default got an overall Page Speed Score of 88 (out of 100). (responsive page)
The page default got an overall Page Speed Score of 83 (out of 100). (no responsive page)

From the figure shown above, we can draw the conclusion that the user can get more faster and simper experience with the responsive website since it is 2 times faster which is 2.018s while the non-responsive website get the page load speed of 5.349s. Speed is a core feature in website creation, responsive web design not only meet the customer’s requirement and also help the web provider restore the loss.
7.2 **Black Box testing**

Black box testing is applied during the development of project work. Black box testing is primarily used for testing the functionality of the system.
Website function black box testing:

<table>
<thead>
<tr>
<th>Test number</th>
<th>Description</th>
<th>Expected outcome</th>
<th>Pass / Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Register a user with all the information fulfilled: 1) Input all the information in the text box and scroll all Seekbars to a certain value 2) Press the submit button</td>
<td>A successful message shows on the screen, indicates register successfully.</td>
<td>Pass</td>
</tr>
<tr>
<td>2</td>
<td>Register a user without all the information fulfilled: 1) Input the information in one text box 2) Press the submit button</td>
<td>An error message should pop up on the screen that indicates registering data unsuccessfully.</td>
<td>Pass</td>
</tr>
<tr>
<td>3</td>
<td>Register a user with the password less than 7 byte</td>
<td>An error message should pop up on the screen that indicates minimum password should be 7</td>
<td>Pass</td>
</tr>
<tr>
<td>4</td>
<td>Change the password with the security answered the same when the user registered</td>
<td>A successful message shows on the screen, indicates change the password successfully.</td>
<td>Pass</td>
</tr>
<tr>
<td>5</td>
<td>Change the password with the security answered not the same when the user registered</td>
<td>An error message should pop up on the screen that indicates the security answer is not correct</td>
<td>Pass</td>
</tr>
<tr>
<td>6</td>
<td>Change the password with the old password not the same when the user registered</td>
<td>An error message should pop up on the screen that indicates the old password is not correct</td>
<td>Pass</td>
</tr>
<tr>
<td>7</td>
<td>Cancel the data fields 1) Click cancel button</td>
<td>Seekbar’s and EditText’s values need reset to default values.</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
| 8 | Cancel the data fields  
1) Input the data in one of the data field or scroll one Seekbar  
2) Click cancel button | Seekbar’s and EditText’s values need reset to default values. | Pass |
| 9 | Forget the password with choosing the correct security question and typing the security answer correctly | An email with old password will be sent from the official E-health email | Pass |
| 10 | Forget the password with choosing the wrong security question | An error message should pop up on the screen that indicates the security question is not correct | Pass |
| 11 | Forget the password with typing the security answer wrongly | An error message should pop up on the screen that indicates the security answer is not correct | Pass |
| 12 | Plot data  
1) type in all the information and submitted | The glucose chart, exercise chart, weight chart and diet grid-view will display correctly | Pass |
| 13 | Zooming in and out  
1) Visiting the website with iPhone and iPad  
2) Turn the device in different orientation | The website will display well whether the iPhone or iPad visits, and whether it is portrait or landscape | Pass |
| 14 | Search the doctor and give the specified doctor authority to access the patients specified items | The authenticated doctor will view the specific items of the patient | Pass |
8. Conclusion

The main purpose of the report is to establish a general E-health web application framework including the cloud platform selecting, security mechanisms defining and the usage of the responsive web design technique. Through the systematic comparison, the MWA cloud platform and ASP.Net, HTML5, CSS3 has been chosen as the main tools due to the well compatibility and operability. In addition, a general security guideline, common login structure and RBAC access control structure has been given to protect the personal information. Moreover, four main methods used to realize the responsive web design have been introduced in the report. And a responsive web framework has been designed to offer a basic referenced model for the future specific application. Finally, a prototype web application based on the general framework has been designed and implemented. Through testing, it proved that the responsive web page loads more faster than the non-responsive web page.
9. Future Work

Since the framework and a prototype have been done in the project with in limited time, there are some ways that we thought can be further improved and implemented in the future work.

First of all, personal data storage will be a main risk for privacy security, especially the password encryption in the cloud database. Some kinds of encryption measures such as RSA and DES, etc can be applied to improve the data security level. In addition, communication between client and server needs encryption for avoiding the sniffing.

Secondly, this prototype just a simple application to show how the framework is applied, so the responsive web design mainly aims to the mainstream handheld device (iPhone and iPad) in the market. Some other type system of the mobile such as the Android will be added to well-adapt. In addition, the mobile UI will be further improved to be more proper and comfortable according the designing people acceptable standard.

Thirdly, considering the inconvenience in remembering many website username and password, the account combining with some existed account of website and software such as MSN, Facebook, etc is necessary. It will reduce the user’s burden.

Lastly, since the MS cloud database has been selected as the development part of the model, so the data transfer will be further researched and implemented in case the owner of the website want to change the database vender. Huge amount of data transfer will be a big problem in the future if this situation will happen.

The purpose of all these works aims to provide user a pleasing experience and great user interaction. Technology changes the life, so learning new technique constantly is quite necessary and important.
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11. Enclosures

Enclosure 1 Articles for literature review


Enclosure 2 Report for responsive web load speed simulation

![Graph and table showing performance metrics for various website elements and their load times.](image-url)
Enclosure 3 Abbreviations

A:
ASP: Active Server Pages
B:
B/S: Browser/Server

C:
CSS: Cascading Style Sheets
C/S: Client/Server

D:
DRM: Digital Right Management

E:
E-health: Electric Health Record
EU: Europe Union

G:
GAE: Google App Engine
GOS: Ground Operating System

H:
HTML5: Hypertext Markup Language
HKR: Högskolan Kristianstad
HIPAA: Health Insurance Portability and Accountability Act

I
IaaS: Infrastructure as a Service
ICT: Information and Communication Technology
IIS: Internet Information Services
IT: Information Technology

J:
JS: Java Script

M:
MAC: Mandatory Access Control
MWA: Microsoft Windows Azure

N:
NASDAQ: National Association of Securities Dealers Automated Quotations

O:
OOP: Object-oriented programming

P:
PaaS: Platform as a Service
PHI: Protected Health Information

Q:
QOS: Quality Of Service

R:
RBAC: Role-Based Access Control
RWD: Responsive Web Design

S:
SaaS: Software as a Service
SLA: Service-level Agreement
SOAP: Simple Object Access Protocol
SQL: Structured Query Language

U:
UCON: Usage Control
UI: User interface

Enclosure 4 Meeting Investigation