CHAPTER 2
THEORETICAL FOUNDATION

2.1 Oral Health

Every person on Earth (excluding those who are defectively born) has an external organ known as the mouth, this external organ functions as part of human’s digestive system and to communicate with one another. Dental and oral health is an important part of people’s overall health and well-being and maintaining them requires a lifetime commitment [5]. Keeping one’s oral health impacts not only their overall health like frequent dry mouth, broken teeth, receding gums and toothache but also socially as they cause bad breath and loose teeth [5].

The earlier people learn proper oral hygiene habits the easier it will be to avoid costly dental procedures, long-term and more serious health issues [5]. In order to achieve and maintain proper oral hygiene, some steps such as stopping the use of all types of tobacco, limiting sugar intake, reducing alcohol intake, using protective gears when doing sports and to brush and floss the teeth regularly [6]. By doing the steps mentioned earlier, a healthy mouth can help people maintain a healthy body as oral inflammation may be linked to heart disease, endocarditis, higher premature birth rate and low birth weight (in pregnant female) [5]. While socially, a perfect teeth and gums along with fresh breath can boost a person’s self-esteem in socializing with the others.

2.1.1 Oral Health Conditions

There are many types of oral health conditions which can be affected by many factors and conditions. However, in this thesis, the author will be focusing mainly on the oral health conditions which occurs due to bad hygiene or unhealthy diet. The most common oral diseases caused by bad hygiene and unhealthy diet are dental caries (tooth decay) and periodontal (gum) disease [5].

2.1.1.1 Dental Caries (Tooth Decay)

Dental caries or commonly known as tooth decay is a condition where there is a permanently damaged areas in a person’s tooth/teeth that develop into tiny
openings/holes [7]. It is the most common widespread chronic disease worldwide and establishes a major global public health challenge regardless of any gender and age [11]. As cavities do not cause any pain or can be hardly physically seen in the beginning of the phase, it is commonly left untreated and eventually becomes bigger [8].

According to FDI World Dental Federation, untreated decay of perpetual teeth has a worldwide predominance of over 40 percent for all ages consolidated and is the most prevalent condition out of 291 diseases (recorded in Global Burden of Disease Study) [11].

Dental caries is a multifactorial disease, meaning that it can be caused by many factors in a person’s lifestyle [11]. Although the reasons for dental caries vary, the most common thing that causes it are the bacteria that exist in a person’s mouth, the bacteria turn sugar into acid which creates plaque [8]. Due to the acidic nature of the plaque, it slowly erodes the enamel in a person’s teeth, which leads to tiny openings [8].

Signs of dental caries may be identified by a lot of symptoms including, but not limited to [7]:

- Tooth sensitivity.
- Toothache (pain that occurs without any apparent reason).
- Visible holes or pits in teeth.
- Brown, black or white stains on surface of teeth.
- Pain when biting.
- Mild to sharp pain when eating or drinking something sweet, hot or cold.

It is recommended for people to brush and floss their teeth twice per day, reduce intake of acidic and sugary food in their diet and to do a regular check up to their dentist at least once every six months [8].

People that are experiencing any symptoms of dental caries needs to go to the dentist as soon as possible as if left untreated it may lead to variety of complications, which include [7]:

- Ongoing tooth pain.
• Tooth abscess, which can become infected and trigger life-threatening complications, like an infection that enters the bloodstream or sepsis.
• Development of pus around the infected tooth.
• Increased risk for breaking or chipping a tooth.
• Difficulty chewing food.

2.1.1.2 Periodontal (Gum) Disease

Periodontitis which is also known as gum disease is a gum infection that damages the soft tissues in a person’s mouth [9]. Although many health conditions may lead to periodontitis, the most common cause of periodontitis is due to the bacteria (from the plaque) accumulated in a person’s mouth [10]. Periodontitis is usually categorized into 3 stages [10]:

• Early periodontal – receding gums and gums are easily damaged/bleed during brushing or flossing.
• Moderate periodontal – experiencing pain and bleed around the teeth and gum recession. Teeth will begin to lose its bone support causing it to become loose, may also experience inflammation due to infection.
• Advanced periodontal – connective tissue (gums and bones) starts to deteriorate, causing teeth loss, severe pain when chewing, severe bad breath and foul taste in the mouth.

