CHAPTER 2

THEORETICAL FOUNDATION

This chapter covers the theoretical foundation and frameworks for the problem regarding the research thesis. The theoretical foundation and the frameworks will be used as foundation and framework to support the solution of the problem regarding the topic.

2.1   Theoretical Foundation

The relevant theories is summarized and presented comprehensively and in accordance with the problem. The theories, which support the solution of the problem, can be referenced from the latest research in the field or from textbook and other references.

2.1.1 Project Management

Project management is the tools and technique and the process trough, which a project is planned, monitored and controlled to meets the requirements [3].

Moreover, the project management theoretical foundation based on several parts, which will be described in this sub chapter.

2.1.1.1 Project

Project in definition defines as a temporary endeavor and set of activities, which is undertaken to achieve or create a unique service, product or result [4], [5].

To have a clearer definition of project and understanding a project further, a set of attributes of a project is summarized in a table figure. The table figure for the project attributes can be seen from the Table 1, below:

Table 2. 1 Project Attributes [4].

Project Attributes	
1. Project has a unique purpose.	• A project has defined objective and creates unique service, product or result.
2. Temporary.	• A project always has a scheduled start date and finish date.
3. Project requires resources.	• A project needs resources from different areas such as hardware, software, people to undertaken the series of activity in the project.
4. Project is developed using progressive elaboration.	• A project defined initially broadly, which becomes clearer and more specific as it progress. A project suggested to be developed in increment.
5. A project should have a primary customer or sponsors.	• Project sponsor is a party that provides the direction and funding of the project.
6. Uncertainty.	• Each project is unique meaning that, sometimes there are no exact solution to determine the exact objective, time and the cost of the project.

2.1.1.2 The Triple Constraints

The triple constraints limited the project in three areas (the scope, the budget and time), which makes each project, is unique [4]. In order for a project to be successful a project need to balanced these three often-competing goals. Figure 2.1 shown below illustrate of triple constraints in project management.

Figure 2. 1 Triple Constraints

The triple constraints traditionally consisted only the time, cost and scope, these are the primary things that need to be aware of, moreover resource, schedule and quality were added to create a more balance and more successful project [6].

2.1.1.3 Project Management Framework

Project management framework is a set of processes, technique, tools and templates that encouraged and designed to be used together, to plan, monitor, and control a project [7].

The project management framework is divided into several key elements that depend with each other for a project success level.

2.1.1.3.1 PMBOK Process Group

A process is considered as a numbers of activities done in order to achieved a specific result, product or service [8]. A PMBOK process group is a classification of project management process, which is divided into five categories. The five classification process groups can be seen from the figure below:
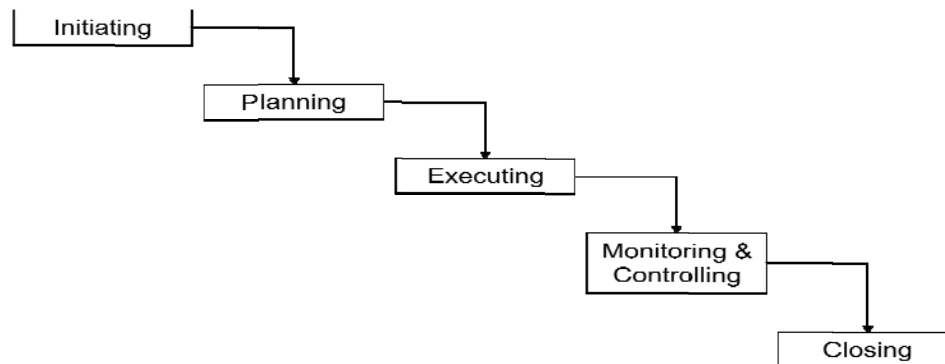

Figure 2. 2 PMBOK Process Groups

Furthermore, the in-depth explanation regarding each process is as follows [4]:

- **Initiating**: The initiating processes include the defining activities of a project or project phase. The initiation processes occurs during

each project phase, to ensure that the project are going in the right way and worth continuing.