As specialized periodontal care is not generally available because of the shared risk factors and due to its two-way relationship with some systemic illnesses, many people do not know about it and the measures to completely prevent it [11]. The known and simplest preventions for this disease are also the same as those in dental caries, people just need to keep their oral hygiene clean, to visit dentist twice a year and to consume daily intake of vitamin C [9].

The symptoms of the disease are also similar to those in dental caries, that includes [9]:

• Swollen gums.
• Change of colour (dusky red or purple in colour) in gums.
• Gums bleeds easily.
• Bad breath.
• Loose teeth.
• Induces pain when chewing.

2.2 Serious Game

Serious games are games that are used to facilitate learning and behaviour improvement in addition to being entertaining [46]. Serious gaming is used in a variety of settings, including education, healthcare, marketing, sustainability projects, training, consulting and other companies and industries, since it is designed to solve problems in a variety of fields while also providing fun and interaction [46]. The advantages of serious games are that they provide safe space to experiment, increasing engagement, improving memorization and retention [47].

There are 5 main elements of serious games [47]:

• Story or plot.
• Gamification.
• Challenge or competition [48].
• Simulation.
• Risk and consequences [48].

Serious games have had a serious impact on human society, as the following examples are not only successful in gaming sales but also simulator training for real life purposes [49]:

• Microsoft Flight Simulator (1982).
• Tiltfactor Laboratory (2003).
• World Without Oil (2007).
• IBM City One (2010).
• Superbetter (2012).

2.3 Virtual Reality

Virtual reality (VR) refers to a computer-generated simulator which simulate an artificial three-dimensional environment where a person can interact with by using electronic devices, such as special glasses with displays or gloves equipped with sensors [30]. This is made possible by simulating as many senses as possible, such as sight, hearing, touch, and smell, the machine becomes the creator of this artificial world [32]. Although this technology
might seem new, this technology has been around for decades as there was a device known as Headsight which was created in 1960s [31]. The distinction between Augmented Reality (AR) and Virtual Reality (VR) is that AR simulates artificial objects in the actual world while virtual reality creates an artificial environment in which to live [32].

There are three major types of simulations in VR [35]:

- non-immersive - generates a data-generated world, but also allows the user to be aware of their physical environment and retain control over it.
- semi-immersive - giving users the illusion of being in a different reality as they concentrate on the digital image, giving users a partly virtual environment, while still enabling users to remain connected to their physical environment.
- fully-immersive simulations - provide users, complete with sight and sound, with the most realistic simulation experience. The right VR glasses or a head monitor is needed to experience and engage with totally immersive virtual reality (HMD).

2.3.1 Oculus

Oculus Rift is virtual reality (VR) technology developed by Oculus VR in 2016 [33]. Oculus is a head-mounted system that allows users to naturally interact with virtual 3D environments [33]. The aim of this virtual reality technology is to provide users with immersive experiences generated by machines, as it provides a more intimate and natural way for humans and computers to interact in relation to games in a conventional way [34].

Several game examples that can be played by using this Oculus includes [34]:

- Chronos
- Minecraft VR
- Elite: Dangerous
- Keep Talking and Nobody Explodes
- Apollo 11 VR Experience

2.4 Back-end Application Development
The majority of sites on the Internet today are mostly dominated by dynamic sites [12]. By definition, this means that the site will continue to change according to the current content status [12]. A blog page is a good example of a dynamic website where the content changes dynamically when users add, update or delete posts. Dynamic applications depend to some extent on servers or databases [13]. These online servers are often called back-end systems.

Back-end development is a software engineering division that focuses on operations on servers that take place behind the scenes. As front-end applications are responsible for providing services to users or displaying application content to users, back-end applications are responsible for, but not limited to, data processing, business logic and database interactions [14]. A back-end system usually consists of three parts: server, application and database [13]. This is the part of the application that the user cannot see and interact with. It stores, manages and organizes data inside the database [14].

![Back End Diagram](https://via.placeholder.com/150)

Fig. 2.1. Illustration of backend developer’s work range [15].

### 2.4.1 RESTful API

Representational State Transfer (REST) is a style of software architecture for web applications that provides a standard interaction between online computer systems [16]. Programming interfaces are called REST APIs or RESTful APIs for applications implementing the REST architectural form.

Six guiding principles exist in REST architecture that serve as the core concepts [17]:

- Client-server
The server application should not be affected by any changes made to the client application, nor by anything else. As a result, the components will be able to independently grow and develop.

- **Cacheable**
  All of the server responses can be marked as cacheable or uncached. For future corresponding requests, the client may use cacheable data.

- **Stateless**
  Each request from the customer must include all the elements essential to understand the request. The server does not store any client status. Thus, on the client side, the session state is retained.

- **Code on Demand**
  With the REST architecture, by installing and running code such as applets or scripts, client functionality can be expanded, eliminating the need for pre-implementation of functionality. A common example is how JavaScript, in this case the browser, adds more features to the client [18].

- **Layered Framework**
  By requiring the components not to be able to look outside the layer in which they communicate, this architecture imposes a hierarchical layer structure. By using this architecture, it increases the service's modularity and improves the security advantages, leaving the most vulnerable portion of the device behind the most sophisticated interface [17].

- **Uniform Interface**
  For the same requests, the server provides the same interfaces, regardless of the variety of client applications which request them. Therefore, in a structured way, the URI and the request response are generated to respond to requests from different applications.

### 2.4.2 HTTP

Hypertext Transfer Protocol is an application level stateless protocol used for distributed, collaborative and hypermedia information systems [18]. From the point of view of the client server concept, there is a set of principles for
transferring hypermedia documents such as HTML [19]. Through requests and responses, clients and servers communicate.

The process can be divided into five parts [20]:

- The client sends the server an HTTP request.
- The request is retrieved by the server.
- The server processes the request.
- The server returns to the client an HTTP response.
- The client receives the response.

HTTP is stateless, meaning that each command or request is independently processed without first knowing the details or status of the client. Therefore, in each HTTP request, all data required to process the request, such as user credentials, must be provided [21].

There exist Six HTTP methods, each of which is used for various purposes [22]:

- GET - to request a representation of the specified resource defined by the request URI.
- HEAD - only HTTP headers of the standard GET request are returned by this process.
- POST - this method is used to propose an entity to the specified resource and most of the time results in some sort of side effects on the server.
- PUT - a method of substituting the target resource with the request’s payload.
- DELETE - a particular resource is eliminated by this method.
- CONNECT - to establish an HTTP tunnel to the server.
- OPTIONS - this method returns descriptions of the communication options for the target resource.
- TRACE - performs a message loop-back test along the path to the target resource.
- PATCH - a method for updating the latest resource status.
2.4.3 8 Golden Rules

The 8 golden rules are guidelines in the process of making an interface design or user interface for a website [66]. 8 golden rules are first introduced by Ben Shneiderman in the book Designing the User interface as one of the set principles [65]. The features developed from Shneiderman's golden standards may be seen in a variety of user interface guidelines created by companies such as Apple, Microsoft, and Google [64]. The visual manifestation of these criteria is much more visible in the popular interfaces that arise [64].

The 8 golden rules are:

- Strive for Consistency
  In terms of design, consistency means that each page must utilize the same template. Allow consumers to not be confused by the fact that each page on our website has a distinct look [66].