- **Planning**: The planning processes main activities include devising and maintaining the set of activities for the project in a reasonable time, workload, and human resource by referring also with the budget available. Each of project management knowledge area needs the planning process to achieve a successful project [4].

- **Executing**: This process refers to the activity of allocating resources and executing the plan created earlier and to achieve the end project result. According to [4] the activity in this part includes project team management, quality assurance, information distribution etc.

- **Monitoring and Controlling**: This process group activity mainly focusing in continuously monitors the progress of the project; in order for the project to meets its objective.

- **Closing**: As it process name suggests, the closing process groups refers to the formalize acceptance of the final result of the project, documenting all of the project documents, and ending the project.

2.1.1.3.2 PMBOK Knowledge Area

PMBOK knowledge area according to [9] is a collection of knowledge area that are accepted generally and the key competencies to be best practices in the project management environment.
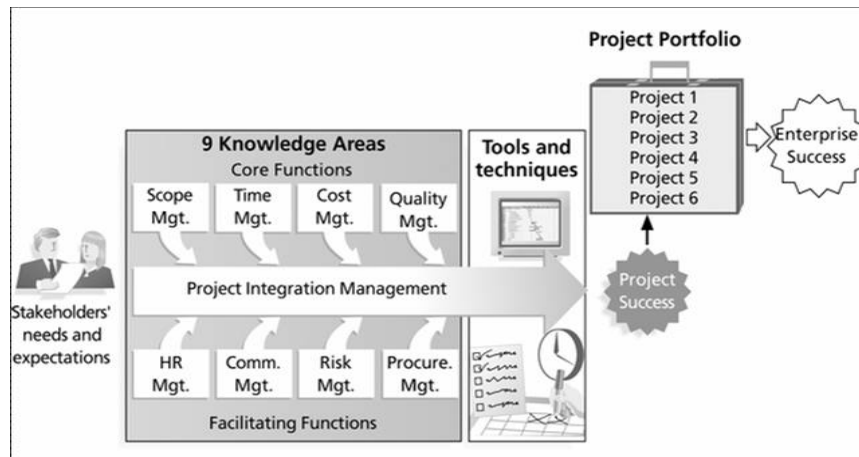
Figure 2. 3 PMBOK Knowledge Area

Each of the knowledge areas shown in the project management illustration above consists of some or the entire PMBOK process group, mentioned earlier. The scope, time, cost and quality management are the core function knowledge area as their leads to project objectives specifically, and the other four considered as the facilitating functions because the project objectives achieved trough these processes [4].

The detail of each PMBOK knowledge areas will be discussed below:

- Scope Management: Scope management involves in all the process of setting the boundaries of the project, of what will be and will not be in the project.

- Time Management: Project time management includes all the process needed towards the completion of a project to meets the time constraint [4]. In this project management knowledge area a **milestones** in the project are defined, and a **Gantt chart** also created.

A **milestone** is a significant event in the project without any time duration. **Gantt chart** is a standard format chart that shown the schedule information, including activity needs to be done, their start date, finish date, and dependencies between each tasks in a project using calendar format.

- Cost Management: Cost management involves all the process needed for a project to ensure that the project cost within the budget given.

- Quality Management: Quality management refers to all the process involves to ensure that a project meets the satisfaction level, in which a reason for a project based on [4].

- Human Resource Management: All Processes to use the most effective way in human resources that involves in a project are included in this area [4].

- Communication Management: It is all the process to make sure an effective and appropriate information collection, reporting, documentation and distribution in a project [4].

- Risk Management: It involves the process in which a decision of the risk management plan created.

- Procurement Management: It involves all the process needed to acquire goods and service outside an organization performing the project.

2.1.2 Networking Model

Networking model discussed in this thesis is the OSI Layer:

2.1.2.1 OSI Layer

The OSI (Open System Interconnection) layer is a networking model developed by the ISO that provide an abstract description of the network communication process [10], [11], [12]. The OSI model consisted of seven layers representing network communication process step in each layer, it is a theoretical model designed to show how a protocol stack should be implemented. The list and explanation of each layer is summarized in the table below:

Table 2. 2 The OSI Model [10], [11], [12].

No	Layer	Description
7	Application	• Provides interaction between that application and network used by the end users.
6	Presentation	• Handles issues with the presentation of data.
5	Session	• Establishing a one to one session between the sending and receiver, establishing rules for exchanging data during the session.
4	Transport	• Transfer the data, flow control, reassembles data at destination and handle structuring of messages.
3	Network	• Responsible for delivering the data packets to the destination, create and addresses packets for end-to-end delivery.
2	Data Link	• Creates and addresses frames for host-to-host delivery on LAN and between WAN devices.
1	Physical	• Translated the data and the headers into transmittable signal and put on the wire to travel across network, transmits binary data over media between devices.

2.1.3 Network Category

The network categories based on physical scope that will be discussed in this theoretical foundation are LAN and WAN:

2.1.3.1 LAN

LAN or Local Media Network describes as a network that spread over limited areas [11]. In [10] it defined as a group of end users and their devices under administration control.

2.1.3.2 WAN

WAN or Wide Area Network is a network that have coverage of large geographic area and a network that connected the local area network that located far apart geographically [10].

2.1.4 Header

Header is a form of information added by each layers as the data passes trough each layers from the networking models [10].

2.1.5 Encapsulation

Encapsulation is the process of adding the control information as a data passes down trough each layers [10]. In detail, it is the process where a device adds networking header and tracker to data from application for the transmission onto transmission medium [11].

2.1.6 De-encapsulation

De-encapsulation is the process of removing the data extra information, and sending the original application data to the destination application layer. It is the process happened after that data received, it examines the headers and trailers information at the successive layers and delivered the data to the right application [10], [11].

2.1.7 Packets

Packets are the small, manageable chunks, and easily transmitted units, which a data is broken for transmission across the network [11], [12].

2.1.8 Fragmentation

Fragmentation is the process of breaking a packet into smaller units, whenever the data are transmitting over a network medium that could not support the original size of the packet [12].

2.1.9 Fragments

Fragment is the piece of larger packet that has been broken down to a smaller size following the fragmentation process [11].

2.1.10 Data Compression

Data compression is the reduction of the data size in order to facilitate faster transmission of the data trough the network [11]. Data compression is one of the issues handled by the presentation layer.

2.1.11 Network Media

Network media defined as the means by which the signal is travelling from one networked media to the other media [11].

For the purposes of telecommunication, transmission media is divided into two categories guided media and unguided media.

2.1.11.1 Guided Media

Guided media is the network media that provided a conduit between devices; it provides a direction to any signal that travelling trough this media and it constrained by the physical limitation of the medium [12].

2.1.11.1.1 Fiber Optic Cable

Fiber optic cable is a physical medium cable made of glass or plastic that has the capability of transmitting signals in the form of light. Fiber optic is the most expensive network media, but they do offer several advantages over others. The advantages include higher bandwidth, security and immunity to electromagnetic interference [11], [12].

Fiber optic cable has two mode types, which are the single mode and the multimode. Explanation of the mode types will be discussed below [11], [12]:

- Single Mode

  Single mode cable has a small diameter. In single mode the light travels down the axis of a cable or also called as axial. The speed can reach up to 10 Gbps, and it typically used in WAN.

- Multimode

  The multimode cable is the cable that has the ability to receive multiple beams from a light source, the beams entering the cable move trough the core in different paths. It typically used in LAN network.

2.1.11.2 Unguided Media

Unguided media is classification of network media that transmit electronic waves without the presence of physical conductor. This classification of network media also referred to as wireless communication. It incorporate wireless devices communicating with the traditional cable [11], [12]

2.1.11.2.1 Radio Waves

Radio waves are electromagnetic waves ranging between 3 KHz and 1 GHz in frequencies [12].