- Enable Frequent Users to Use Shortcuts
  As the number of people using the internet grows, so does the desire for faster ways to do activities [64]. For example, both Windows and Mac include keyboard shortcuts for copying and pasting, allowing users to browse and use the user interface more quickly and easily as they gain expertise [64].

- Offer Informative Feedback
  Always provide informative feedback to users [66]. Feedback does not have to be only in the form of a request from the app to the user, it may also be in the form of a change in the way each user interacts with the app, with the goal of ensuring that the user understands that the information they enter on the website is correct [66].

- Design Dialog to Yield Closure
  Make sure the users aren't left in the dark. Inform them of the consequences of their actions [64]. When customers finish an online purchase, for example, they would enjoy a "Thank You" message and a proof of purchase receipt [64].

- Offer Simple Error Handling
  Make sure the user doesn't make any mistakes when performing the process [66]. This is critical so that people are not perplexed while
attempting to use website features. The objective is for users to be able to fill out forms correctly and avoid errors, therefore instructions or guidelines for filling out forms in accordance with the format are generally provided [66].

- Permit Easy Reversal of Actions
  This is an important point, and the focus of this point is to make it easier for the user to return to the previous page or cancel the action [65]. The back button and the cancel option are the solutions for this point; provide a back button on each page, as well as a cancel option on each form on the website [66].

- Support Internal Locus of Control
  Allow users to take the initiative and initiate actions. Give people the impression that they have complete control over what happens in the digital world [64]. Earn their trust by designing the system to operate in the way they expect it to [64].

- Reduce Short-Term Memory Load
  This point focuses on how to build a website that does not overwhelm the user's memory when using the website's features [66]. To implement this point, developers must establish a basic design so that users have no difficulty utilizing the website's features [66].

2.4.4 Database

A data system that stores structured information is known as the database. Usually, a database is managed using a database manager (DBMS) [25]. A DBMS serves as an interface between the database and its users or applications, enabling them to manage, retrieve and update the data themselves [26]. Some examples of DBMS are MySQL, SQL Server, Clipper and MongoDB [27].

One way of storing information is to use a database system, the other way is by utilizing the file system (spreadsheets and other types of files) [28]. The key distinctions between a database and a spreadsheet and other tools are the storage and manipulation of data, the usability of data, and the quantity of data that can be stored there [26].
The following are other benefits of the use of a database system [29]:

- **Data Integrity**
  The data can be considered accurate and consistent in a database system. This means that, at the request of the user, the data that a user gets access to the precise and latest data and that applies to all requests from other users.

- **Data Security**
  In a database system, access to the database is available only to authorized users. Users of databases are authenticated with certain username and password combinations, and unauthorized users do not have access to the database.

- **Sharing of Data**
  The data in a database system can be viewed simultaneously by several database users at any one time. In addition, other users will also have this information updated each time a user changes the data.

- **Reducing Data Redundancy**
  Multiple files in different locations, devices, or even multiple systems are stored by file-based computing systems. It will be unavoidable to have multiple copies of the same file. By storing the data in a single database system, a database system avoids data redundancy and changes to the database are immediately reflected.

- **Consistency of Data**
  In the database and for all users who see the database, the data is always shown the same. When changes are made to the database, users will have the updated data accessible.

- **Backup and Restoration**
  DBMS automatically takes care of the backup and recovery so that users do not have to back up data on a regular basis. Also, in case of an error, the system will restore the database.

- **Privacy**
  Certain rules can be applied regarding which database users have access to which data.
2.4.5 Data Chart

A chart is a graphical representation of information. In a visual, a chart can represent what is normally a table with rows of numbers. Rather than looking at raw data, this helps the viewer to rapidly comprehend similarities and trends [61]. Charts are ideal for comparing one or more value sets, and they can quickly display the data sets' low and high values [61]. Charts may also demonstrate how different pieces of something, such as the device type used by mobile website users or total sales split down by sales rep, make up the whole [62]. Outliers, the typical trend, and the range of information in values are better understood using distribution charts, but relationship charts are better for demonstrating how one variable connects to one or more variables [62].