2.1.12 Transceiver

Referred also as access point, transceiver is a device that used to transmit and receive data between wireless devices or devices and the wired network [11].

2.1.13 Bridges

Bridges is a segmenting and sub netting devices that connect and passes packets between two network segments that use the same protocol [11].

2.1.14 Router

Router is a network layer device that uses one or more metrics to determine the best and the optimal path along which network traffic should be forwarded [11].

2.1.15 Switch

Switch is a network device that filters, forward and floods frames based on the destination of each frame [11].

2.1.16 Sub-Netting

Sub-netting is a process when a network is divided into several smaller groups with each sub-network having their own sub-network [12].

2.1.17 Sub-Network

Sub-network is the network segmented into a series of a smaller network following the sub-netting process and sharing a particular subnet address [12].

2.1.18 Subnet Address

Subnet address is the specified address of an IP address that recognized by the subnet mask as the sub-network [11].

2.1.19 Subnet Mask

Subnet mask is a mask used to extract network and sub-network information from the IP address to distinguish between different sub-network [11], [12].

2.1.20 IP Address

IP address is a dotted decimal format, 32 bit binary address assigned to hosts using TCP/IP that uniquely defines the connection of a host or a router to the Internet, it used by the IP to identify an interface connected to an IP networks [12].

2.1.21 Hosts

According to [11], hosts simply define as a computer or a networked device on a network.

2.1.21 Internet

Internet is a network that combines enterprise networks, users individually and ISP (internet service provider) into single global IP network [10:].

2.1.22 Web Browser

Web browser is an application where an Internet page requested by the end users referring to the web server on the Internet, to be displayed [11].

2.1.23 Hubs

Hub is a hardware or software device that contains multiple independent but connected modules of network and internetwork equipment [12].

2.1.24 Security Technology

2.1.24.1 Firewall

Firewall is network access control device that based on defined network policy, implements access control for a network, it designed to blocked all traffic network access except the authorized allowed access [13], [14].

2.1.24.2 Encryption

Encryption is the process of converting a message and packets into an unintelligible form trough algorithm formula that is unreadable without special knowledge of the formula [13], [14].

2.1.24.3 Decryption

Decryption is the process of converting the encrypted data packets or messages using the applied formula to make it into a readable form after it received [14].

2.1.24.4 Authentication

Authentication is the process used to verify a person or a process as an authorized user and prevents any unauthorized users from gaining access [13]. Password is currently the commonly used mechanism for authentication.

2.1.25 TCP/IP Protocol

According to [11], TCP/IP protocol is the most common network/transport solution networks. TCP/IP considered not only as transport and network protocol but

refers also as a complete suite protocols operate at other layers in the networking model.

2.1.25.1 Network Layer Protocol: IP (Internet Protocol)

IP is the network layer protocol in the TCP/IP protocol stack that offers a connectionless internetwork service. The IP protocols enable routing tasks by using IP address to specific network devices [11].

2.1.25.2 Transport Layer Protocol: TCP and UDP

The transport layer in the TCP/IP protocol includes two-transport layer protocol. The two protocols described below:

- TCP (Transmission Control Protocol)

  TCP is a connection-oriented protocol that establishes a session between two network devices before sending a data. TCP provides a reliable data transmission, and it typically being used in file transfer, web browser and e-mail applications [10], [11].

- UDP (User Datagram Protocol)

  UDP is a connectionless transport protocol typically used in video streaming and DNS (Domain Name System) that exchanged data without any guaranteed delivery but provide low-overhead data delivery [10].

2.1.26 Routing

Routing is the process when a router receives an incoming/outgoing frame, removed/added header information and trailer, then forward to the destination based on IP address [10].

2.1.27 Routing Protocol

Routing protocol is a protocol that used between routers, in which routers shares their information regarding the routing path [10].

2.1.28 Gateway

Gateway is a device or software that used to connect two different and separate networks that used different communication protocols; it acts as an entrance to another network/connection point [11], [12].

2.1.29 Server

Server is a node or software that provides services to the user/clients [12].

2.1.30 GSM

GSM (Global System for Mobile Communication) is a standard technology for mobile telecommunication uses a Time Division Multiple Access (TDMA) based technology considered as circuit switched network with integrated encryption and incorporated key providing privacy and fraud elimination [15], [16].

2.1.31 2G

2G (Second Generation) are the evolution of the telecommunication technology with digitally encrypted voice, and data services (example: GSM) [17].

2.1.32 3G

3G is an evolution telecommunication technology following the 2G technology, that offers simultaneous use of speech and data transfer a higher bit rates, and higher level of quality of services [16].

2.1.33 EDGE

EDGE (Enhanced Data Rates for GSM Evolution) is a backward technology compatible mobile phone technology, with faster transmission rates considered as 3G technology [16].

2.1.34 BTS and BSC

BTS stands for Base Transceiver Station, for the description refer to transceiver explanation discussed earlier. **BSC** (Base Station Controller) is the station that control one or more BTS, for separating different data flows and direct them to the right network [16].

2.1.35 Telecommunication User Identifier

2.1.35.1 SIM

SIM (Subscriber Identity Module) is a credit card shape identifier in identifying the telecommunication users, to retrieve services accordingly, regardless of the end devices [18].

2.1.35.2 IMSI

IMSI (International Mobile Subscriber Identity) is a unique number inserted into the SIM card to identify the telecommunication provider into the mobile network system [18].

2.1.35.3 BlackBerry PIN

BlackBerry PIN (Personal Identifier Number) is a unique eight characters identification number allocated to BlackBerry device. It locked with each BlackBerry device and used differentiate and authenticate each BlackBerry devices [19].

2.1.36 GRX Network

GRX (GPRS Roaming Exchange) is a connection mediator that serves as the hub for GPRS connection for user in attempt to extending their connectivity (roaming), thus eliminated the needs of dedicated link between service providers [20].

2.1.37 GPRS

GPRS (General Packet Radio Services) is a packet switched network service that can be used by the 2G and 3G technology user, with the main feature of faster data transfer, and their always online feature without time limitation [16], [17], [21].

The GPRS core network structure will be discussed in the sub-chapters below:

2.1.37.1 Core Network

The core network provides mobility, transport, and session for packet services in 2G and 3G technologies.
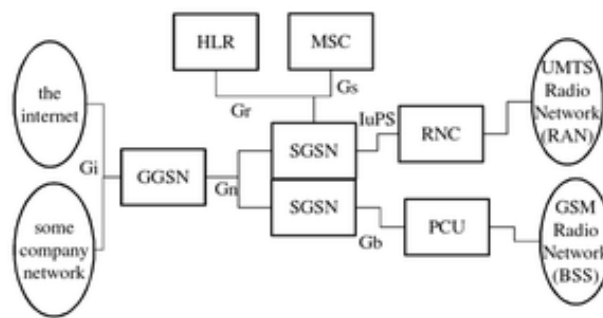

Figure 2. 4 GPRS Core Network [22].

Below are the explanations of the elements in the structure [16]:

- BSS stands for Base Station Subsystem and it refers to BTS.

- RAN (Radio Access Network) is the transceiver for the 3G technology.

- RNC (Radio Network Controller) and PCU (Packet Control Unit), both of this separates packet data and circuit switched data (voice) for 3G and 2G technology.

- GGSN (Gateway GPRS Support Node): responsible for interworking between the external network packet and GPRS network.

- SGSN (Serving GPRS Support Node): Ensure the delivery of the data packet to and from mobile devices in services area.

- HLR (Home Location Registry) is Database of subscribers authorized to use the network and MSC (Mobile Switching Unit) deals with mobile voice matter.

2.1.38 RADIUS

Radius is Remote Access Dial In User Service is the protocol in the networking area that contributed in the authentication, authorization and accounting issues for a mobile device to use the network [16].