2.5 Development Technologies

2.5.1 Unity

Unity for developers is a 3D / 2D game engine and a versatile IDE platform [30]. "Integrated Development Environment" which stands for IDE, defines an interface that gives access to all the resources needed in one place for development [30]. As of September 2019, 52% of the top 1000 mobile games were powered by Unity, in addition to 60% of AR/VR content, the device is simply the most popular game engine in the world [32]. There are many game making platforms that are similar to Unity yet it is the most used by developer [32]. Unity has been used to create games like Pokemon Go, Heathstone, Rimworld, Cuphead, and plenty more [31].

The advantage of using Unity includes [32]:

- Wide Scope
  
  Many people already know Unity, as people do not have to learn a new engine, which is a very convenient thing.

- Great Engine for Beginners
  
  It is a very useful tool for students and aspiring developers, since Unity is free of charge. With the inclusion of Bolt, which helps developers to apply logic without having to learn how to code in their projects.

- Fast and Agile
It allows for very quick iteration and when brainstorming for a new game idea, it can be incredibly useful.

- **Convenient Portability**
  Unity is also easy to port, with game being effectively ready with one click to go on all 25 different platforms.

- **Enables Users to Build Their Own Tools**
  Not only does Unity's Asset Store make it easy for developers to purchase instruments, but the engine also makes it very easy to create tools.

- **Convenient to VR Developers**
  When they work together with VR powerhouses, new APIs, characteristics and paradigms are easily introduced.

### 2.5.2 phpMyAdmin

Introduced on September 9, 1998, phpMyAdmin is an open-source software tool written in PHP [39]. PhpMyAdmin's main aim is to manage the administration of MySQL over the web [39]. Through using this software, users can create, update, drop, modify, delete, import, and export MySQL database tables. PhpMyAdmin is translated into 72 languages and supports both LTR and RTL languages to ease the use of a wide variety of users [40].

Some of the features of phpMyAdmin include the following [41]:

- Web Interface.
- Control of MySQL Databases.
- Administration of multiple servers.
- Searches of national or subset databases.
- Live charts to track the operation of the MySQL server.

### 2.5.3 Google Charts

Google Charts is an excellent tool for displaying statistics on a website. The chart gallery has a wide variety of ready-to-use chart kinds, ranging from basic line charts to sophisticated hierarchical tree maps [63]. Google's charting tools are versatile, easy to use, and free, as well as configurable, cross-browser compatible, dynamic, and interactive. Create an interactive dashboard by connecting charts and controls [63].
The charts that are used are:

- **Line Chart**
  A line chart, also known as a line plot, line graph, or curve chart, is a style of chart that shows data as a sequence of markers linked by straight line segments. It is a simple chart that may be seen in a variety of areas [63].

- **3D Pie Chart**
  A pie chart is a spherical statistical visual that is split into slices to show numerical proportion. The arc length of each slice in a pie chart is proportionate to the quantity it depicts [63].

- **Scatter Chart**
  Points are plotted on a graph in scatter charts. Tooltips with extra information appear when the user hovers over the points [63].

### 2.5.4 MySQL

MySQL is an Oracle-developed relational database management system (RDBMS) based on a Structured Query Language (SQL) [43]. The most popular open-source database system in the world is MySQL, a scalable and efficient software [42]. MySQL is an integral part of almost every PHP program that is open source. WordPress, Joomla, and Drupal are fine examples of PHP & MySQL-based scripts [44]. MySQL and SQL are not the same, MySQL just adds more features, support, procedural programming, control-flow mechanisms, and more to the original SQL standard [43].

The reasons why MySQL is very popular is due to [45]:

- An industry standard
- Flexible and simple to use
- Elevated efficiency
- Secured

![Image](image.png)

**Fig. 2.1. Illustration of how MySQL works [45].**