2.1.39 GRE Tunnel

GRE (Generic Routing Encapsulation) is a tunneling protocol that used in the network environment to tunnel the traffic. GRE encapsulate a network layer protocol packet types over another, inside the IP tunnels [14]. It does not have any encryption, but does have low overhead tunneling.

2.1.40 APN

APN (Access Point Node) is an identifier consisting two parts (network identifier and operator identifier) that used to identify an IP packet data network that a mobile user want to use, have access to, or to communicate with and also used to define the service type for the user (WAP, MMS) [23].

2.1.41 VRF

VRF (Virtual Routing and Forwarding) is a technology that allows more than one instances of a routing table to exist in the same time, within the same router, which allows same/overlapping addresses can be used without conflicting, as the instances are self reliable [24].

2.1.42 POP3 and IMAP

POP (Post Office Protocol) and IMAP (Internet) are the two most used application layer Internet standard protocol used for receiving e-mail. The protocol used by the local e-mail clients to receive the e-mail from the remote server using a TCP/IP connection [14]. POP3 and IMAP4 is the latest version and also the current standard of used.

2.1.43 Bandwidth

Bandwidth is the measurement of the carrying information capacity of a line or a network [12].

2.2   Theoretical Framework

Based on the presented theory in the theoretical foundation section, a coherent model or formula, which shows the relationship between variables, should be formulated to seek for the solution. This model provided in this section should clarify how the design of solution may be constructed.

2.2.1 Project Lifecycle

According to [4], project lifecycle is a collection of project phases, in detailed it shows the work that needs to be done, who will be doing it, when and what are the **deliverables** (product or services including part of software, technical reports, part of hardware etc, as part of a project) for each phase of the project.

The project lifecycle vary between different industries, but traditionally it divided into four phases: concept, development, implementation, and close out phase [4]. The first two phases referred as project feasibility focusing more on planning rather than the actual work, and the latter two phases focusing in the other way around.

The figure below shows the illustration of a traditional project lifecycle and sample from their deliverables from each phase.

Feasibility   **Acquisition**

| Concept | Development | Implementation | Close-out |

Deliverables:
• Management Plan
•Preliminary Cost
Estimate

Deliverables:
•Project Management
•Budgetary Cost
Estimate

Deliverables:
•Finished Work Packages
•Cost Estimate (Definite)
•Performance Report

Deliverables:
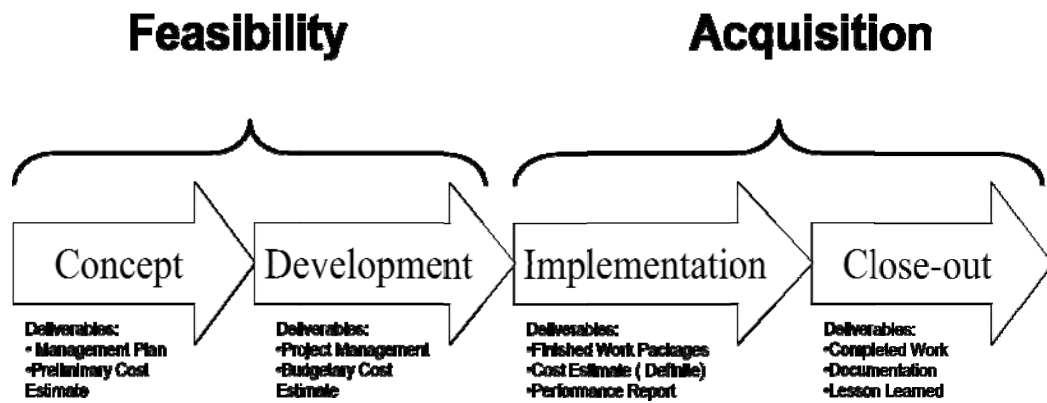•Completed Work
•Documentation
•Lesson Learned

Figure 2. 5 Traditional Project Lifecycle and Sample Deliverables [25].